**From:** Government Services<GovernmentServices@doc.govt.nz>
**Sent on:** Sunday, August 16, 2020 10:21:46 PM
**To:** Ngaire Best<nbest@doc.govt.nz>
**CC:** Yvonna Kerekes<ykerekes@doc.govt.nz>; Mervyn English<menglish@doc.govt.nz>; Bruce Parkes<bparkes@doc.govt.nz>; Graeme Ayres<gayres@doc.govt.nz>; Neal Gordon<Ngordon@doc.govt.nz>; Government Services<GovernmentServices@doc.govt.nz>
**Subject:** 20-B-0645 - Briefing - Request - Governance and management of large and complex projects
**Attachments:** ME Presentation to DGTF (AKLD Islands)_21 July 2020_.pptx (1.28 MB)

Kia ora Ngaire (Please note that I have also copied in Graeme Ayers and Neal Gordon)

Context and purpose

The Minister's office has requested a briefing, see message from Huia Forbes below, which we have assigned to you.
**If you don't think this request sits with you, please inform us asap.**

Outputs and timing

- Please email Government Services a link to the approved document by **27 August 2020**. **Please note this date has been entered by default, and you may wish to discuss the due date with the Private Secretaries if a longer timeframe is needed.**
- We will let you know when hard copies are needed.
- Name the document in docCM as follows:

20-B-0645 – Briefing – Title

- Save attachments to docCM and name them as follows: 20-B-XXXX – Attachment 1 – Title
- You are responsible for setting the **permissions** in docCM – consider who needs access, and **make sure Government Services has full access**

Resources to use to produce quality documents

- Use the current templates and the guidance in them.
- Use the intranet guidance on effective writing for Ministers, including peer review.
- Note that sometimes GS reviews briefings and memos for quality and risk. Should we review your advice, we may suggest changes for you to consider.

Ngā mihi

Gabrielle

**Gabrielle Muir**
Ministerial Support Advisor (Government Services)
Policy & Visitors Group
Department of Conservation - Te Papa Atawhai
M: +64 027 564 0691

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**From:** Huia Forbes <Huia.Forbes@parliament.govt.nz>
**Sent:** Friday, 14 August 2020 4:55 p.m.
**To:** Ngaire Best <nbest@doc.govt.nz>; Government Services <GovernmentServices@doc.govt.nz>
**Cc:** Eoin Moynihan <Eoin.Moynihan@parliament.govt.nz>; Mervyn English <menglish@doc.govt.nz>; Bruce Parkes <bparkes@doc.govt.nz>
**Subject:** Governance and management of large and complex projects

Kia ora,

Yesterday the Minister met with Mervyn English to discuss the review of the Maukahuka Auckland Islands project. I attach a powerpoint presentation from that meeting.

One of the findings was a need to review how large and complex projects are governed and managed. The Minister would like a paper to be prepared that reviews the potential structures for these types of projects in the future.

In particular: what is required to provide effective governance and project management in these large projects?
At the meeting it was noted that those charged with Governance need to have the right set of skills and knowledge so that they understand the role of governance when working under the direction of Ministers and Cabinet as well as the need to be providing proper oversight of the project.
Project management also requires specific skills distinct from those required of technical experts. There was also recognition that those tasked with project management need to have sufficient time to put into the project. An significant issue for the Maukahuka project was the ways in which those tasked with different roles interacted.
Would you be able to prepare a paper that considers options available to DOC when undertaking large projects such as Maukahuka or even some of the large scale Jobs for Nature work such as the Raukūmara. Two options were discussed at the meeting:

- Use an organisation such as Predator Free which has governance through the board and project management expertise at the office. This might require secondment from DOC and would risk becoming disconnected from DOC.
- Setting up a structure within DOC that could deal with internal tensions and ensured those involved had the right skills.

The Minister understands that you are very stretched and wonders if there would be scope for a contractor to undertake the necessary work?
The Minister may also raise the issues with SLT as she considers the governance and management of large, complex and ambitious projects important when we are funding a number across the country.
**Can I suggest you talk to Mervyn to get more context and advise what you think will be possible in this regard – including a timeframe.**
Ngā mihi,
Huia

**Huia Forbes |** Private Secretary (Conservation)
Office of Hon Eugenie Sage
Minister of Conservation | Minister for Land Information | Associate Minister for the Environment
6R Bowen House, Parliament Buildings | Private Bag 18041 | Wellington 6160 | New Zealand
T: +64 4 817 9862 | C: +64 27 620 9710 | E: huia.forbes@parliament.govt.nz

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# Maukahuka Pest Free Auckland Island

## COVID-19 Impact Analysis

Submitted by: Veronika Frank, Project Coordinator

15/4/2020

**File ref:** DOC-6269945

Department of Conservation
Te Papa Atawhai

New Zealand Government

# Initial Impact Analysis

Context:

The following table will enable an initial understanding of the level of impact **caused by the Covid-19 lockdown** on your project. Although full impacts may not yet be known, please endeavour to provide the best information that you have available, or at least an indication of likely impact.

| Impact Type | Impact Analysis | Description of Impact |
|---|---|---|
| 1. Overall impact of Covid-19 lockdown on your project | Amber - Moderate Impact - Project impacted (e.g. time, cost, resources) but NO key delivery milestones will be missed | No immediate impact on resources or deliverables for the remainder of 19/20 but significant risk to funding for 20/21 and winter bait trials on Auckland Island planned for Sep 2020.<br>High level of funding uncertainty for 20/21 (and therefore future of project) as this was due to come from IVL.<br>The field trials have some key dependencies which are impacted by COVID-19: ability to secure shipping services and associated support contracts and a second round of Landcare run feral cat pen trials (These were planned for April but have been delayed due to COVID-19 restrictions, it is unknown when these will be run) |
| | | |
| 2. Will you require additional funding to complete your project? | Yes >25% of Current Budget | Not known yet but potentially require $400k as replacement if previously allocated Year 1 IVL funds are no longer available.<br>Locked in transfer to 20/21 of $250k of Round 1 IVL funds had been previously submitted due to toxic bait trial now falling into new FY (known for months, due to operational requirements not related to COVID), also $150k of Round 1 IVL funds were indicated as IPET to fund the core project team between 30 June and Aug as no other funding for 20/21 has yet been secured. |
| 3. Will your project now run into an additional financial year? | No | IVL IBC was for 19/20 and 20/21 but only funds for 19/20 have been released. |
| 4. Do you have ongoing contractual obligations through the lockdown period? | Yes | No issues. Rent of shipping container for storage, some ongoing research |
| 5. Is your project funded by IVL Tranche 2 money, or any other funding source, that has now been retracted? | Yes - Other | $800k of funding for 19/20 was from Round 1 IVL, $400k of which is now in question.<br>An additional $3.8m of Round 1 IVL funds for year 2 were approved by the three Ministers in August 2019, we have a request with the DG (DOC-6217078) to release $2.2m of this to fund the project in 20/21, the outcome of this is currently unknown |

| | | | | |
|---|---|---|---|---|
| | | We have responded to two requests for economic stimulus work post COVID-19 to fund 20/21 & 21/22 (DOC-6261207, DOC-6265343) as well as contributed to Brent Beaven's work for framework for optimisation of landscape scale work (20/21 – 24/25). | | |
| | | | | |
| 6. Will you need additional time to deliver the project? | No | Dependant on the winter trials proceeding, minimum 26week delay if these did not proceed this winter | | |
| 7. Will you miss any **KEY** delivery milestones? | Yes | Potentially the bait trials on Auckland Island planned for Aug/Sep as these are reliant on securing shipping and associated support services which may not be available. Also affected would be the trial of a prototype flat packed bivvy and site clearance for the Infrastructure program. | | |
| | | | | |
| 8. Have you had to release, or lost, resources from your project due to lockdown? | No | [Briefly describe numbers and types of resources, internal and external] | | |
| 9. If yes to 8, will all/some/ none of the same resources be available to return to the project after lockdown? | Choose an item | [Briefly describe any potential shortfall in pre-lockdown resources, internal and external, once lockdown is lifted] | | |
| 10. Are any of your suppliers/contractors no longer in business? | No | [If Yes, briefly describe any known shortfall in suppliers/contractors and any initial plans to find new suppliers/contractors if known] | | |
| 11. Are Iwi or Hapu resources required for ongoing delivery of project? | Yes | 11a. If Yes to 11, are they still available to your project? | Yes | But very limited |
| | | | | |
| 12. Is there any scope that cannot now be delivered? | No | [Briefly describe scope that cannot now be delivered even with additional time, funding etc. e.g. because of a missed breeding season] | | |
| 13. Are there any Benefits that cannot now be delivered? | No | [Briefly describe benefits that cannot now be delivered even with additional time, funding etc. e.g. because of a missed breeding season] | | |

| | | |
|---|---|---|
| 14. Are there any new risks/issues that could impact the organisation e.g. DOC reputation? | Yes | Risk of losing the current state of readiness if funding for 20/21 is not secured, Contracts for two critical roles end soon: Science Support 30th June and Project Manager 10th July |
| 15. Does your project have any interdependencies? | Yes | Framework for prioritising landscape projects – Martin Kessick<br>Development of cat toxin - Threats Team |
| | | |
| Any other key information, recommendations etc.? | | |

**From:** Leonie Fechney<lfechney@doc.govt.nz>
**Sent on:** Thursday, February 4, 2021 2:25:17 AM
**To:** Rose Hanley-Nickolls<rhanleynickolls@doc.govt.nz>
**Subject:** FW: maukahuka context meeting summary and actions

Ngā mihi nui

**leonie**

**Leonie Fechney**
Acting Director, Partnerships - *Kaihautū Manutātaki*
Department of Conservation -*Te Papa Atawhai*
Level 3, 161 Cashel Street, Christchurch 8011
[redacted]
www.doc.govt.nz
**Conservation leadership for our nature *Tākina te hī, Tiakina, te hā o te Āo Tūroa***

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**From:** Leonie Fechney <lfechney@doc.govt.nz>
**Sent:** Wednesday, 1 April 2020 10:32 AM
**To:** Aaron Fleming <afleming@doc.govt.nz>; Stephen Horn <shorn@doc.govt.nz>; Veronika Frank <vfrank@doc.govt.nz>; Christine Officer <cofficer@doc.govt.nz>; Phillipa Gardner <pkgardner@doc.govt.nz>; Rebecca Brook <rbrook@doc.govt.nz>; Sarah Hucker <shucker@doc.govt.nz>; John McCarroll <jmccarroll@doc.govt.nz>; Dave Wilkins <dwilkins@doc.govt.nz>; Brent Beaven <bbeaven@doc.govt.nz>; Martin Rodd <mrodd@doc.govt.nz>; Justine Solomon <jsolomon@doc.govt.nz>; Estelle Leask <eleask@doc.govt.nz>
**Cc:** Leonie Fechney <lfechney@doc.govt.nz>
**Subject:** maukahuka context meeting summary and actions

Kia ora Maukahuka whanau

Thanks for all tuning in on Monday.

Rebecca – I'll get you to enter it into the main document at some stage □□

Please note that these notes are for internal context only and not for sharing externally as the partner discussion is all verbal at this stage.

Partners Update

- [redacted]) - [redacted] have indicated that they could lead the third party fundraising for this project. Martin had contacted [redacted] before shifting into his role in the Regional IMT covid19 response. He advised that [redacted] considered that the current global situation with covid19 would make fundraising harder but not impossible. What [redacted] need from DOC is our position on Maukahuka in terms of funding commitment. This is not likely to be forthcoming until the landscape restoration prioritisation piece of work is completed (see below under finance).
- Martin has forwarded to [redacted] an information package (which includes the storymaps etc).
- A memo was also prepared for Martin Rodd (with input from Sarah Hucker and John McCarroll) for him to discuss with [redacted] on the departments responsibilities around concessions and coastal permits in the sub-antarctic (this latter piece of work was required because [redacted] were actively engaging with two cruise operators – [redacted] both of whom were keen to support the project).
- The monthly update to partners was sent out by Rebecca for March.
- Learnings from the Te Manahuna Aoraki Partnership with [redacted] is currently being compiled by Phillipa G and she can share her findings verbally with the team once completed.
- In terms of other support for the project from business who may or may not be captured by a dedicated fundraiser [redacted] Christine advised that the business partnerships group has developed a draft business partnership framework.

  **Action:** Christine to circulate to group
- While we await the department's decision on this project:
  1. Development of a set of principles to guide any partner agreement (from the doc and Ngai Tahu perspective) recognising that any agreement needs to be developed with the partner. this needs to be the aim is to only have to rely on the legal agreement his legal document is

only needed when things deteriorate or there is a difference of opinion and that all partnerships should be based on the 'spirit of partnership'

Action: development of partnering agreement principles **lead: Phillipa** – with team members Christine Officer and Estelle Leask

2. Refreshing and testing the set of partnering models (governance, fundraising and delivery) – these were developed by Phillipa G post the partnering design hui and were presented to the Maukahuka Governance Group. The context for developing these was when [redacted] was considered the lead partner. This has now changed and [redacted] has indicated that they will be an investor as opposed to the lead – what this means in reality will become clearer after May when DOC is likely to make a decision around commitment to the various landscape restoration projects. In the interim, please note that these models were developed as DOC and Ngai Tahu partnering with a third party and provide a range of senario's where this could be applied for Maukahuka.
3. Further work on the partnering models

Actions:

- talk through and collect contributions from [redacted] – **lead Phillipa**
- talk through and collect contributions from na Runaka and / te Runanga o Ngai Tahu – **lead Estelle** (noting that Estelle has already initiated this and that Phillipa is there to provide support if required)

Ngai Tahu

- Estelle is working with na Runaka on the *Iwi relationship vision document* for Maukahuka and has sought input from Te Runanga o Ngai Tahu over the partnering models (governance, funding and operational delivery)

Finance

- Still awaiting decision on IVL release of funding for 2020/21
- The landscape restoration prioritisation piece of work (tasked to martin Kessick from SLT / led by Brent Beaven) is deemed essential work within DOC and is still continuing with a completion date of the end of April / May at this point in time. This process is not so much about the IVL now but more focussed on guiding investment decisions in general (pers. comms. Brent Beaven 30th March).

Operational delivery

- Operation Endurance returned.
- Ops team continuing with operational delivery work.

I think that's it ! Apologies if Ive missed anything Im not good at multitasking in terms of writing notes and facilitating the meeting 

Let me know if there is any further context or actions that need to be included.

Stay safe and well.

Nga mihi

Leonie

**Leonie Fechney**
Partnership Manager / Pou Manutātaki
Department of Conservation—*Te Papa Atawhai*
Level 3, 161 Cashel Street, Christchurch 8011
[redacted]
www.doc.govt.nz
**Conservation leadership for our nature *Tākina te hī, Tiakina, te hā o te Āo Tūroa***

**From:** Leonie Fechney<lfechney@doc.govt.nz>
**Sent on:** Thursday, February 4, 2021 2:24:06 AM
**To:** Rose Hanley-Nickolls<rhanleynickolls@doc.govt.nz>
**Subject:** FW: Project Muakahuka - lou's decision

Ngā mihi nui

**leonie**

**Leonie Fechney**
Acting Director, Partnerships - *Kaihautū Manutātaki*
Department of Conservation -*Te Papa Atawhai*
Level 3, 161 Cashel Street, Christchurch 8011
[redacted]
www.doc.govt.nz
**Conservation leadership for our nature *Tākina te hī, Tiakina, te hā o te Āo Tūroa***

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**From:** Leonie Fechney <lfechney@doc.govt.nz>
**Sent:** Tuesday, 21 April 2020 9:03 AM
**To:** Barry Hanson <bhanson@doc.govt.nz>
**Cc:** Leonie Fechney <lfechney@doc.govt.nz>
**Subject:** Project Muakahuka - lou's decision

Here's the email I referred to on Friday

**Leonie Fechney**
Partnership Manager / Pou Manutātaki
Department of Conservation—*Te Papa Atawhai*
Level 3, 161 Cashel Street, Christchurch 8011
[redacted]
**www.doc.govt.nz**
**Conservation leadership for our nature *Tākina te hī, Tiakina, te hā o te Āo Tūroa***

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**From:** Barry Hanson <bhanson@doc.govt.nz>
**Sent:** Tuesday, 14 April 2020 11:46 AM
**To:** Leonie Fechney <lfechney@doc.govt.nz>
**Subject:** FW: Project Muakahuka

FYI

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**From:** Kay Booth <kbooth@doc.govt.nz>
**Sent:** Monday, 13 April 2020 7:19 PM
**To:** Barry Hanson <bhanson@doc.govt.nz>
**Subject:** FW: Project Muakahuka

B – this will deserve a chat me thinks.... Welcome back! k

Kay Booth
Deputy Director-General Partnerships
Department of Conservation *Te Papa Atawhai*
E: kbooth@doc.govt.nz
M: +[redacted]

---

**From:** Lou Sanson <lsanson@doc.govt.nz>
**Sent:** Monday, 13 April 2020 5:47 p.m.
**To:** Michael Slater <mslater@doc.govt.nz>
**Cc:** Rachel Bruce (DDG) <rhbruce@doc.govt.nz>; Kay Booth <kbooth@doc.govt.nz>; Martin Kessick <mkessick@doc.govt.nz>; Mervyn English <menglish@doc.govt.nz>
**Subject:** Project Muakahuka

Thanks All

My decsion is to secure staff at cost provided by Mike for 12 months. I will then sign that amount across from IVL.

Kay will advance new Governance structure for PF Rakiura as number one priority for Barry [redacted]

Mervyn to advise on PF Rakiura governance structure.

Aaron will lead Treaty Partner engagement as TM to Barry.

Mike will look at how many of the 20 permanent staff and seasonals can move across onto the new PF Rakiura work as our key driver of Biodiversity work on Rakiura ( eg Tin Range dotterls becomes a key part of PF Rakiura.)
Great to get to this decsion.
Sincere thanks to Martin for advice and Mike and Kay's work to date.
Lou
Lou Sanson
Director-General | Tumuaki Ahurei
Department of Conservation | Te Papa Atawhai
On 13/04/2020 11:49 am, Michael Slater <mslater@doc.govt.nz> wrote:
Hi
I need to talk to you about this as it is dribbling on.I think we are ready to make a clear decision about Maukahuka -ie it is on hold for the next few years until such time as the funding environment changes and full funding for this particular project is secured.The work to date is not lost as the concept and piloting work done is still valid and the project is ready to go now to implementation once funding is secured.
Most of the Maukahuka team have contracts through to June and are now actively looking for other work given our inability to give them employment security beyond June.If we want to (as we have all discussed) secure them as a specialized technical team to now refocus into PF Rakiura then you do need to sign that funding memo as we had previously agreed.The only issue at that point that you had was in regard to the location for the cat trial.I thought you were going to sign the memo(that secures the team) with a qualifier that your approval was subject to resolving the location of the cat trial work(ie could it be done at Rakiura as part of that programme).
So to get this moving with some clarity around our priorities why dont we agree this afternoon that
1.Maukahuka is officially on hold for next few years till funding environment secured.
2.PFRakiura remains one of our top priority Landscape PF projects and we will refocus attention there
3.As a result of 1 and 2 we secure the current Maukahuka technical team to refocus their attention on to PF Rakiura
4.As result of 1,2,and 3 you now sign the drawdown memo for $2.2mill IVL (already approved as part of Tranche 1) to allow above to occur with a qualification around location for cat trial if you consider that essential.
This has hung around long enough and has probably frustrated us all to a fair degree.
Let's nail this this afternoon if at all possible.
Cheers Mike
Sent from Workspace ONE Boxer
On 13/04/2020 10:15 am, Lou Sanson <lsanson@doc.govt.nz> wrote:
Hi
I haven't signed release of $2.2mill from IVL for PF Maukahuka given Martin's recommendation to me on landscape project prioritisation on 1 April.
I assume Kay is getting PF Rakiura established so we can transfer some of staff with permanent or contracts to end of their contracts.
Is this all correct?
Lou
Lou Sanson
Director-General | Tumuaki Ahurei
Department of Conservation | Te Papa Atawhai

**From:** Aaron Fleming<afleming@doc.govt.nz>
**Sent on:** Wednesday, April 15, 2020 4:15:49 AM
**To:** Lou Sanson<lsanson@doc.govt.nz>; Michael Slater<mslater@doc.govt.nz>; Kay Booth<kbooth@doc.govt.nz>; Barry Hanson<bhanson@doc.govt.nz>; Martin Rodd<mrodd@doc.govt.nz>; John McCarroll<jmccarroll@doc.govt.nz>
**CC:** Sandra Griffiths<sgriffiths@doc.govt.nz>
**Subject:** Maukahuka - next steps
**Urgent:** High

Hey all,
As context, following the SLT decision to pause Maukahuka the following has happened:

- John and I met with Stephen Horn who is naturally disappointed at the news, but understands why the decision was made
- Barry, Martin, John and I have met to discuss the sequence of stakeholder/staff conversations to occur over the next 24-48 hours
- John is supporting Stephen with a reshape of the IVL release memo to focus on the staff resourcing through to June 2021. This will include a stabilising of the Maukahuka project and a transition from Maukahuka through to PF Rakiura

We have assigned leads for the following conversations to occur over the next 24-48 hours, and drafted some short key messaging:

- Ta Tipene (he had a special interest in Maukahuka and narrated the video) – **Lou are you happy to phone Ta Tipene tomorrow in a mana to mana approach?**
- Maukahuka team – **Aaron leading,** 3pm tomorrow
- PF Rakiura Leadeship Group incl Paul Norris – **Barry leading,** Paul Norris esp prior to 3pm tomorrow so Bridget Carter is informed
- Treaty Partner – **Aaron leading** – phone conversations with Gail, Michael, Stewart, Sarah Wilson tomorrow
- Maukahuka Governance Group – **Aaron leading** - by email once Gail is informed
- [redacted] **– Martin Leading** – after 12pm tomorrow

Key Messages:

- DOC has needed to reassess its approach to southern landscape predator control programmes with our new COVID-19 environment and context.
- Amazing work has been achieved over the past few years on preparing Maukahuka for success, and the team working on this project have done an incredible job.
- With COVID-19, right now is unfortunately not the time to further progress Maukahuka towards an implementation phase, and DOC will be looking to stabilise and pause the project so that it can be picked up again as economic conditions allow.
- This has created an opportunity for the resources previously committed on Maukahuka, including team members should they wish to, to be transitioned towards assisting with the design phase for Predator Free Rakiura to further understand what the work for the next phase of this project will look like. This will be done in partnership with others and further work needs to be done to shape this up.

Thanks for your support for what is a challenging time for the team who have worked really hard on Maukahuka over a number of years.
Aaron

**Aaron Fleming**
**Kaihautū Matarautaki** *Director Operations – Southern South Island*
**Te Papa Atawhai** *Department of Conservation*
Whakatipu-wai-Māori Office
1 Arthurs Point Road | PO Box 811 | Queenstown 9348
[redacted] | E: afleming@doc.govt.nz | W: doc.govt.nz
**Kaiawhina-Manahautu** *PA*: Alison Mountney amountney@doc.govt.nz

**From:** Aaron Fleming<afleming@doc.govt.nz>
**Sent on:** Friday, May 29, 2020 5:01:51 AM
**To:** Brent Beaven<bbeaven@doc.govt.nz>; Martin Rodd<mrodd@doc.govt.nz>
**Subject:** RE: Project Muakahuka - future work

Yup that is probably best. Nothing but support today for the Kaupapa.
Only criticism is that DOC decided to pause Maukahuka without consulting with Treaty Partner

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**From:** Brent Beaven <bbeaven@doc.govt.nz>
**Sent:** Friday, 29 May 2020 8:33 a.m.
**To:** Martin Rodd <mrodd@doc.govt.nz>; Aaron Fleming <afleming@doc.govt.nz>
**Subject:** RE: Project Muakahuka - future work
Great.
Will that be our standing approach Aaron? I will presume so unless I hear otherwise from you.
Quite happy to engage in person at any point if they would like.
BB

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**From:** Martin Rodd <mrodd@doc.govt.nz>
**Sent:** Friday, 29 May 2020 8:14 a.m.
**To:** Brent Beaven <bbeaven@doc.govt.nz>
**Subject:** FW: Project Muakahuka - future work
Hey Brent – just checking you received this note, Aaron will talk Maukahuka with KR today.
M

---

**From:** Aaron Fleming <afleming@doc.govt.nz>
**Sent:** Thursday, 28 May 2020 4:50 PM
**To:** Martin Rodd <mrodd@doc.govt.nz>; Barry Hanson <bhanson@doc.govt.nz>
**Subject:** FW: Project Muakahuka - future work
KR tomorrow and I'll give a verbal update
Aaron Fleming Te Papa Atawhai (sent from mobile device)
On 28/05/2020 4:24 PM, Martin Rodd <mrodd@doc.govt.nz> wrote:
Clearly this is your call. As a contribution, I'd work through John and the Rūnanga.
Best
Martin

---

**From:** Brent Beaven <bbeaven@doc.govt.nz>
**Sent:** Thursday, 28 May 2020 4:21 PM
**To:** Barry Hanson <bhanson@doc.govt.nz>; Aaron Fleming <afleming@doc.govt.nz>; Martin Rodd <mrodd@doc.govt.nz
>
**Subject:** FW: Project Muakahuka - future work
The one group that I'm not communicating with is Ngai Tahu. What is your recommended approach here? Would you like to forward my updates, or do you want me to connect directly?
BB

---

**From:** Brent Beaven
**Sent:** Thursday, 28 May 2020 11:41 a.m.
**To:** Barry Hanson <bhanson@doc.govt.nz>; Martin Rodd <mrodd@doc.govt.nz>; David Talbot <dtalbot@doc.govt.nz>; Aaron Fleming <afleming@doc.govt.nz>; Julie Knauf <jknauf@doc.govt.nz>; Amber Bill <abill@doc.govt.nz>; Ben Reddiex <breddiex@doc.govt.nz>; Hilary Aikman <haikman@doc.govt.nz>; John McCarroll <jmccarroll@doc.govt.nz>; Leonie Fechney <lfechney@doc.govt.nz>
**Cc:** Martin Kessick <mkessick@doc.govt.nz>; Kay Booth <kbooth@doc.govt.nz>; Michael Slater <mslater@doc.govt.nz>
**Subject:** Project Muakahuka - future work
Hi
I want to keep you in the loop on progress with the work I am doing on the Maukahuka project. In summary, Lou has tasked the Biodiversity Group with developing advice on what an effective forward work programme could look like for the Maukahuka team. This will include the proposed "Moth Balling" actions as well as what projects (such as Rakiura) could form an effective pipeline of work for this team.
Update:

- Lou has now signed off the IVL funding release memo that will enable a "soft pause" on the project. This funding enables the completion of tasks that are in train to pause the project so that knowledge isn't lost. It is expected that the "pause" work will keep the team occupied for the next 8 months or so.

- Lyndsay Murray has agreed to help me with the task around developing a future workplan. Lyndsay will have connected with most of you by now to see if you want to have a chat and how that might best work for you. This first stage, we are thinking of as "capture" and will be connecting with the team, managers, partnership group, tools to market team….and anyone else we get directed to on the way. The aim is to clearly gather up the skills of the team and thus what would be the "right" work, as well as what the opportunities and "must dos" are. Once we have gathered / captured all of these, we will look to sift and sort them into a potential "pipeline" of work. Mervyn's review will become a key input to this work as we seek to align any governance recommendations against a proposed work programme to ensure alignment.
- To date, this task has been issued via a series of emails and discussions. I will pull this together into one written task assignment by the end of this week and make this available so that it is clearer what the work is.
- We are meeting with the Maukahuka team on a fortnightly basis to keep them informed on how this work is developing. They are also heavily involved in the "Capture" process.

I have kept this email purposely short as I know you are all super busy and know most of the context. Nevertheless, I am always happy to field questions, concerns or critical issues. If you need to know more I am only an email or phone call away.

Best regards,
Brent

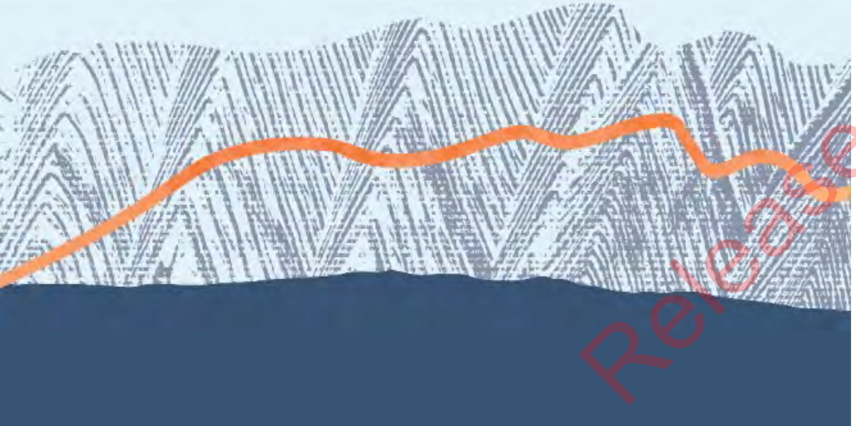
**Brent Beaven**
Director PF2050
Department of Conservation - *Te Papa Atawhai*
M: +64 21 394 321
**Conservation for prosperity** ***Tiakina te taiao, kia puawai***
[www.doc.govt.nz](http://www.doc.govt.nz)

# The “Pause” Decision

- No clear responsibility for who should make a formal recommendation to DG on pausing, or similar major project decision.
- MOC not consulted, Project Team surprised.
- Limited paper trail for decision – Bio DDG priority.
- Now good work being done on how to use work in progress.

# Key Requirements

## Looking forward ...



- From initiation, establish stage-gated plan that has funding as integral, including sources.
- Experience and skills in setting up new entities – externally sourced.
- A governance group with full authority to guide DDGs.
- Separation of governance, technical advisory and management.
- Strong local connections critical.
- Project leads report direct to Governance Board.
- External experience with new skills mentors internal staff.

## Sandra Griffiths

**From:** Lou Sanson
**Sent:** Wednesday, 29 April 2020 9:15 p.m.
**To:** Martin Kessick
**Subject:** RE: Project Muakahuka Governance Review

Great idea.
In context a key reason even before Covid of need to pause Maukahuka was the Philanthropy Strategy looked to bearing no return and Nov 2019 decsion by NEXT to pull out also. Impt this is in here.
In reality I think Mervyns governance review will find the Philsnthropy part was being led by staff with no capability to do this work

Lou Sanson
Director-General | Tumuaki Ahurei
Department of Conservation | Te Papa Atawhai

On 28/04/2020 4:49 pm, Martin Kessick <mkessick@doc.govt.nz> wrote:
Kia ora Lou,

Further to our phone call, here is my thinking to date on the approach I'd like to recommend to you post Maukahuka. This email is currently with Mike & Kay for comment and CIs. Don't share it any further at present as it may change. It would be helpful if you think this aligns with what is needed.

Kia ora both,

I'm contemplating sending the email below to Lou in relation to his questions about Maukahuka. Apologies for the detail but I have been doing a lot of thinking about this and had a few conversations with my team as well. I've set out a number of suggested tasks that I hope will allow us all to move forward (while working to the respective parts of the accountability triangle). These tasks are for both near & long term horizons.

I'm happy to have a follow up discussion before I send this to Lou. I feel we need to move on this quite quickly.

Regards

> Kia ora Lou,
>
> I think it's a good idea for Mervyn to conduct the review. Brent and I will be happy to have a chat to him and forward any relevant emails or information that we have. While Mervyn is conducting that review we do need to move forward with our PF Islands work and I believe there is a great opportunity for my team to provide some additional advice on the SSI Biodiversity programme at the same time.
>
> Unusually I'm going to start this email with a recommended way forward through a set of tasks. The reasoning follows the tasks to try to keep this brief and focused on your first read:
>
> 1. We need better Comm's to communicate the Maukahuka 'pause' decision (**SPA - Ops with CEU support**).
> 2. There are some Maukahuka 'close out' or 'mothball' steps that we need to take to realise the investment we've made (and there are IVL funds that can be drawn down to do this) (**SPA advice – Bio with Op's support. SPA delivery thereafter Op's with Biop support**).
> 3. A review of the approach to our Maukahuka programme is supported (**SPA - Chief of Governance with Ops, P'ships & Bio support**)
> 4. There is a need for my team to provide some additional strategic advice on the implementation of the previous LS Scale Investment strategy (**SPA - Bio Group with Op's & P'ship support**).
> 5. Such advice would include a recommended way forward on South Westland (which could be our next 'flagship'2050 programme) and Rakiura (which could be a project to bundle up for PF Ltd to commission

and build independently with iwi, the community & stakeholders). (**SPA advice – Bio with Op's & PF Ltd support**)

6. We could use the opportunity to review the wider Southern Winds programme in SSI and Island Strategy (**SPA advice - Bio with Op's support. SPA delivery – Op's with Bio support**).

A summary of the thinking is set out below

Context

- You made the call to 'pause' the Maukahuka project based on strategic advice from the Bio Group and having received CIs from the relevant DDGs.
- As I understand it, your decision was based around the impact of Covid 19 on funding streams (Maukahuka was heavily dependent on partner funds & the IVL, which is in the proves of being repurposed) the likelihood that DOC will incur a baseline reduction in the 2020/21 FY & the signal from government that it wants to invest in projects that create employment where there is likely to be growing unemployment (making the optics of an investment in the subantarctics at this time challenging).
- The decision was to "pause" Maukahuka, not stop it.
- The plan is to keep the team engaged in relevant work until Maukahuka can be recommissioned in a few years.
- One option you considered was to redeploy the team on other Island eradication work such as Predator Free Rakiura.
- You have now received additional CIs post your decision and you have decided to conduct a review of the Maukahuka Programme.

Critical Issues

- HT learn from the communication of your decision? Was there a task assignment for Ops to lead the Comm's? Aaron has told the team via Leader led, but I'm unsure whether there was/is a Comm's plan for communicating with all DOC, partners, iwi, public. It feels like it might just be drifting out through those involved in hearing it from Aaron. Do you need to task Operations for a 'complete' Comm's package to be developed? I'm very happy for CEU to support that. Task 1 above - Within the next 3 days
- HT engage the Maukahuka Team? I understand that you've heard from Stephen that the team are aggrieved that they didn't have an opportunity to engage on the decision making process. They also raise CIs around not closing out the Maukahuka programme properly. Maukahuka has a lot of momentum and projects in train. To pause this programme in a mannere that ensures it can be successfully restarted requires some further investment. I would suggest that you task my team to provide you a 'close out' or 'mothball' programme for Maukahuka that allows us to identify how we 'bank' what we've invested and extract maximum value from that investment. Task 2 above - Within the next 5 days
- HT ensure we learn as much as we can from the Maukahuka 'muddle'? The programme has Op, P'ships & Bio ownership of different elements of the work but no clear overall SPA. You have heard from Stephen that; there were identified issues with it sitting as a local, as opposed to national project, the project lead was a T5 who had to report to a District Manager to a very busy regional director who was struggling to find time and connect with Wellington office, delegations for decisions were sitting at the wrong levels (delaying decisions and progress). A straight shift to another project without sorting out these underlying structural issues will simply replicate the muddle. You have commissioned the Chief of Governance to undertake a review of the programme. Task 3 above (which I assume you have set with Mervyn) - Bio Group is happy to support the review over the coming weeks.
- HT ensure we redeploy the Maukahuka team on the right set of PF tasks until Maukahuka can be recommissioned? Rakiura by itself is not ready for this sort of team. Rakiura is a community led project and the next stages are focussed around planning and some field trials. The team is an ill-fit for this type of project and we will likely lose most of them unless we can move them to a more 'delivery ready' programme of PF work. See contribution paragraphs below.

Contributions

- We need to decide a way forward for the implementation of the landscape scale investment plan while also ensuring we realise the investment to date in programmes like Maukahuka and the SSI delivery team. I think that the PF 2050 & Threats Units within my Group are well placed to start that work for Op's. Task 4 above – SPA Bio with support from Op's & P'ships.

- We should also take the opportunity to simplify, or 'de-muddle' the approach within which that team has been operating. This will no doubt be the focus for Mervyn's task and it is likely that the Bio Group contribution to his review will be to suggest that a national team (similar to Tiakina Nga Manu) focussed on eradication be considered (Such a national team could develop a pipeline of projects. Rakiura by itself is not currently the answer, but would be part of the sequencing with perhaps some planning and pilot trial support for Rakiura and the Chathams (and maybe Coromandel, Bluff and Te Manahuna Aoraki) and a budget to progress eradication on the remainder of the offshore islands around NZ over the next 5 years, then pick up Maukahuka again and then our next PF2050 projects (Rakiura or Chathams implementation?). I am getting a head of the review slightly but want to seed the idea of lifting Island eradication to a national level and reduce the complexity for Op's teams trying to hold all this together.
- In the interim however, I think that Op's would benefit from my Group (not just PF & Threats Units but other disciplines) looking at Rakiura, South Westland and the entire SSI island bio programme. Tasks 5 & 6 above – SPA Bio with support from Op's.
- There is one additional thought to perhaps consider. A number of our key PF partners & stakeholders have expressed a desire to move Rakiura forward at pace (these include PF Ltd, NEXT & ZIP). We could consider 'handing over' Rakiura as a PF project to be run and administered by PF Ltd. This would obviously take some working through and clarification of roles but it would provide them with a flagship project of their own that they could invest in and prove the success of the model that they promote. I simply offer this as a different way of thinking about our partner contributions. Any steps we take here would have to include Ngai Tahu as well as the strong community interest in the programme.

I would be very happy to discuss this further and would hope that we could at least commission tasks 1 to 4 above.

Regards

**Martin Kessick**
Deputy Director-General, Biodiversity— *Tumuaki Kāhui Kanorau Koiora*
Department of Conservation—*Te Papa Atawhai*
[redacted]

**From:** Lou Sanson <lsanson@doc.govt.nz>
**Sent:** Monday, 27 April 2020 10:18 a.m.
**To:** Martin Kessick <mkessick@doc.govt.nz>
**Cc:** Kay Booth <kbooth@doc.govt.nz>; Michael Slater <mslater@doc.govt.nz>; Aaron Fleming <afleming@doc.govt.nz>; Barry Hanson <bhanson@doc.govt.nz>
**Subject:** Project Muakahuka Governance Review

Morena
We will get Mervyn to complete the review I promised to Stephen Horn as part of putting Project Muakahuka on hold. It will be focussed on Governance
The biodiversity issues Stephen raises ( PF Rakiura practical? Titi Islands instead? Finish PAPP Trial? Fiordland Reprioritised Biod Plan now urgent) are in reality Martin's work of role and will be picked up in his Stretch Goal Pathway.
Could you pse send Mervyn the task assignments to Aaron and Barry , along with current Governance structure so he can phone each of you and the respective task team leaders.
Any critical issues let me know.
Cheers
Lou

Lou Sanson
Director-General | Tumuaki Ahurei
Department of Conservation | Te Papa Atawhai

**Sandra Griffiths**

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**From:** Lou Sanson
**Sent:** Monday, 13 April 2020 5:47 p.m.
**To:** Michael Slater
**Cc:** Rachel Bruce (DDG); Kay Booth; Martin Kessick; Mervyn English
**Subject:** Project Muakahuka

Thanks All
My decsion is to secure staff at cost provided by Mike for 12 months. I will then sign that amount across from IVL.
Kay will advance new Governance structure for PF Rakiura as number one priority for Barry ( with Ed Chignall and Devon McClean, Sam Morgan - has offered $28 mill)
Mervyn to advise on PF Rakiura governance structure.
Aaron will lead Treaty Partner engagement as TM to Barry.
Mike will look at how many of the 20 permanent staff and seasonals can move across onto the new PF Rakiura work as our key driver of Biodiversity work on Rakiura ( eg Tin Range dotterls becomes a key part of PF Rakiura.)
Great to get to this decsion.
Sincere thanks to Martin for advice and Mike and Kay's work to date.
Lou

Lou Sanson
Director-General | Tumuaki Ahurei
Department of Conservation | Te Papa Atawhai

On 13/04/2020 11:49 am, Michael Slater <mslater@doc.govt.nz> wrote:
Hi
I need to talk to you about this as it is dribbling on.I think we are ready to make a clear decision about Maukahuka -ie it is on hold for the next few years until such time as the funding environment changes and full funding for this particular project is secured.The work to date is not lost as the concept and piloting work done is still valid and the project is ready to go now to implementation once funding is secured.
Most of the Maukahuka team have contracts through to June and are now actively looking for other work given our inability to give them employment security beyond June.If we want to (as we have all discussed) secure them as a specialized technical team to now refocus into PF Rakiura then you do need to sign that funding memo as we had previously agreed.The only issue at that point that you had was in regard to the location for the cat trial.I thought you were going to sign the memo(that secures the team) with a qualifier that your approval was subject to resolving the location of the cat trial work(ie could it be done at Rakiura as part of that programme).
So to get this moving with some clarity around our priorities why dont we agree this afternoon that
1.Maukahuka is officially on hold for next few years till funding environment secured.
2.PFRakiura remains one of our top priority Landscape PF projects and we will refocus attention there
3.As a result of 1 and 2 we secure the current Maukahuka technical team to refocus their attention on to PF Rakiura
4.As result of 1,2,and 3 you now sign the drawdown memo for $2.2mill IVL (already approved as part of Tranche 1) to allow above to occur with a qualification around location for cat trial if you consider that essential.

This has hung around long enough and has probably frustrated us all to a fair degree.
Let's nail this this afternoon if at all possible.
Cheers Mike

Sent from Workspace ONE Boxer

On 13/04/2020 10:15 am, Lou Sanson <lsanson@doc.govt.nz> wrote:
Hi
I haven't signed release of $2.2mill from IVL for PF Maukahuka given Martin's recommendation to me on landscape project prioritisation on 1 April.

**From:** Martin Kessick<mkessick@doc.govt.nz>
**Sent on:** Saturday, April 4, 2020 11:49:24 PM
**To:** Michael Slater<mslater@doc.govt.nz>
**Subject:** FW: Landscape Scale Investment Advice
**Attachments:** Ranking landscape scale sites based on their biodiversity benefits - DOC-6255385.docx (505.44 KB)

Kia ora Mike,
Here is the first of a few emails I intend to send Lou today (cc to Ken, Kay & Peter). This one describes the first outcome from the landscape scale investment plan that Brent has been developing over the past few weeks (that we provided an update from at Pounui).
In short, we are saying that The top four landscape sites for current investment are: Coromandel, Chatham Islands, Rakiura and Te Manahuna Aoraki. We would defer Auckland Islands (for perhaps as long as five years with the team being employed to undertake an island eradication programme) and [redacted]
The team used landscape-scale sites identified as part of the broader landscape-scale investment plan work. This included using the existing "Ecological Resilience" sites identified under the Tomorrow Accord between DOC and the NEXT foundation, as well asking for contributions from Operations, Biodiversity and Partnership Groups.

Lou is desperate for this and, in its absence, is 'casting the die' through his conversations both internally and externally. Unless you have a major allergic reaction I would like to get this away to bring some of what he is thinking and saying into the basic elements of a strategic frame. There are obviously many more conversations to come.
Kia ora Lou,
I'm really pleased to provide you with the first proposed strategic decisions from the landscape scale investment plan that Brent has been developing over the past few weeks.
The team supporting this work has used landscape-scale sites identified as part of the broader landscape-scale investment plan work. This included using the existing "Ecological Resilience" sites identified under the Tomorrow Accord between DOC and the NEXT foundation, as well asking for contributions from Operations, Biodiversity and Partnership Group. The outcome of this work is attached as a ranking of landscape sites based on their biodiversity value. What Brent and I have then done is apply our judgment, to come up with some recommendations, after applying what we know about the following lenses;

- the broader context of other Groups,
- our discussions with you,
- our treaty partner preferences and opportunities,
- our philanthropic partners emphasis and,
- our current COVID reality

I have tried to describe the approach and our recommendations below. You do not need to read the attached technical paper but it is interesting. It highlights a list of the landscape management sites that, if managed, would give the biggest biodiversity return; but also provides a list of top ecosystems and top catchments. If we focussed our work around these most impactful areas, we would have quite a different looking approach to conservation and something that I will be taking into the finalisation of the Biodiversity pathway and more detailed discussion with Mike and Kay.

**The Technical Output**
The sites in the table below are ranked in order from high ecological integrity to low ecological integrity ("EI"). Basically, sites with high EI scores provide for the greatest biodiversity gain when management is applied across listed pressures – i.e., ecological integrity is maximised. This table has 12 landscape-scale projects to choose from. The advice of my Group is that if we reordered on the basis of readiness; the Maukahuka and Te Manahuna Aoraki projects are ready or near ready for long-term investment, and the Chathams, Coromandel, Rakiura and possibly Kahurangi are ready to consider for 3-4 years of scoping.
This is the 'pure' Biodiversity Group advice and is not completely reflected in our recommendations below.

| ProjectName | EI (NoMgmt) | EI (\ Mg |
|---|---|---|
| Auckland Island/Maukahuka | 0.364 | 1 |
| Fiordland South | 0.36 | 0.7 |

| | | |
|---|---|---|
| **Coromandel Peninsula - Moehau to Karangahake** | 0.251 | 0.6 |
| **Pureora** | 0.324 | 0.6 |
| **The Chathams** | 0.298 | 0.6 |
| **Northland Kaitaia** | 0.259 | 0.5 |
| **Taranaki** | 0.322 | 0.6 |
| **South Westland** | 0.438 | 0.6 |
| **Te Manahuna Aoraki** | 0.416 | 0.6 |
| **The Kahurangi Project (Kahurangi o Mohua)** | 0.337 | 0.5 |
| **Predator Free Rakiura** | 0.372 | 0.5 |
| **Waiau toa Molesworth** | 0.323 | 0.4 |

* Once costs determined, investment readiness will be 'ready'

^ Assumed 50:50 cost split with partners

What the Biodiversity Group is saying is that:

- Selecting any of the projects off any of these lists will work towards overarching goals of gaining the most return for biodiversity.
- Selecting any similar projects not on these lists will undermine those gains and is not recommended.
- Final project selection will depend on working with our Partner, funds available, testing delivery preferences with Operations (capability, capacity etc), and feasibility of all proposed actions. In other words, a good social process. We have not yet undertaken these steps.

NB. A combined “offshore island” programme was put up for consideration, but didn’t fit the final definition of landscape. However, the grouped islands project are already the highest ranked EMUs – no further impact justification to work on these is needed, they just aren’t landscape-scale work. They are worthy of investment, are a PF 2050 interim goal and will appear on the Biodiversity pathway.

**Recommendations**

With the information we have, before full social process and as our best Biodiversity advice to you for integration where needed, our advice is.

1. The top four landscape sites for current investment are: Coromandel, Chatham Islands, Rakiura and Te Manahuna Aoraki.
2. While Auckland Island has the highest EI and is ranked number 1, with the country heading into a prolonged recession, a prolonged disruption to services, the requirement to make jobs available close to home and global financial recession making fundraising difficult, we recommend that we press pause on the Auckland Island for 5 years (This is not a stop, but a pause).
3. The equivalent spend to Auckland Islands across the next five years could set the Readiness stage (full business case, detailed plan and field verification trials) completed for Chatham Island and Rakiura as well as completing an eradication programme on the last 20 offshore islands.
4. The funding level that we were looking at for the Auckland Islands ($20m across 5 years) can create a broader suite of biodiversity and job creation benefits across the country.
5. The Auckland Island team could be redeployed onto the offshore islands work, maintaining and building the skill set (and supplier skill set). After five years, this eradication “centre of excellence” can be used to deliver Chatham Island, Rakiura and/or Auckland Islands, and then build toward our mainland eradication sites that will follow.
6. At the end of five years, Chatham Island and Rakiura would be ready to implement a full eradication programme and these two projects would directly employ a number of FTEs pa for five years.
7. [redacted]. Further investment here meets a diminishing returns model – we will not get the same impact as using that funding elsewhere. Added to that is the gap in new technology – we would be accelerating the current, most expensive methods.
8. The Islands programme should also be considered for investment as high biodiversity benefit.
9. Further investment to create employment should use this group of lists to guide locations to achieve the most biodiversity benefit.

We are now engaging with Kay to test this against her pathway work and with Mike for any additional context and to identify any CIs in how this work would be tasked to deliver.

Regards
**Martin Kessick**
Deputy Director-General, Biodiversity— *Tumuaki Kāhui Kanorau Koiora*
Department of Conservation—*Te Papa Atawhai*
[redacted]

**From:** Martin Kessick<mkessick@doc.govt.nz>
**Sent on:** Monday, April 13, 2020 12:14:28 AM
**To:** Lou Sanson<lsanson@doc.govt.nz>
**CC:** Kay Booth<kbooth@doc.govt.nz>; Michael Slater<mslater@doc.govt.nz>; Mervyn English<menglish@doc.govt.nz>
**Subject:** FW: Landscape Scale Investment Advice
**Attachments:** CI's from PG.docx (18.15 KB)

Kia ora Lou,
Since I forwarded this advice to you I've received CIs from my colleagues. I've set these out below (and note that with the exception of only one CI – [redacted] – the rest have been reconciled in my advice to you (integration is complete in my view but for that one location):

DDG Support

1. Support for the work completed, the approach taken and the assessments made in the Biodiversity advice provided to you (all).
2. Agreement with the top 4 sites for current investment, ie. **Coromandel, Chatham Islands, Rakiura, and Te Manahuna Aoraki** (all).
3. Agreement that **Maukahuka/Auckland Island** be deferred (all).

DDG CIs for Reconciling

4. [redacted]
5. Request to include **Southern Fiordland & South Westland** (Mike).
6. Request to undertake scoping exercises for **Southern Fiordland, South Westland** & **Te Paki** (Kay).

CIs for delivery tasks to Partnerships & Operations

7. Identified CIs addressing aspects of project implementation are described in the attached memo (Kay).

It is also worth noting that the assessment provided by the Biodiversity Group does not; apply for urban landscape projects (with high engagement value) or consider a range of existing landscape projects (some of which sit outside this assessment (eg. Te Hoiere/Pelorus catchment) (Kay). This will be built in to future assessments as part of the continuing Biodiversity pathway work.

Final Biodiversity Recommendations

- The assessment is supported by DDGs and there is agreement that **Coromandel, Chatham Islands, Rakiura, and Te Manahuna Aoraki** proceed while **Maukahuka/Auckland Island** pause for at least 2 to 3 years.
- I would be happy to support the additional inclusion of **Southern Fiordland, South Westland** & **Te Paki** for identification as optimised sites for further investment (noting that the CIs raised are capable of being addressed through the appropriate delivery tasks that you will now set with both the Partnerships & Operations Groups if you accept this advice).

The only site that will need further discussion and integration across business groups is Taranaki. I am sure that all DDGs would be happy to be team members to you in deciding how & whether to approach decisions about the future size, scale & nature of further investment at this site.
Regards
**Martin Kessick**
Deputy Director-General, Biodiversity— *Tumuaki Kāhui Kanorau Koiora*
Department of Conservation—*Te Papa Atawhai*
[redacted]

**From:** Martin Kessick <mkessick@doc.govt.nz>
**Sent:** Sunday, 5 April 2020 3:16 p.m.
**To:** Lou Sanson <lsanson@doc.govt.nz>
**Cc:** Michael Slater <mslater@doc.govt.nz>; Kay Booth <kbooth@doc.govt.nz>; Ken Hughey <khughey@doc.govt.nz>; Peter Brunt <pbrunt@doc.govt.nz>
**Subject:** Landscape Scale Investment Advice
**Importance:** High
Kia ora Lou,
I'm really pleased to provide you with the first proposed strategic decisions from the landscape scale investment plan that Brent has been developing over the past few weeks.
The team supporting this work has used landscape-scale sites identified as part of the broader landscape-scale investment plan work. This included using the existing "Ecological Resilience" sites identified under the Tomorrow Accord between DOC and the NEXT foundation, as well asking for contributions from Operations, Biodiversity and Partnership Group. The outcome of this work is attached as a ranking of landscape sites based on their biodiversity value. What Brent and I have then done is apply our judgment, to come up with some recommendations, after applying what we know about the following lenses;

- the broader context of other Groups,
- our discussions with you,
- our treaty partner preferences and opportunities,
- our philanthropic partners emphasis and,
- our current COVID reality

I have tried to describe the approach and our recommendations below. You do not need to read the attached technical paper but it is interesting. It highlights a list of the landscape management sites that, if managed, would give the biggest biodiversity return; but also provides a list of top ecosystems and top catchments. If we focussed our work around these most impactful areas, we would have quite a different looking approach to conservation and something that I will be taking into the finalisation of the Biodiversity pathway and more detailed discussion with Mike and Kay.

**The Technical Output**
The sites in the table below are ranked in order from high ecological integrity to low ecological integrity ("EI"). Basically, sites with high EI scores provide for the greatest biodiversity gain when management is applied across listed pressures – i.e., ecological integrity is maximised. This table has 12 landscape-scale projects to choose from. The advice of my Group is that if we reordered on the basis of readiness; the Maukahuka and Te Manahuna Aoraki projects are ready or near ready for long-term investment, and the Chathams, Coromandel, Rakiura and possibly Kahurangi are ready to consider for 3-4 years of scoping.
This is the 'pure' Biodiversity Group advice and is not completely reflected in the final recommendations below.

| ProjectName | EI (NoMgmt) | EI (\ Mg |
|---|---|---|
| Auckland Island/Maukahuka | 0.364 | 1 |
| Fiordland South | 0.36 | 0.7 |
| Coromandel Peninsula - Moehau to Karangahake | 0.251 | 0.6 |
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| Waiau toa Molesworth | 0.323 | 0.4 |

* Once costs determined, investment readiness will be 'ready'

^ Assumed 50:50 cost split with partners

- Selecting any of the projects off any of these lists will work towards the overarching goals of gaining the most return for biodiversity.
- Selecting any similar projects not on these lists will undermine those gains and is not recommended.
- Final project selection will depend on working with our Partner, funds available, testing delivery preferences with Operations (capability, capacity etc), and feasibility of all proposed actions. In other words, a good social process. We have not yet undertaken these steps.

NB. A combined "offshore island" programme was put up for consideration, but didn't fit the final definition of landscape. However, the grouped islands project are already the highest ranked EMUs – no further impact justification to work on these is needed, they just aren't landscape-scale work. They are worthy of investment, are a PF 2050 interim goal and will appear on the Biodiversity pathway.

**Optimised Recommendations**
With the information we have, before full social process and as our best Biodiversity advice to you for integration where

needed, our advice is.

1. The top four landscape sites for current investment are: **Coromandel, Chatham Islands, Rakiura and Te Manahuna Aoraki**.
2. While Auckland Island has the highest EI and is ranked number 1, with the country heading into a prolonged recession, a prolonged disruption to services, the requirement to make jobs available close to home and global financial recession making fundraising difficult, we recommend that we **press pause on the Auckland Island for 5 years** (This is not a stop, but a pause).
3. The equivalent spend to Auckland Islands across the next five years could set the Readiness stage (full business case, detailed plan and field verification trials) completed for **Chatham Island and Rakiura as well as completing an eradication programme on the last 20 offshore islands.**
4. The funding level that we were looking at for the Auckland Islands ($20m across 5 years) can **create a broader suite of biodiversity and job creation benefits** across the country.
5. The **Auckland Island team could be redeployed** onto the offshore islands work, maintaining and building the skill set (and supplier skill set). After five years, this eradication **"centre of excellence"** can be used to deliver Chatham Island, Rakiura and/or Auckland Islands, and then build toward our mainland eradication sites that will follow.
6. At the end of five years, **Chatham Island and Rakiura would be ready to implement a full eradication programme** and these two projects would directly employ a number of FTEs pa for five years.
7. [redacted] Further investment here meets a diminishing returns model – we will not get the same impact as using that funding elsewhere. Added to that is the gap in new technology – we would be accelerating the current, most expensive methods.
8. The **Islands programme should also be considered for investment** as high biodiversity benefit.
9. Further investment to create employment **should use this group of lists to guide locations** to achieve the most biodiversity benefit.

Mike and I have had a brief chat about these recommendations. He supports the approach and recommendations but would like to see **Fiordland & South Westland** added to the recommended suite of four. He also wants to know more about the impact of any change in our funding approach to **Taranaki.**

I will also now engage with Kay to test this against her pathway work and with Mike for any additional context and to identify any CIs in how this work would be tasked to deliver. Until we have an opportunity to do that I would not recommend sharing this list outside DOC. We are at the integration stage in support of your decision. The suite may change in your view as a result of others pathways and CIs.

Regards

**Martin Kessick**
Deputy Director-General, Biodiversity— *Tumuaki Kāhui Kanorau Koiora*
Department of Conservation—*Te Papa Atawhai*
[redacted]

**From:** Martin Kessick<mkessick@doc.govt.nz>
**Sent on:** Saturday, September 14, 2019 11:56:38 PM
**To:** Kay Booth<kbooth@doc.govt.nz>; Lou Sanson<lsanson@doc.govt.nz>; Lian Butcher<lbutcher@doc.govt.nz>; Barry Hanson<bhanson@doc.govt.nz>
**CC:** Bruce Parkes<bparkes@doc.govt.nz>; Michael Slater<mslater@doc.govt.nz>; Jan Esquilant<jesquilant@doc.govt.nz>
**Subject:** RE: PF Auckland Islands

Thanks Kay,
I promised an email over the weekend on this that brings together some of my teams thinking as a contribution to the discussion with Mike. Here it is:

Broader Context First

In terms of our Islands work this is what we are noticing;

1. The Pacific reset is requiring extra invasive eradication support from us (meeting with Kay & her team recently). To achieve this, MFaT was considering funding two FTEs and expenses, but we have issues around capacity of existing managers to take another two staff on.
2. PF2050 interim goal requires all uninhabited island to be pest free by 2025. We currently have no programme of work underway to deliver on this milestone. We aren't going to achieve this goal unless we take action now.
3. The Auckland Islands programme does seem to be struggling (it will be great to test this with Mike now that he is back). It seems to us that what should be a clear set of cost pressures across a 4 -5 year period is causing churn with everyone individually trying to make sense of it all and contributing to confusion and mixed messages. The one year of funding, without a multi-year commitment to fund the pre-eradication work, is putting T5 staff in an untenable position which is what we are now hearing.
4. What we are now hearing is the request to make a commitment to a 4-5 year budget based on current best figures (about a $1m per year?) to give the team the confidence to get the right people and infrastructure to position us to achieve this eradication.
5. There are also growing questions about organisational structure. It appears as though, largely through pressures on the Ops line, that we have a T5 staff member (with limited delegated authority and relatively constrained limits of discretion) managing a nationally significant project. He reports to a District Manager; who reports to a very busy Regional Director who is trying to connect into National advice and SLT individually.
6. There is also the question of governance being raised.

A Different Way of Thinking About This

A dedicated DOC Islands team?

Island eradication and biosecurity are what we hang our hat on as an organisation. We are internationally renowned, but we still have 91 islands to remove pests from and there is no dedicated programme of work. It's not efficient to cobble together short term funding to complete an eradication and either pull in contractors, or re-train people up to the very highly skilled standard required…often relying on Keith Broome to support. As there is no programme approach, these skills then lapse until we repeat the cycle at the next island. This reactionary approach means that we are averaging less than one island per year. It's not good support to Ops & it means we are falling well short of our potential.

The Opportunity

We all know that Islands are our key biodiversity sites. They punch above their weight, especially in regard to penguin and seabird habitat. They also have high tourism values. It would be a hell of a DOC Story if we could turn around in a few years and declare internationally that we had cleared pests off all of our islands.

If we were serious about achieving that goal we'd need to lift our game to 10+ islands per year. This can be achieved by a dedicated islands eradication team who can combine planning and consents as well as operational delivery….a bit like we have done with Tiakina Nga Manu. There are lots of figures bandied about to achieve this but we think about $4m per year over that time period could perhaps do it.

Form & Function

We think the key is to combine several functions to create a dedicated islands team. What we can see in play as the opportunity would be to combine (under a single Manager) the following expertise into one Unit, allowing sharing of skills and capacity across the islands function:

1. National Island Eradication team - $4m per annum for five years.
2. 2x international islands eradication advice – funded from Pacific Reset MFaT
3. Existing Islands Biosecurity Function – funding already within DOC.
4. Auckland Islands programme (adding this would provide dedicated management a stronger link to national

biodiversity advice & national level skills. It also anchors the PF & Philanthropic approach)

5. Potentially some external science advice, critique, connection & challenge e.g. a James Russel type.

A key question is whether this is a traditional Ops-led programme (As Kay points out below, I'm not sure that it is but would love to play that through with Mike). If it isn't we should stop treating it as such and elevate it accordingly. Ops Regional, Ops National, Partnerships, Biodiversity Threats Unit, External entity? I have a view but would really value an informed discussion and I need Mike's context for this advice.

Funding

There is a strong IVL link and, because it is such a key step on both the PF strategic pathway and the Pests & Species SGs Roadmaps, would be a really coherent stand alone budget bid. The opportunity to capitalise on the work that Barry is leading, together with PF Ltd (who need other pathways than just expanding the current approach) should provide a huge leverage opportunity for new Government investment. Achievable, measurable, transformational, additionality, internationally significant, system enabling players to play to strengths.

Regards

Martin

**Martin Kessick**
Deputy Director-General, Biodiversity— *Tumuaki Kāhui Kanorau Koiora*
Department of Conservation—*Te Papa Atawhai*
[redacted]

**From:** Kay Booth <kbooth@doc.govt.nz>
**Sent:** Sunday, 15 September 2019 12:47 a.m.
**To:** Lou Sanson <lsanson@doc.govt.nz>; Martin Kessick <mkessick@doc.govt.nz>; Lian Butcher <lbutcher@doc.govt.nz>; Barry Hanson <bhanson@doc.govt.nz>
**Cc:** Bruce Parkes <bparkes@doc.govt.nz>; Michael Slater <mslater@doc.govt.nz>; Jan Esquilant <jesquilant@doc.govt.nz>
**Subject:** Re: PF Auckland Islands

Kia ora colleagues

Currently travelling from Virginia to BC. Reading emails on the plane, as you do....

If you pursue this conversation while I'm still away (I'm back Mon 23rd), can you please plug in Barry. He has a good strategic view on this project arrangement and can talk to the Partnerships Group potential role.

My input:

1. Project approach.

This project was set up as DOC-led project. Rather than a collaborative partnership project (eg Taranaki, Te Manahuna Aoraki). Hence Operations rather than Partnerships lead.

Q: Should it remain as a DOC-led project. If not, then who are the key partners (eg PF2050 Ltd).

2. Leadership capacity.

If project approach remains as DOC-led, then feels like a dedicated project team is required.

Q: Where to source required project leader.

There will be other points that I've not commented on. But this is my starter for ten.

Kay

Kay Booth
Deputy Director-General Partnerships
Department of Conservation
Te Papa Atawhai
kbooth@doc.govt.nz
[redacted]

From: Lou Sanson
Sent: Wednesday, 11 September, 4:15 AM
Subject: Re: PF Auckland Islands
To: Martin Kessick
Cc: Bruce Parkes, Michael Slater, Kay Booth

Great

Stephen is fantastic resource but desperately wants leadership. He is leading in absence of this.

Sent from my Samsung Galaxy smartphone.

-------- Original message --------
From: Martin Kessick <mkessick@doc.govt.nz>
Date: 11/09/19 8:03 PM (GMT+12:00)
To: Lou Sanson <lsanson@doc.govt.nz>
Cc: Bruce Parkes <bparkes@doc.govt.nz>, Michael Slater <mslater@doc.govt.nz>, Kay Booth <
kbooth@doc.govt.nz>
Subject: Re: PF Auckland Islands
Thanks Lou,
Bruce & I have been discussing this. We are really just waiting for Mike to return. I have more detail on possible approaches after a bit more thought. I'll put it into an email over the weekend so that we can discuss when Mike is back.
I have been doing a lot of thinking after our engagement with Ops Directors last week. We aren't running the model according to its design. I genuinely believe that's why they are so pressed as Directors. This programme is a good example. It's step change conservation being run from a BAU machine. The machine can't cope. Almost every other Ops Director is trying to do the same.
I'm really keen to discuss with Mike when he's back as I really wsnt to understamd his perspective & understanding before discussing further. Jacqueline will be a good counterpoint for perspective on how it's all holding together.
Talk to you tomorrow.
Regards
Martin

Sent from my Samsung Galaxy smartphone.

-------- Original message --------
From: Lou Sanson <lsanson@doc.govt.nz>
Date: 11/09/19 7:45 PM (GMT+12:00)
To: Martin Kessick <mkessick@doc.govt.nz>
Cc: Bruce Parkes <bparkes@doc.govt.nz>, Michael Slater <mslater@doc.govt.nz>, Kay Booth <
kbooth@doc.govt.nz>
Subject: PF Auckland Islands
Hi Martin
I saw Stephen Horn today in Wgtn Office
- he agrees PF Auckland Islands needs leadership above him and Aaron just doesnt have time needed.
- IVL $750K will get us to 30 June 2020, thereafter we need $4mill/year for 5 years reducing to 10 years.
- he needs to begin CAPEX procurement programme in autumn 2019 but no budget yet to do this and if delay we push out start to FY2021/22.
- he needs MPI/EPA help on certification of new PAPP sausage baits for cats.
- he is confident Barry can raise 50% via philanthropy
- he seemed very open to PF2050 leadership if this would work.
Lou

Sent from my Samsung Galaxy smartphone.

**From:** Martin Kessick<mkessick@doc.govt.nz>
**Sent on:** Sunday, May 10, 2020 4:41:15 AM
**To:** Mervyn English<menglish@doc.govt.nz>
**Subject:** RE: Predator Free Auckland Islands
**Attachments:** Landscape Scale Investment Advice.eml (759.37 KB), Landscape Scale Investments on a Map.eml (67.1 KB), FW Landscape Scale Investment Advice.eml (109.3 KB), FW Project Muakahuka Governance Review.eml (53.21 KB), RE PF Auckland Islands.eml (41.58 KB)

Kia ora Mervyn,
I have attached the following emails:

- MK to LS of 5/4/20 incl report & recommendations for action/decision.
- MK to LS of 7/4/20 incl maps
- MK to LS of 13/4/20 referring to CIs from Mike and Kay regarding advice.
- MK to LS of 1/5/20 recommending pathway forward after decision.

I've also attached an email from MK to KB (cc LS) of 15/9/19 identifying the muddle & recommending a possible course of action to resolve. I've also attached the response from KB of 16/9/19 (Kay was overseas at the time and had an Acting DDG Partnerships).
Let me know if you need anymore.
**Martin Kessick**
Deputy Director-General, Biodiversity— *Tumuaki Kāhui Kanorau Koiora*
Department of Conservation—*Te Papa Atawhai*
[redacted]

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**From:** Mervyn English <menglish@doc.govt.nz>
**Sent:** Sunday, 10 May 2020 3:18 p.m.
**To:** Martin Kessick <mkessick@doc.govt.nz>
**Subject:** Re: Predator Free Auckland Islands
Martin, keen to read the document re your advice to Lou that informed his decision. Could you forward this please, Word form best for me !
Also, is there an actual decision paper, and/or email that you are aware of
Cheers
Get Outlook for iOS

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**From:** Martin Kessick <mkessick@doc.govt.nz>
**Sent:** Sunday, May 10, 2020 2:32 PM
**To:** Lou Sanson
**Cc:** Michael Slater; Kay Booth; Mervyn English
**Subject:** RE: Predator Free Auckland Islands
Excellent thanks Lou.
We'll obviously all stand behind your decision. Brent and I can pick up any details at our meeting with MOC the following day.
Good news on FY2020 budget.
Regards
**Martin Kessick**
Deputy Director-General, Biodiversity— *Tumuaki Kāhui Kanorau Koiora*
Department of Conservation—*Te Papa Atawhai*
[redacted]

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**From:** Lou Sanson <lsanson@doc.govt.nz>
**Sent:** Sunday, 10 May 2020 12:44 p.m.
**To:** Martin Kessick <mkessick@doc.govt.nz>
**Cc:** Michael Slater <mslater@doc.govt.nz>; Kay Booth <kbooth@doc.govt.nz>; Mervyn English <menglish@doc.govt.nz>
**Subject:** RE: Predator Free Auckland Islands
These are key points she raised with me that she will raise at Status tomorrow.
FY2020 Budget looking good.

Lou Sanson
Director-General | Tumuaki Ahurei
Department of Conservation | Te Papa Atawhai

On 10/05/2020 12:33 pm, Martin Kessick <mkessick@doc.govt.nz> wrote:
Kia ora Lou,
Perhaps some context before we go any further:

- Maukahuka isn't the number 1 priority on our Biodiversity Pathway. Our Pathway presentation contained three slides at the end that illustrated how we are translating strategy into action. The Freshwater Stretch Goal roadmap was one, the landscape scale advice summary table was another and a first cut at a form of response to David's planning task was the third. The Minister has asked for follow up meetings on the FW SG on Tuesday morning (and how it might be helpful for Marine) and on the work behind the LS Scale Investment Plan on Tuesday afternoon. 30 minutes for each.
- I don't know what conversation she had with Stephen or how that came about. Maukahuka is costed in our advice at $21m over the next five years with additional & significant partner funds needed.
- PF Rakiura is undoubtedly harder because of the community elements & is in the process of definition. However, it has more immediate relevance, support & value as a contribution to the PF goal.
- The decision to pause Maukahuka was yours on the basis of my teams advice & the critical issues from Mike & Kay. We should reflect on how we engaged the Minister and what communications took place (not sure whether that is within scope of Mervyn's review or not).

At the meeting on Tuesday afternoon Brent and I will contextualise the LS Scale investment table and explain how the other lenses applied in providing you with the advice that Maukahuka be paused and that in the Biodiversity Group view that was the right decision.
In answer to your questions:

1. The cost of delivery over the next five years is $21m. We are working with Mike to devise a plan to 'pause' the programme successfully which he will submit to you as a funding release memo from the IVL for roughly $2m+
2. I can't speak to the philanthropy strategy or the suggested course of action.
3. It's good that she was impressed with the governance structure which was lead through the Op's line with multi group support. That approach is under review as part of Mervyn's task.
4. I am accountable for the strategy & bio advice about the relative optimised bio value (delivered to you already under task assignment from you). Kay for the best advice about partner contributions & opportunities to enable delivery (under task assignment to you) and Mike for the actual delivery of the strategy as action with support from partner contributions (under task assignment to you).

How the last three questions and answers operated in the lead up to the decision you made are the subject of Mervyn's review. This will be a contribution to the way in which this work is led in the future.
Regards
**Martin Kessick**
Deputy Director-General, Biodiversity— *Tumuaki Kāhui Kanorau Koiora*
Department of Conservation—*Te Papa Atawhai*
[redacted]

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**From:** Lou Sanson <lsanson@doc.govt.nz>
**Sent:** Sunday, 10 May 2020 12:04 p.m.
**To:** Martin Kessick <mkessick@doc.govt.nz>
**Cc:** Mervyn English <menglish@doc.govt.nz>; Michael Slater <mslater@doc.govt.nz>; Kay Booth <kbooth@doc.govt.nz>
**Subject:** Predator Free Auckland Islands
Hi Martin
Ms Sage hadnt realised that PF Aucklands was our number 1 priority on our Biodiversity Pathway until you took her through it on Friday
She also spoke to Stephen Horn who indicated he only needs $10mill per year over 10 years and why PF Rakiura is even harder.
She was surprised we paused it without a paper of Ministerial options.
She is requesting a paper from Biod ;
1. What would be amount to keep it running for next 4 years on a per year basis and where we could reprioritise resource from?
2. Why our philantropy strategy delivered very little over two years and should we employ a professional fundraiser like Antarctic Heritage Trust ?
3. The current governance structure .
She was impressed with Project Muakahuka Governance structure but unclear what Project Maungahuka is.
4. Who is accountable DDG? ( I said it was ultimately you as Predator Free project with tasks to Kay and Mike )
Cheers
Lou
Lou Sanson
Director-General | Tumuaki Ahurei
Department of Conservation | Te Papa Atawhai

# DG TASK FORCE

Cover sheet for agenda item 9

Department of Conservation
*Te Papa Atawhai*

| | |
|---|---|
| **Meeting date:** | 21 July 2020 |
| **Lead SLT member (approved paper)** | Lou Sanson, DG |
| **Prepared by:** | - |
| **Subject:** | Predator Free Maukahuka - Critical DOC Governance Learnings |

| | |
|---|---|
| **Paper type** | For noting |
| **Purpose of paper** | To review Governance of PF Auckland Islands for learnings to improve DOCs governance, management and execution of complex Predator Free projects. |
| **Persons attending item** | Mervyn English |
| **Time required** | 30 minutes |

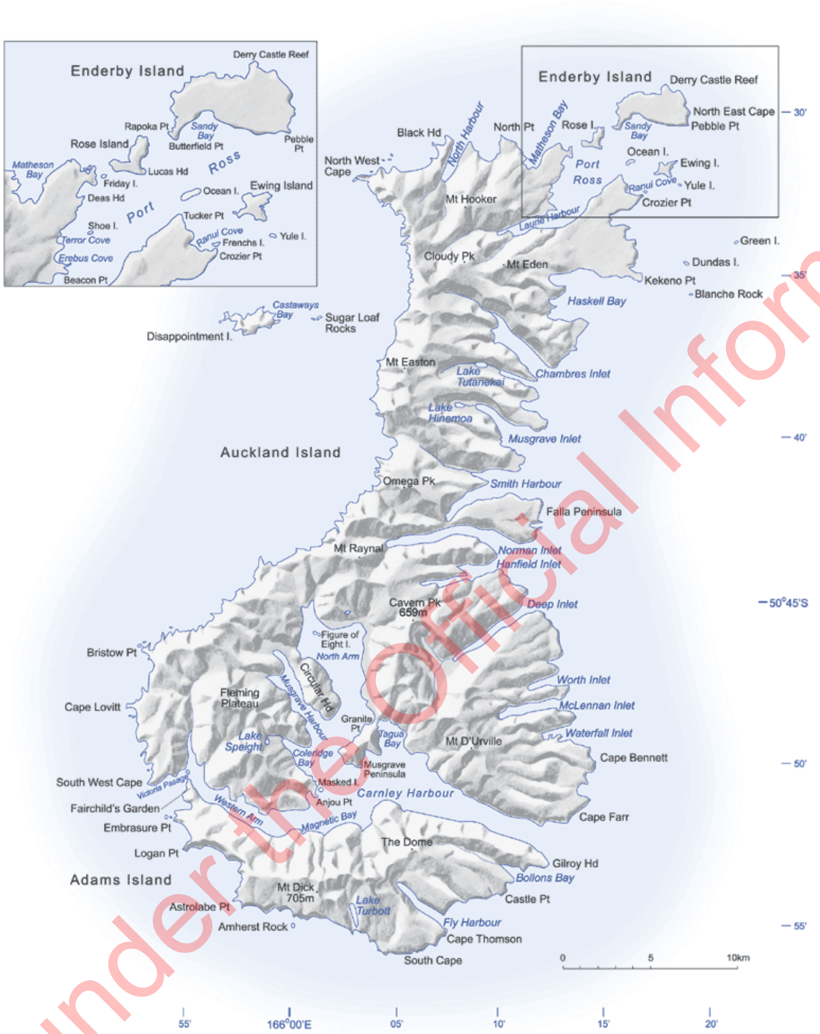
## Context / Background

1. In August 2016, DOC completed the Predator Free Antipodes Island operation and declared it Predator Free in February 2018.
2. An Invercargill Predator Free Team of 8 persons had been established to lead Antipodes Island and they were redeployed to investigate Predator Free Auckland Islands. The leadership was assigned to DDG Operations, with external fundraising assigned to DDG Partnerships based on the success of Million Dollar Mouse Project raising 50% of funds for Antipodes Island.
3. It is not clear if task assignments or overall SPA was ever established for the task, although a Governance structure was established in 2017 led by DDG Operations. Significantly strong Treaty Partner relationships were built through this Governance structure.
4. The project was acknowledged to be a "muddle" in 2019 and various attempts to establish overall SPA failed. The DG takes full accountability for not solving this muddle.
5. The IVL was used to fund the investigation and the last tranche of $1.5 million approved in June 2019 was conditional on dedicated Project Management capability being established (specifically at stratum 3 complexity).
6. A number of major risks emerged during the project initiation, which may have been missed or inadequately addressed from a Risk Management framework in our Governance, such as: use of helicopters to fly DOC staff long distances over open ocean without survival training; ultimately a helicopter crash; loss of shipping services; redeployed NZ Defence ship transport; complexity and skill required to lead external fundraising of $50 million; lack of dedicated business analyst to develop a cost-benefit business case with external critique for a $100 million project.
7. In March 2020, with the rapidly emerging COVID situation and urgency to reprioritise across DOC with loss of IVL funding, the DG made the decision to pause the project on advice of the DDG Biodiversity until the potential $100 million funding needed to proceed from investigation to project execution was clear. Unfortunately, this decision was not delegated up to the Minister.

MAUKAHUKA PEST FREE AUCKLAND ISLAND

# Technical feasibility study report

**Contributing authors:** Finlay Cox, Veronika Frank, Stephen Horn, Rose Hanley-Nickolls, Paul Jacques, Estelle Pera-Leask, Rachael Sagar and James Ware
**Reviewers:** Department of Conservation / Te Papa Atawhai Island Eradication Advisory Group




This report should be cited as: Horn S., Cox F., Hanley-Nickolls R., Jacques P., Sagar R., Ware J., Frank V. Technical feasibility study report for eradication of pigs, mice and cats from Auckland Island; *Department of Conservation Te Papa Atawhai*, Invercargill, New Zealand (2020).

**Disclaimer: this document represents thinking at the time of publication and is intended to present technical detail that informs an assessment of feasibility by technical advisors and relevant managers. Operational planning will refine programme methods and timelines and operations are expected to adapt to knowledge gained throughout the project.**

Maukahuka
PEST FREE AUCKLAND ISLAND

Department of Conservation
Te Papa Atawhai

## Document build status

| Version | Date | Author | Reason for change |
|---|---|---|---|
| 1.0 | 03/04/18 | Horn S., Jacques P., Ware J. and Cox F. | Initial draft |
| 2.0 | 29/03/19 | Cox F., Jacques P., Sagar R., Ware J. and Horn S. | Draft post summer 2018/19 trials to reduce uncertainties |
| 2.1 | 04/09/19 | Sagar R., Hanley-Nickolls R. and Horn S. | Draft post summer 2018/19 to reduce uncertainties and feedback following June IEAG meeting |
| 3.0 | 28/02/20 | Sagar R., Frank V. and Horn S. | Final version following feedback from IEAG and winter trials 2019 |

## Contents

*Plate 1. Feral pigs (*Sus scrofa*), house mice (*Mus musculus*) and feral cats (*Felis cattus*) are the species the Maukahuka project aims to eradicate from Auckland Island (46 000 ha), and are the last remaining mammalian pests in the New Zealand Subantarctic area (NZSIA; 76 000 ha). Following their eradication, the total pest free area in the NZSIA will expand by more than 250%, increasing habitat for over 500 native species. Photo credit: Stephen Bradley and Finlay Cox/DOC.*

# Executive summary

## Context

The feasibility study of a project (Maukahuka) to eradicate pigs, cats and mice from Auckland Island in the New Zealand Subantarctic Islands Area (NZSIA) has been completed by New Zealand's Department of Conservation (DOC). The purpose of a feasibility study is to understand the costs, benefits, risks and technical challenges and allow informed decisions on the design of an eradication project to give the best chance of success. Alternatively, it allows a project with a high chance of failure to be 'shelved' before committing large sums of money. Feasibility studies are a standard part of DOC's eradication best practice.

Here we assess more than three years work to establish the feasibility of eradicating pigs (*Sus scrofa*), mice (*Mus musculus*) and feral cats (*Felis catus*) from Auckland Island. The report addresses three key questions: why do it; can it be done and what will it take? And provides a reference and justification for stakeholders. It outlines methodologies for the eradication of each target species, identifies the scale of the undertaking so it can be considered and resourced appropriately, and highlights the next steps needed for quality project design. Findings from the work to date are captured in the document in detail to inform project planning. We used an evidence-based approach and expert elicitation, including extensive field trials to reduce uncertainty and test methods. DOC's Island Eradication Advisory Group (IEAG) and several other experts have provided technical advice and review.

## Background

Invasive mammals are a threat to global biodiversity, especially on islands where endemic species are particularly vulnerable. Auckland Island (46 000 ha; 465 km south of Bluff), the fifth-largest island in New Zealand, our largest uninhabited island and the largest island of the Auckland Islands group (57 000 ha) is recognised for its outstanding natural heritage values. The Auckland Islands are a stronghold of taonga, harbouring remarkable and rare Subantarctic flowers and animals. Their isolation in the productive waters of the Southern Ocean has shaped extraordinary adaptions and unique biodiversity, represented by 500+ native species. There are diverse communities of seabirds, land birds, marine mammals, plants and invertebrates, many of them endemic and of conservation concern; recognised internationally by its status as a United Nations Educational Scientific Cultural Organisation (UNESCO) World Heritage site, one of 213 recognised natural sites in the world and one of only two such sites in New Zealand. It is also a World Centre of Floristic Diversity (International Union for the Conservation of Nature; IUCN) and an Important Bird Area (Birdlife International). After nearly 30 years of pioneering work by in the region, Auckland Island is now the last island in the NZSIA (76 000 ha) where mammalian pests remain.

## Why do it?

The Auckland Islands are the most biologically rich of NZSIA (Campbell, Antipodes, Bounty, Snares and Auckland Islands). However, introduced pigs, mice and cats on main Auckland Island have inflicted severe ecological damage over the past 200 years and continue to erode the ecological integrity of the island. Native biodiversity is now severely diminished on Auckland Island relative to nearby pest-free islands in the archipelago.

Eradicating pigs, mice and cats from Auckland Island will achieve globally significant biodiversity benefits and many other consequential benefits including leverage for other large-scale conservation work, capability development and authentic collaboration with DOC's Treaty Partner Ngāi Tahu and other project partners. Successful eradication of mammalian pests would complete the vision of a pest-free NZSIA and enable permanent recovery of native wildlife over time.

It will also reduce the risk of incursion to other pest-free islands in the region and associated catastrophic consequences and response costs. In particular there is risk to Adams Island (9 693 ha globally significant and unmodified), which is within swimming distance (min. 548 m) of pests from Auckland Island and a vital refugia for local biodiversity.

DOC administers the islands and has a clear mandate for the work. The eradication of pests from these islands is a vision shared by Treaty Partner Ngāi Tahu ki Murihiku who are tāngata whenua and strongly support the goal. The project provides significant opportunities to strengthen and role model the Treaty partner relationship. Maukahuka would provide important momentum for the national Predator Free 2050 (PF2050) goal via development of capability in several fields of pest management technologies demanded by the step change in scale and helping to leverage investment in conservation including progression of conservation goals in the global Subantarctic. It aligns with the New Zealand Government's PF2050 objectives, the New Zealand Biodiversity Strategy, the protection afforded as part of the NZSIA World Heritage Area and will fulfil statutory obligations.

Eradication of mammalian pests is the only way to achieve the desired long-term benefits. Suppression of pests is not feasible at this remote location and pioneering scale due to the complex logistics, the prohibitive ongoing cost and limited benefits (short-term relief for some native species at a few sites).

The most efficient and likely way to achieve success is via eradication of all three species in sequential operations in short succession. This approach extracts the most value from the large investment in setup while minimising infrastructure maintenance compared to separate projects over a longer timeframe. The investment and effort to establish a specialised project team, supplier relationships and retain capacity and capability is large and would not be repeatable in the short term. Removing only pigs, or pigs and mice would drastically reduce the biodiversity benefits compared to removing all three pest species.

Removing pigs alone would lead to an increase in palatable plants and likely subsequent increases in mice and cat populations and predation on native bird and invertebrates (e.g. Marion Island). This would severely limit the recovery of the island, preventing the return of endemic terrestrial birds and burrowing seabirds, which are keystone species in this ecosystem. Mice can have extensive detrimental impacts on islands (e.g. Marion Island, Gough Island, Antipodes Island, Midway Atoll), including the local extinction of some invertebrates, severe suppression of land birds and in some cases, preying on large seabirds resulting in zero recruitment. Removing cats and mice alongside pigs would allow bird, plant and invertebrate populations to re-establish and grow, maximising ecosystem recovery and resilience.

## Can it be done?

The eradication of pigs, mice and cats from Auckland Island has been assessed against five principles of eradication and found to be feasible. Methods and capabilities are available or can be developed within specified timeframes with appropriate resourcing and sequencing. The project and the associated challenges are large. The site itself presents significant challenges relating to the scale of the island, remoteness, isolation, steep terrain affecting accessibility, poor weather, lack of infrastructure, difficulty in servicing and the immense quantities of gear and personnel required to be transported.

The project's implementation encompasses an extensive infrastructure programme followed by eradication of pigs, mice then cats (in that order) and each programme timed according to the seasons to maximise assistance from the environmental conditions. Pigs must be eradicated first to make the attempts on mice and cats possible (pigs will create gaps in bait coverage for mice and interfere with traps and baits for cats). The mouse eradication method compliments that for cats. Too long a delay after the pig eradication risks vegetation regrowth that could make cat hunting unfeasible.

Assessment against the five principals of eradication:

1. All individuals of the target species can be put at risk by the proposed eradication techniques.

Pigs can be eradicated using an intensive and sustained application of a suite of overlapping techniques (trapping, aerial hunting, and ground hunting plus Judas pigs to aid validation). Aerial hunting requires the development of capability with high-resolution thermal camera technology and aerial hunting teams. This tool makes the operation feasible by reducing the area to be ground-hunted by half and significantly reducing the risk of leaving animals behind in difficult terrain. The island should be temporarily fenced in two locations to create three management blocks.

Helicopter application of cereal baits containing rodenticide is the only feasible method for eradicating mice. Auckland Island is four times larger than the largest mouse eradication globally to date. Despite never having been eradicated at this scale, a large-scale trial over 1000 ha on Auckland Island showed mice can be eradicated in the summer season at a lower bait application rate than typically used (2 x 4 kg/ha compared with best practice of 2 x 8 kg/ha usually in winter). This departure from best practice is required to make the volume of bait and the likelihood of comprehensive bait coverage feasible given the limited number of flyable hours due to weather and the constrained logistics of the remote location. The method requires improvement to the helicopter bucket mechanism for reliable bait application at the proposed sowing rate.

Trials on Auckland Island have greatly informed the feasibility of eradicating cats and reduced uncertainties. The eradication of cats is dependent on developing data processing capability for managing the volume of imagery from an island-wide grid of approximately 1500 trail cameras. This will help optimise the time between a cat being detected on camera and its image being processed, recognised, and responded to. The cat eradication should occur soon after baiting to eradicate mice to take advantage of potential knockdown of cats via secondary poisoning and the late autumn/winter conditions. It is also highly desirable to have a cat-specific toxic bait (VTA) available for aerial application following the mice eradication. This is the only tool that can potentially put every cat at risk and would greatly improve the likelihood of success and opportunity for rapid completion. A team of cat detection dogs, skilled handlers and trappers are key to the detection and despatch of surviving cats. If a cat specific VTA is not available, targeted trapping and use of lures with the aid of the camera grid would be relied upon to eradicate cats. This would take much longer cost more and carry a greater risk of failure.

2. Pests can be dispatched at a rate exceeding their rate of increase at all densities

To succeed, all operations require treatment and monitoring methods to be applied at sustained intensity until completion. Each operation can be designed to do this and remove individuals at a higher rate than they can be replaced, but seasonal timing is important. Well-designed monitoring with careful data collection and timely analysis is needed to inform decision making. This will allow operations to adapt as the situation changes (e.g. population density, behaviour, seasonal changes) and contribute to confidence that eradication has been achieved to avoid premature conclusion and failure.

Pig population density can be quickly reduced with lured trapping and aerial hunting before ground hunters are deployed. Mice will be breeding during the summer when baiting is planned though mice baiting is a one-off tool, targeting all individuals with two comprehensive treatments of the site in the space of several months. The interval between treatments should exceed 14 days to enable young mice emerging from nests access to bait. Baiting should be completed by March to avoid alternative food in the case of a large tussock seeding event in any given year. Cat population density can be quickly reduced by primary (cat VTA) and secondary poisoning (eating poisoned mice), allowing ground hunters to mop up surviving cats with the aid of the island-wide network of trail cameras to target trapping effort.

### 3. The probability of the pest re-establishing is manageable to near zero (sustainable)

The isolation of the site and managed visitation mean that once eradication is achieved, the risk of incursion is low and manageable. The nearest populations of pigs, mice and cats are several hundred kilometres away, too far for the possibility of self-introduction. DOC is the authority that governs island access for management purposes and approximately 800 visitors per annum under tourism concessions with biosecurity provisions in the mandatory landing permits. A deep-sea fishing fleet regularly shelters near the island and should be engaged to manage incursion risk. The extraordinary amounts of equipment, people and supplies to be taken to and from Auckland Island during the eradication project significantly elevates the risk the biosecurity risk. This has been effectively managed on other Subantarctic islands and is achievable for Auckland Island given timely investment in planning and additional biosecurity facilities.

### 4. The project is socially acceptable to the community involved

The Maukahuka project is strongly supported by DOC's Treaty Partner Ngāi Tahu, (represented on several occasions by kaumatua Tā Tipene O'Regan) and stakeholders including tourism concessionaires. DOC's project to rid Antipodes Island of mice in 2016 (Million Dollar Mouse) achieved significant recognition and public support and similar public interest is expected for Maukahuka. This project is aligned with the statements of intent in the local Conservation Management Strategy (CMS) and Ngāi Tahu's vision document Te Tangi a Tauira. The use of toxins will draw some negative response, though their use is targeted for a short period in a one-off event on an uninhabited island. Auckland Island pigs have value for specific medical research because of their disease-free status and there is interest from at least one venture in recovering some pigs before eradication.

### 5. The benefits outweigh the costs

The proposed pest eradication requires large but one-off investment for permanent and internationally significant biodiversity benefits with low to zero ongoing cost to sustain.

Eradication of pigs, mice and cats will immediately halt the destruction of indigenous fauna and flora to enable recovery and protection of over 500 native species. It would increase the total pest-free area in the NZSIA by over 250%, from 30 000 ha to 76 000 ha. This will secure the region as predator-free and reduce the extinction risk for more than 100 endemic species. The isolated landmass of the Auckland Islands makes them important breeding grounds for 25 seabird species (albatross, petrels, penguins, cormorants, terns and gulls) that forage the surrounding seas. Removing pigs, mice and cats will compliment by-catch reduction work and improve the health of the Southern Ocean ecosystem boosting resilience against projected climate change threats. Twenty-five native bird species that currently only breed in significant numbers on pest-free offshore islands in the archipelago will be able to naturally repopulate Auckland Island. Rapid recovery of invertebrate populations will provide food for returning land birds and nutrient cycling and pollination for plants. Iconic Subantarctic megaherbs will again flourish in the largest habitat available to them.

Maukahuka will deliver improved predator control tools and expertise to support PF2050 and is a tangible and necessary precursor to other ambitious PF2050 projects. Disbenefits, such as by-kill of native species and disturbance to vegetation from the infrastructure programme are expected to be minor and expected to rapidly reverse over 5 – 20 years (demonstrated on Enderby Island). Per hectare costs are comparable to other island eradication projects and annualised costs over ten years are comparable to other landscape-scale conservation projects. Project failure could jeopardise political and public goodwill towards future operations, but challenges are known and can be planned for and success will inspire people to undertake even more ambitious work.

Maukahuka will continue the progress of conservation in the global Subantarctic and enhance New Zealand's reputation for conservation leadership. For Ngāi Tahu the project is another vital step in restoring the mana and mauri (energy, power and life force) of the whenua (land) they are kaitiaki (guardians) of and hold stewardship over. Tangibly, it will provide employment opportunities, opportunities to exercise customary rights of mahinga kai, mātauranga, tikanga and kawa and to demonstrate an exemplar Treaty Partner relationship. Operated from a regional centre in Invercargill, Southland this project will provide significant economic stimulus locally and support development of supplier capability for conservation regionally and nationally.

### Infrastructure and logistics

Establishing appropriate infrastructure and reliable logistics are essential precursors to facilitate operations. The pig programme will take approximately one year to deliver, mice up to 6 months and cats between one and three years depending on tools and efficacy. The infrastructure and logistics programme is the largest single component of the project, bigger than any of the individual eradications. It will take two to three summers to establish prior to the eradications and one to two summers to demobilise afterwards. The remote location and scale of infrastructure required greatly enhance the project cost, complexity and timeframes. Operational delivery will be land-based as ship-based operations would be prohibitively expensive (several tens of thousands of dollars per day for ship charter) for the length of time involved and the size of a ship needed. Significant island-based infrastructure would also still be needed in addition to manage helicopters (hangarage, fuel and crews).

Facilities are needed to support year-round island occupancy for several years and facilitate regular access to all parts of the island by ground hunting. A main central base is needed to accommodate approximately 24 people, in addition to two smaller subsidiary bases (one north and one south), three boat sheds, 17 field huts, four helicopter hangars and fuel stores to manage up to 150 000 L of Jet A1 at a time. Maintenance and compliance requirements run throughout the life of the project.

A supplier is needed for shipping large volumes of cargo (approximately six voyages over the project), e.g. buildings and materials for infrastructure installation and extraction, helicopter fuel for each phase and mouse bait. Over 1200 t of supplies and materials are expected to be shifted to the island over its life. Operational preparations include several large expedition style tasks such as placement of 500 t of mouse bait (approximately 35 x 20-foot shipping containers in volume) plus fuel at nine load sites several months before baiting; and installation of 1500 trail cameras across a rugged island 50 km long with a team of 20 people. Delivery of each operation will occur while concurrently planning and preparing for the next. Dedicated project and contract management capacity is an important function for each stage and should not be underestimated.

Each eradication is dependent on helicopter support, ranging from two helicopters for the pig programme up to six for baiting mice and totals approximately 80 months of helicopter support, in addition to 20 helicopter transits between the mainland and island. Multiple single-engine helicopters will need to be positioned to/from the mainland several times. Certain suitable helicopter models can fly the 465 km directly to Auckland Island from Invercargill under current rules. This simplifies the logistics as the helicopters don't have to be shipped. The helicopter tasks and pilot skills are specialised and different for each eradication. Additionally, pilots with expert long-lining skills are required to unload and load ships for the infrastructure programme and regular resupplies. For example, the 500 t of bait and 150 000 L of fuel for the mouse eradication alone equates to over 800 helicopter movements from ship to shore.

The vast amounts of gear and supplies will require a dedicated mainland biosecurity facility in excess of current local DOC capacity, as well as island facilities to receive and handle them. The logistics and biosecurity of several large supply items (e.g. mice bait produced in Whanganui; flat-packed buildings; large volumes of jet fuel) will need to be managed at storage facilities near to the eventual port of departure. The supply chain steps include: procurement, containerisation, transport to port of departure, handling and storage in a bio-secure facility, quarantine, transport to port, shipping to island, offload by helicopter or small vessel, biosecurity check, storage on island and return of items/waste to the mainland. Logistics will need to be coordinated by dedicated roles with a fit for purpose inventory system.

Regular passenger transport services are required to resupply and changeover island teams with monthly voyages expected during the pig programme and 6-monthly during the cat programme. Aviation options (helicopters, floatplanes) can't provide a complete solution due to payload limitations and cost respectively, so marine transport will be necessary. However, few suppliers exist, and the frequency of work doesn't warrant the permanent allocation of a supply vessel in Bluff. Securing certainty of supply will be important.

### What will it take?

A multi-species eradication using all preferred eradication tools will take up to 10 years from commencement of the infrastructure operation. This could be reduced if operations go well but is ambitious and requires a high level of resourcing and support at all stages. There will be a lag time from the decision to proceed until momentum and readiness to implement are achieved, this can be minimised by progressing some tasks in the interim.

This will be the largest eradication project that DOC has undertaken. The operational cost of the full project is estimated at $84m over 10 years, based on conservative estimates of operational duration due to weather constraints and modelled on short staffing rotations. Longer staff deployments than proposed here are achieved in other programmes, which would be significantly cheaper and simplify logistics.

Likely funding options focus on joint Government and philanthropic sources. Personnel and helicopter costs stand out as the largest cost components of the project. Operational teams of 25 – 30 people will be needed for each programme with a support team of 15 – 20 people on the mainland to service island work and prepare operations to run sequentially as well as undertake the full range of project management tasks.

Two helicopters are required on-site for a large part of the operating period. It is estimated that the option of purchase/lease of two helicopters to remain on island could save between $4 and $5 million in standby fees. This option was successfully modelled during the rodent eradication on South Georgia.

Stopping needs to be evidence-based as stopping without adequate validation of success risks project extension and presents the greatest danger to budget over-runs. Conversely, opportunities to complete the project early (whilst retaining confidence in the result) will offer the most savings.

Each successive operation provides an obvious stage-gate decision point for continuation of the project. Once infrastructure is in place it can be maintained at a cost until operations are ready or funded.

The project is pushing the boundaries of what DOC can achieve so a partnerships approach is the preferred model, though such a model is yet to be tested or delivered by DOC at this scale. A workable partnership agreement and an operating model to control funds, govern, manage, and deliver the project would be needed in such a case. Several options are available, the final structure will be dependent on the identity and preferences of the parties involved.

## Key Risks

### 1. Subantarctic weather may delay or inhibit completion of operations resulting in overruns in cost and time or programme failure.

The Subantarctic provides the most challenging weather conditions in New Zealand for operations dependent on helicopters and shipping. Conditions are changeable, can be extreme and potentially damaging for equipment and could deter, delay or prevent supply and/or operational activity. Frequent low cloud and high winds about mountain passes essentially dissect the island and prohibit feasibly operating from a single location. The frequency and duration of suitable operating conditions have a direct impact on each programme's duration, particularly aerial baiting of mice where sustained poor conditions risk failure to achieve comprehensive bait coverage.

Mitigation:

- Budget for operational duration with enough contingency to realistically account for potential operating conditions.
- Resource well to achieve objectives within the required timeframes (e.g. base at least six helicopters on Auckland Island for the mice eradication to make rapid progress with baiting when conditions are suitable).
- Locate accommodation and helicopter infrastructure in each third of the island to provide localised access, enabling operations to use short weather windows and make methodical progress when travel to distant locations from one base would be inhibited.
- Use satellite internet capability and internet-based weather forecasting to predicate operating opportunities in advance.
- Prioritise work in places where access is most limited (the western coast and areas above 400 m altitude) when conditions are suitable.

### 2. If procurement is not fit for purpose it could delay the project by years at several stages, create uncertainty for inter-dependant multi-million-dollar contracts and require repetition of costly and time-consuming processes for every engagement.

Procurement for the project involves at least 10 one-off procurements over $100 000 and many more repeat procurements above this threshold for helicopters, shipping, and passenger transport. Government procurement processes aim to test suppliers and provide best outcomes for DOC through competitive tendering but are not geared well for extraordinary activities with few potential suppliers such as for this project.

Mitigation:

- Investigate custom procurement options and reduce risk to attract suppliers.
- Engage openly with suppliers and seek industry advice early during planning to understand capacity and find solutions.
- Delegate financial authority, supported by Governance, to a level that provides efficient approval processes and connection with the project team.
- Understand how Government procurement rules will be affected if the project is managed and governed via an external entity.

### 3. Inability to secure the reliable supply of shipping and helicopter resources to service the complex logistics may delay or inhibit completion of operations resulting in overruns in cost and time or programme failure.

Feasibility and project timeframes depend on securing transport and helicopter support services to establish an effective supply chain to Auckland Island. Significant dependencies exist such as the timing of core operations, staff rotation rosters and specifications of support infrastructure. Requirements for helicopters and shipping services involve extraordinary and infrequent activities with few potential suppliers. Capacity for the specialist helicopter piloting skills such as aerial baiting, aerial hunting with thermal cameras; and helicopter engineers will be difficult to secure for deployment to the remote site. Coordination with other programmes such as Tiakina Ngā Manu for baiting pilots and helicopters will be required.

Mitigation:

- Simple, flexible, and bespoke procurement options are needed to avoid lengthy processes.
- Define specific needs early in the planning phase and engage with suppliers and industry expertise to build trust, understand capacity and find solutions.
- Consult with other programmes and explore opportunities to co-develop capacity.
- Contract key logistics for the life of the project to provide certainty.
- Embed industry expertise within the team to design procurement and manage complex compliance and contract scenarios. Ensure contract management capacity is resourced appropriately.
- Contract helicopter supplier for pig programme early and perhaps separately from other helicopter services so development of thermal camera capability is ready in time.

### 4. The impact of a serious incident at any stage could have fatal consequences and/or risk the viability of the project.

The operations involve extensive work with helicopters, boats, firearms, remote fieldwork, construction, and chainsaw use in an isolated place. These activities are all in the eight critical risk categories identified by DOC and will be predominantly delivered by contractors. An injured or ill team member may require intensive management on island for several days before medical evacuation is possible. The presence of helicopters on the island vastly improves the ability to retrieve an injured person to a base facility or conduct search and rescue.

Mitigation:

- Run a risk assessment process to identify potentially fatal hazards and plan for them.
- Ensure good team leadership, skilled and valued staff, engage suppliers early to involve them in planning, treat them as team members and develop a shared safety culture.

- Use an effective communications network (satellite internet, VHF radio, inReach devices, helicopter tracking) to provide accurate local forecasting, enable early warning of an incident and access to off-island professional support for managing an incident/patient.
- Include a dedicated safety role on island to help with planning of day to day operations, reporting and debriefing to capture lessons for safety management.
- Incorporate search and rescue capability and paramedic level medical skills in the island teams.

### 5. If improved eradication tools and necessary capabilities are not available, the project will be delayed or no longer viable.

Operations for each target species are pushing current limits of scale for available technology and skills. Technical feasibility is dependent on capability development for both personnel and eradication tools. Required developments will optimise the likelihood of success for each eradication (reduce risk, complexity, duration, cost, while increasing confidence and likelihood of success).

Mitigation:

- Prioritisation of the project's research and development objectives throughout DOC with strategic alignment and management support of development programmes.
- Allocate seed funding so development programmes can be started as early as possible. New technologies must be tested and proven to be reliable and operationalised as far as practicable before rolling out at the scale of Auckland Island.
- Identify stage gates for feasibility to be reviewed if any critical elements change or fail to be realised.
- Ensure comprehensive training plans are in place before staff selection, with adequate lead-in time planned to train staff.
- Plan for succession and contingency throughout all team levels (field team, team leaders, programme leaders, project and contract management, training and supplier capacity).
- Use relationship vision document in development with Ngāi Tahu to contribute to project design for capability development.

### 6. If DOC can't provide and sustain the necessary support for a project of this size, then the project may fail or be terminated early.

The Feasibility Phase has shown that the project is too large and complex for DOC to undertake using business as usual management. A project review in July 2019 highlighted the limited capacity of DOC Tier 3 management levels in Operations to properly support the scale of the additional work, the inhibitory delegations given to the Project Manager and the need for empowered governance. Large landscape-scale projects are relatively new to DOC, corporate systems and support resources are designed to support smaller scale, annual work-plans. The scale of this project requires organisational coordination and enhanced project management.

Mitigation:

- Articulate prioritisation throughout DOC and ensure resourcing is planned and targeted.
- Establish a reporting line with direct access to decision-makers as well as an empowering mandate for the team and appropriate delegation and authority to meet timeframes and manage risk**.**
- Sustained organisation-wide commitment, attention, and action along with new ways of working and a willingness to look for solutions.
- Act on recognised limitations of high-level management capacity.

- Explore the substantial opportunity for in-kind support.
- Ensure flexibility to move funds between financial years to enable the timely management of a complex operational programme.

7. The partnerships approach and need for collaboration may increase complexity and affect the ability to deliver on time and within budget.

There is need for large-scale collaboration with partners to help fund and facilitate the project. Having multiple significant stakeholders requires the utmost care in managing expectations and facilitating governance teamwork to avoid complicating the project instead of enabling it.

Mitigation:

- Seek excellence in project design and leadership.
- Develop a workable partnership approach that reflects the unique needs of the project.
- Carefully consider the implications of partnership commitments and ensure agreements and Governance reflect expectations, mutual benefits and accountabilities including safety.
- Ensure processes allow for timely decision making, management of scope and good communication.
- Apply lessons from review of past and present landscape-scale projects in project design. A review of this Feasibility Phase should also be undertaken to complement the recommendations in this report.

**8. As protocols and legislation change, the requirements for operations at Auckland Island may become untenable.**

Changes to protocols, permissions and legislation will occur over the life of the project and if not anticipated and managed well have the potential to cause significant delay, increase complexity, cost and affect feasibility. Current examples include; review of the DOC helicopter operating protocols (potentially restricting passenger transfer over water and reviewing direct flights of single-engine machines to Auckland Island), a Regional Coastal Plan review (proposing seasonal boat access restrictions Port Ross due to the presence of breeding southern right whales / tohorā (*Eubalaena australis*) in winter) and the Conservation Management Strategy (CMS), which advises against new fuel storage that will be required for Maukahuka.

Mitigation:

- Develop strong relationships with external regulatory bodies and internally within DOC to involve them in design to ensure project needs are understood, considered and actively managed.
- Consider potential exemptions or grandfather clauses to mitigate some of the effects of changes introduced during the project.
- Design for anticipated change where possible.

**9. External disruptions may affect support, significantly delay the project or cause it to be terminated.**

Disruptions may come from a range of sources including changing social or economic context, change in Government or partner interest, national scale disaster, flow-on effects of a serious incident on-site or from availability of critical transport solutions or suppliers. Delays to the delivery timeline are likely the immediate effect, with associated compounding effects including impact on subsequent programmes and contracts, limitations of time-bound permissions, downtime for personnel, contract penalties and asset maintenance requirements. Due to the importance of seasonal timing of the work and dependencies between programmes, even short interruptions are likely to cause up to 12 months delay.

Mitigation:

- Use a collaborative approach to ensure Government and partners hold each to account.
- Model potential scenarios during planning to ensure their implications are understood and minimised.

### 10. If biosecurity is not properly managed, other organisms could be introduced to Auckland Island or current pests spread to pest-free islands in the archipelago.

Unprecedented volumes of equipment, supplies and personnel going to / from Auckland Island present significant biosecurity risk for this sensitive site. Supplies could originate from anywhere in New Zealand and provide an incursion pathway for unwanted organisms as varied as plague skinks (*Lampropholis delicata*), Argentine ants (*Linepithema humile*), rats (*Rattus* sp.) and diseases. A deep-sea fishing fleet also regularly shelters in inshore waters at the island.

Mitigation:

- Develop a biosecurity plan for the project ahead of implementation.
- Ensure standards are included in supplier contacts and biosecurity measures are implemented and additional facilities are available before commencement of infrastructure programme.
- Engage with and educate the fishing fleet to reduce the likelihood of a vessel inadvertently transporting pests and to assist DOC to protect the place and report illegal landing activity.
- Include biosecurity observations in monitoring during and beyond the project to ensure no unwanted organisms establish (e.g. weeds around infrastructure sites).

## Dependencies

Technical feasibility is dependent on the development and readiness of several new and improved eradication capabilities: aerial hunting teams aided by high-resolution thermal camera technology; improved bait bucket for low application rates; software for automated processing of imagery from trail cameras. A cat VTA, registered for aerial distribution is highly desirable. Capacity is also required for cat detection dogs and handlers and specialist bait spreading pilots, which are likely to require active development. If any of these cannot be delivered, project feasibility should be reassessed. Delivery of all three operations is also dependent on the ability to fly single-engine helicopters to Auckland Island by direct flight from the mainland and to reliably secure cargo and passenger shipping services.

## Recommendations

A full set of recommendations to address issues, reduce risk and increase the likelihood of success of the project appear in the appendices of this document. Here we present the 10 most critical recommendations, many of which are actions that can be taken now, ahead of project initiation to reduce uncertainty and progress towards optimal readiness whilst simultaneously providing benefits to other conservation work.

*Table 1. Priority recommendations to address issues, reduce risk and increase the likelihood of success of the Maukahuka Pest Free Auckland Island project*

| Priority | Recommendations |
|---|---|

| | |
|---|---|
| 1. | The scope of the project should encompass eradication of all three pest species delivered in sequential operations in short succession. |
| 2. | DOC should lead with a commitment to the project by securing the Crown investment and articulating an investment strategy for the life of the project to provide investor confidence enabling the required third-party contributions. |
| 3. | Invest in capability developments to optimise technical feasibility:<br>• Thermal camera technology and experienced aerial hunting teams.<br>• Improved helicopter bait bucket for reliable low sow rate application.<br>• Automated image processing software to label and triage imagery from trail cameras.<br>• An effective toxic bait registered for cats that can be aerially applied.<br>• Cat detection dogs and handlers. |
| 4. | Complete the following project design tasks as soon as possible and incorporate into project plan: finalise the relationship vision document between Ngāi Tahu and DOC, governance model, team structure, define delegations and decision-making accountabilities, financial management. |
| 5. | The project operating model must include dedicated high-level management support from within the organisation, so decision-makers are engaged in the project and connected to project management. |
| 6. | Overarching site management plans including NZSIA Biosecurity Plan, Subantarctic Research Strategy and a Subantarctic Strategy should be updated/completed by the relevant district and national teams to guide project design and ensure strategic alignment. |
| 7. | Share Infrastructure Plan to initiate consultation with local teams and authorities and progress interim actions identified. |
| 8. | Embed shipping and helicopter industry expertise into the project team to design procurement and manage complex compliance and contract scenarios. Ensure contract management capacity is resourced appropriately. |
| 9. | Invest early in biosecurity planning and the infrastructure programme to ensure readiness. |
| 10. | Continue engagement with potential funding partners and stakeholders to facilitate better understanding of relative costs, wider benefits, stopping points, complexities, and opportunities. |

## Conclusion

Eradication of pigs, mice and cats from Auckland Island is worthwhile, achievable and sustainable. Maukahuka is a priority eradication project because of its special protection status and the severity of damage from mammalian pests to this taonga. The project is complex with a long timeframe and the scale is significantly increased by the lack of pre-existing infrastructure and remoteness. However, the challenges can be planned for and overcome. The large investment is spread over the life of the project and well protected by the isolation of the site as the risk of pests returning is low. It is the largest island eradication objective for PF2050 that is understood and ready to progress. It offers an attractive opportunity for partnerships and for tangible large-scale outcomes in the medium term to create momentum and advance New Zealand's PF2050 goal.

Several risks require high-level attention during project design and are critical to success. Consideration of these can start early in anticipation of project initiation. Steps that can be taken immediately include initiating /continuing development of required capabilities, progressing permissions, completion of site management plans, securing funding and completing project design. These actions will aid in minimising the lag between a decision to proceed and achieving the readiness required to commence implementation. To progress, a decision to proceed and committed investment strategy are the priority next steps, which would allow critical path tasks to commence.

Maukahuka is a wonderful example of the ambition that DOC has demonstrated in its history of acting to protect and undo damage in our most treasured but challenging places. The feasibility of this project carefully builds on the lessons from the past; we stand on the shoulders of giants. Armed with this knowledge, the wero of kaitiakitanga has been laid down to restore the mana of Maukahuka.

# 1. Introduction

New Zealand's Department of Conservation / Te Papa Atawhai (DOC) has undertaken a study investigating the feasibility of eradicating pigs (*Sus scrofa*), mice (*Mus musculus*) and cats (*Felis catus*) from Auckland Island, in the New Zealand Subantarctic Islands area (NZSIA; Figure 4). The area is recognised globally for its unique biological and cultural values. Auckland Island is the main island of the Auckland Island group, the largest and biologically richest of the New Zealand Subantarctic islands. Within the Auckland Island archipelago, Adams and Disappointment islands are globally significant as some of the largest islands in the world unmodified by people.

Pigs, mice and cats have inflicted severe ecological damage over the past 200 years[1]. Eradication of pigs was proposed as early as 1982, again in 1993 and cats since 2002[1]. In 2016 the Government announced the Predator Free 2050 (PF2050) initiative, including the interim goal of eradicating all invasive predators from offshore island Nature Reserves by 2025. Auckland Island is by far the largest island Nature Reserve and now the only site in the NZSIA where mammalian pests remain. It is New Zealand's fifth largest island and the largest uninhabited island.

A project to eradicate the remaining mammalian pests from Auckland Island would build on previous eradication success in the NZSIA: Auckland Island (goats; *Capra hircus*), Enderby Island and Rose Island in the Auckland Island group (rabbits; *Oryctolagus cuniculus* and mice), Campbell Island (sheep; *Ovis aries*, cattle; *Bos taurus* and Norway rats; *Rattus norvegicus*; cats also disappeared following the removal of sheep and cattle) and Antipodes Island (mice). No mammalian pests exist on the Snares and Bounty Island groups. Nearby Macquarie Island is a large Australian Subantarctic island that has had all invasive vertebrate pests (weka; *Gallirallus australis*, cats, rabbits, ship rats; *Rattus rattus* and mice) eradicated from it.

A mandate for this feasibility study was approved by DOC's Deputy Director-General Operations (DOC-3009605). This document reports on the study's findings. It provides a reference and justification for stakeholders and provides an understanding of the scale and complexity of the problem. This study has used an evidence-based approach and expert elicitation to assess the technical feasibility of eradicating each of the three target species. It addresses three key questions: why do it; can it be done and what will it take? This report outlines the preferred methodology, highlights the risks, and identifies challenges, dependencies and highlights next steps needed for quality project design.

A summary feasibility report (DOC-6085426) was presented to the Governance Group in November 2019. If an eradication project is initiated, the technical feasibility study (this report) will guide components of operational planning. A project plan will be written as an overarching document to guide the management of the project. This will address next steps for quality project design identified in the feasibility study and set out responsibilities, timelines, decision making processes and project reporting.

This feasibility study is based on the resource kit for rodent and cat eradications from the Pacific Invasives Initiative (Version 1.0.2 October 2011). It references feasibility studies from previous DOC eradication projects including: 'Cat and rat eradication on Ahuahu – Great Mercury Island'[2] and the 'Rangitoto and Motutapu pest eradication'[3]. This version was built following review by DOC's Island Eradication Advisory Group (IEAG), which advises on planning and implementation of island eradication projects undertaken by DOC and international groups. In 2018 the IEAG recommended to reduce uncertainties through further investigation before feasibility could be finalised (advice note DOC-5465177). Findings from extensive field trials in summer 2018/19 (DOC-5911275) and winter 2019 (DOC-6099361) have greatly informed this assessment of feasibility. In answering the questions ‘can it be done?’ and ‘what will it take?’, this study has also drawn on the lessons from previous eradication projects. This study has been carried out with expert support from IEAG and many others from within and external to the Department including Alastair Fairweather (Waikato Regional Council), Elaine Murphy (DOC), James Russell (University of Auckland), Grant Harper (Biodiversity Restoration Specialists), Nick Cave (Massey University), Al Glen (Manaaki Whenua Landcare Research) and Richard Griffiths (Island Conservation).

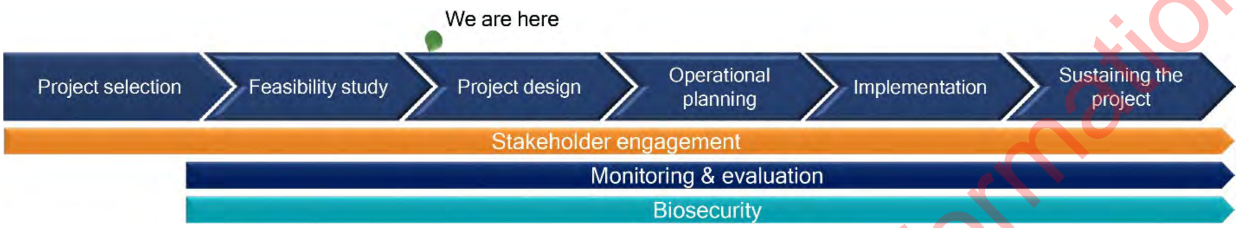



*Figure 1. Eradication best practice project development process*

*Plate 2. A true maritime haven, 25 species of seabird breed at the Auckland Islands. More than 99% of the declining global population of the white-capped albatross / toroa (*Thalassarche cauta steadi*) nest there. A small colony persists on main Auckland Island, though breeding success in areas accessible to pigs is zero. Eradication of mammalian pests from Auckland Island would increase the available safe breeding habitat in the archipelago for seabirds by 420%. Photo credits: Tui de Roy and Paul Sagar.*

## 2. Project goals, objectives and outcomes

### 2.1. Goal

The goal of the Maukahuka Project is the eradication of all mammalian pests from the Auckland Islands.

Maukahuka contributes to the national Predator Free 2050 interim 2025 goal of "*We will have eradicated all mammalian predators from New Zealand's uninhabited offshore islands.*", supporting the New Zealand Biodiversity Strategy (Figure 2).

This work would also complete the vision of a New Zealand Subantarctic Islands area free from mammalian pests, contributing to two of DOC's stretch goals (Figure 2):

- 90% of our threatened species across New Zealand's ecosystems are managed to enhance their populations
- 50% of New Zealand's natural ecosystems are benefiting from pest management

These goals focus effort and help us move towards DOC's vision documented as Intermediate Outcomes.

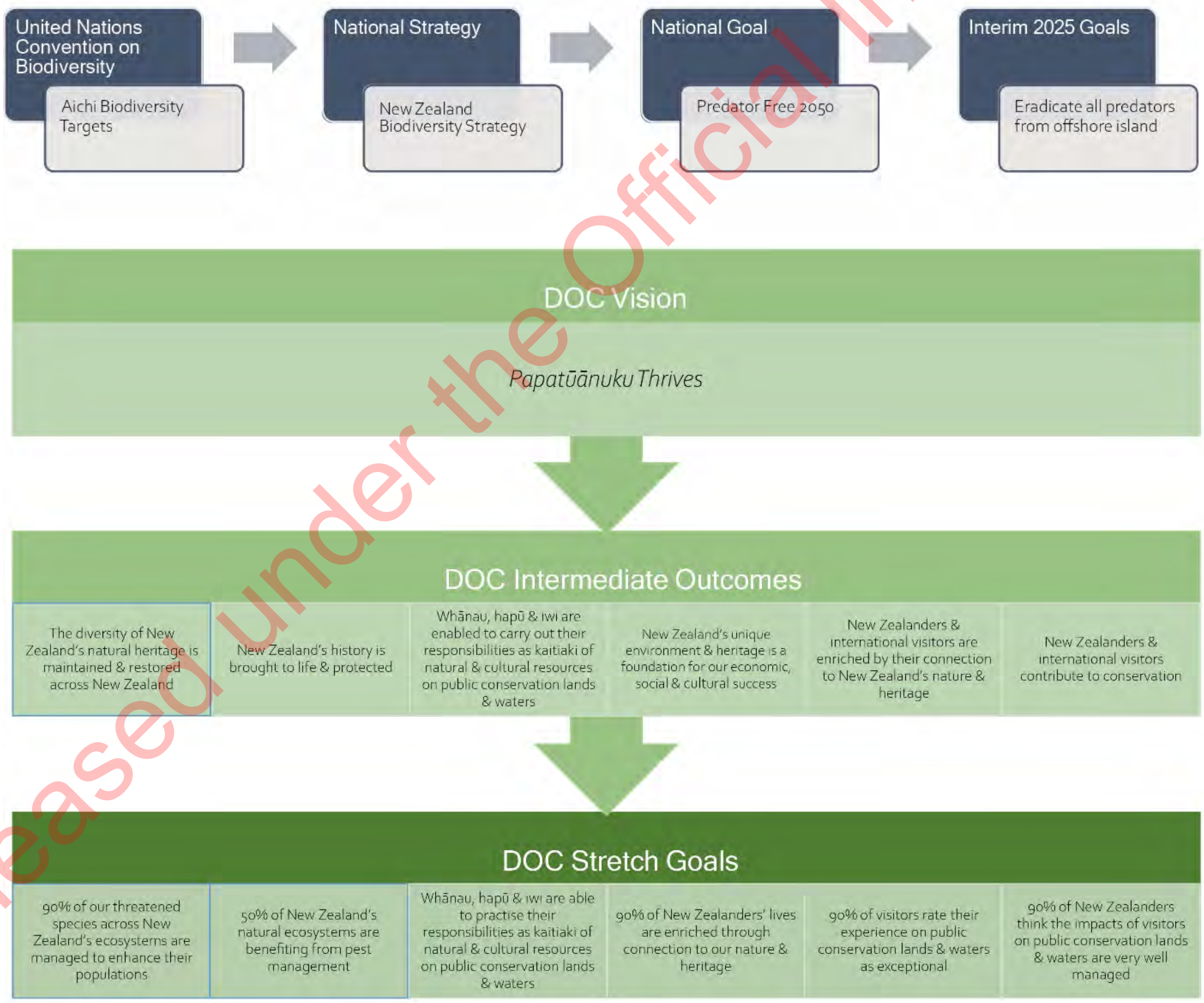



*Figure 2. Relevant (blue boxes) New Zealand Government (grey) and Department of Conservation (green) strategy and goals that the Maukahuka project outcomes will enable.*

## 2.2. Objectives and outcomes

The key objectives of Maukahuka are to eradicate pigs, mice and cats respectively, from Auckland Island (Figure 3). Auxiliary objectives include development of capability, role modelling a true Treaty relationship, successful collaboration with partners and sharing knowledge (Figure 3). Eradicating remaining mammalian pests from Auckland Island is a necessary steppingstone to even more ambitious PF2050 goals.

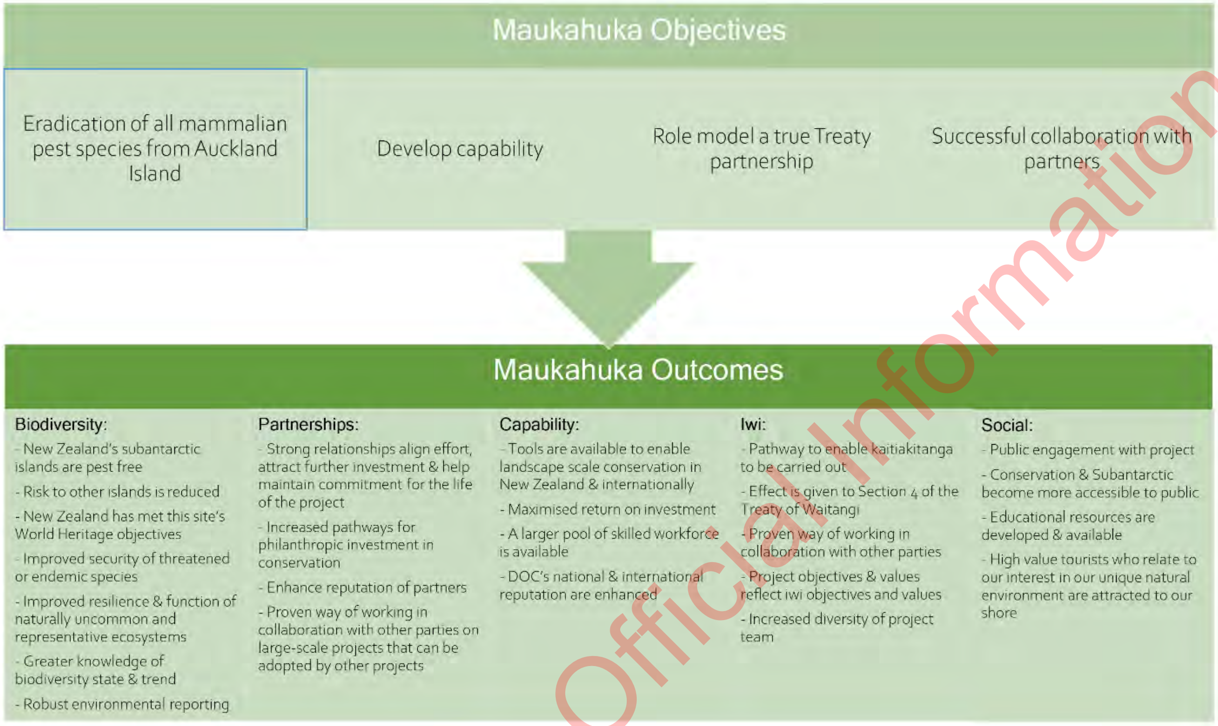



*Figure 3. Objectives and outcomes of Maukahuka – Pest Free Auckland Island. Key objective highlighted in blue.*

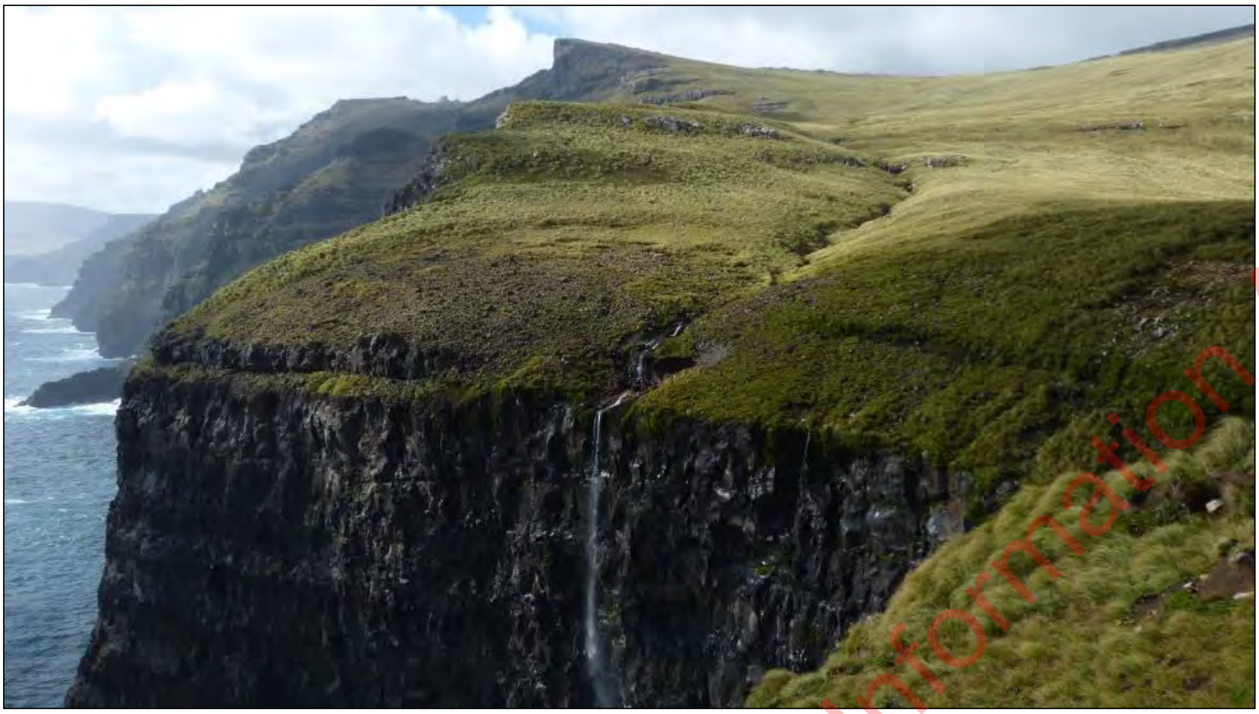


*Plate 3. Maukahuka / Auckland Island has a distinctive character. The ravaged remains of land mass formed from volcanic activity 25 to 10 million years ago has been shaped by an extended period of glaciation and prevailing westerly seas. Formidable cliffs rising over 400 m high run the length of the long western coast and give way to deeply incised cirques and fiords on the eastern side. A dense peat soil layer averages 2 m though can be up to 8 m deep. Vegetation forms distinct bands, running from the eastern coastal swaths of the southern-most forest in New Zealand to dense scrub, tumbling tussock-fields and topped by stunted fellfield meadows of megaherbs. Photo credit: Finlay Cox/DOC and Stephen Horn/DOC.*

# 3. The site

## 3.1. Location


*Figure 4. Locaton of the New Zealand Subantarctic islands*

The remote Auckland Islands (Motu Maha; 50.69°S, 166.08°E) are located 465 km south of Bluff in the Southern Ocean (Figure 4). They are part of the New Zealand Subantarctic islands, five island groups totalling 76 458 ha: Snares Islands/Tini Heke, Bounty Islands, Antipodes Islands, Auckland Islands/Motu Maha and Campbell Islands/Motu Ihupuku (Figure 4). Their associated marine reserves extend 12 nautical miles from the land and collectively cover ~1 400 000 ha. All the island groups lie within 47° and 53° south between the Antarctic and Subtropical convergences, where the marine environment is highly productive. The islands have rich biodiversity, high wildlife population densities and levels of endemism because of their geographical isolation from mainland New Zealand, and from each other.

Auckland Island (46 000 ha) is the largest island in the Auckland Islands archipelago (57 000 ha), which comprises seven large islands (>10 ha) and many additional smaller islands, islets and rock stacks, totalling 217 sites above mean high water spring (MHWS Table 2; Figure 5).

## 3.2. Physical landscape

The Auckland Islands have a distinctive and rugged character. They are remnant land masses formed from volcanic activity 25 to 10 million years ago and shaped by an extended period of glaciation and prevailing westerly seas. The islands are mainly comprised of volcanic lava and scoria blanketed in a peat layer averaging 2 m deep on lowland hillsides and more in lowland flat areas[4].

Auckland Island is 43 km long and 27 km wide at its extremes and has a coastal perimeter of approximately 374 km at MHWS (Figure 5). The terrain is typically mountainous with peaks up to 650 m in altitude. The western side is an almost unbroken extension of formidable cliffs up to 400 m high. The eastern side is much more sheltered, comprised of a series of deeply incised cirques and fiords formed from glaciation. Two large harbours (Port Ross in the north and Carnley Harbour in the south) and some of the ten narrow inlets on the eastern side usually offer sheltered anchorage. There are hundreds of permanent small streams and a few small inland lakes.

*Table 2. Islands of the Auckland Islands archipelago and current mammalian pest status.*

| Name | Size (ha) | Minimum distance to Auckland Island (m) | Mammalian pests |
|---|---|---|---|
| Auckland Island | 45 889 | N/A | Pigs, cats and mice |
| Adams Island | 9 693 | 548 | None |
| Enderby Island | 695 | 2 340 | None |
| Disappointment Island | 284 | 5 730 | None |
| Rose Island | 79.8 | 480 | None |
| Ewing Island | 58.2 | 1 150 | None |
| Ocean Island | 11.9 | 268 | None |
| Masked Island | 5.7 | 118 | Cats and mice |
| Figure of Eight Island | 5.3 | 576 | Unknown |
| **16** other islands (10 named) | 1 – 5 | 7 – 5 400 | Unknown |
| **90** other islands and stacks (14 named) | 0.1 – 1 | 7 – 5 600 | Unknown |
| **102** other stacks (3 named) | <0.1 | 6 – 5 500 | Unknown |
| In total there are **217 sites** in the archipelago with a combined area of **56 816 ha** | | | |


*Figure 5. Map of Auckland Islands, key sites and pest status of islands*

## 3.3. Weather

The climate of the Auckland Islands is the result of interaction between a persistent low-pressure zone at 55 – 65°S and a broad sub-tropical high-pressure zone around 10 – 35°S. The site hosts a bombardment of weather fronts moving from west to east through the Southern Ocean. The daily weather is characterised by long periods of wind and frequent rainfalls. It is typically cold and cloudy but there are times when the island's hills become free of cloud and winds ease with good visibility. The seasonal and daily variations in temperature are small due to the consistent strong westerly flow and maritime environment. Hail can fall in any month and snow will fall on the tops in winter, more frequently at the southern end of the island.

## 3.4. Biodiversity

The geographical isolation of the Auckland Islands and their situation in the highly productive Southern Ocean have shaped a remarkable and unique biodiversity (Table 3), including distinctive plants, birds, invertebrates, marine mammals, fish and marine algae assemblages. Extraordinary examples of adaption and numerous rare and/or endemic biota are present on the island group, which is the most biologically diverse of all the NZSIA. Strong links between the marine and terrestrial environments are facilitated by seabird and marine mammal fauna. The high nutrient input drives ecosystem processes and supports a high level of species richness. The islands are a stronghold for taonga, including several species of toroa (albatrosses, family Diomedeidae), tītī (petrels, family Procellariidae), hoiho (yellow-eyed penguin, *Megadyptes antipodes*), whakahao/rāpoka (sealion, *Phocarctos hookeri*) and many more. Adams and Disappointment islands are globally significant wildlife refugia and are recognised to contain some of the least modified ecosystems in the world.

New Zealand is considered the world capital of seabird diversity. Ninety-six seabird taxa breed in New Zealand, half on which are endemic (breed nowhere else). Seabirds dominate the Auckland Islands (Table 3), a globally significant site for many species as acknowledged by the islands' designation as an Important Bird Area by Birdlife International. Of the 38 indigenous bird taxa on Auckland Island, 25 are seabirds, including three endemic species. The entire global population of Gibson's albatross/toroa (*Diomedea antipodensis gibsoni*) breed on Adams and Disappointment islands, while 99% of the global population of white-capped albatross/toroa (*Thalassarche cauta steadi*) breed on Auckland, Adams and Disappointment islands[5].

The islands land birds comprise of 13 native species, six of which are endemic, the highest count for any of New Zealand's Subantarctic islands[5]. The global population of the enigmatic Auckland Island rail (*Lewinia muelleri*) resides on Adams and Disappointment islands. Adams and Enderby islands are home to kārearea (New Zealand falcon, *Falco novaeseelandiae*), Oceania's southern-most raptor population[5]. Hunting by humans and predation by pigs and cats contributed to the extinction of at least one species, the Auckland Island merganser (*Mergus australis*), last recorded in the early 20$^{th}$ century[1,5]. The invertebrate life is relatively well reported, with more than 280 identified species of which at least 90 are endemic (Table 3). Larger-bodied and flightless invertebrates are well represented on the island group. No reptile or amphibian fauna are present. Freshwater fauna is comprised of 10 known invertebrates and one fish species (kōaro; *Galaxias brevipinnis*). Two species of seal, New Zealand fur seal (kekeno; *Arctocephalus forsteri*) and the New Zealand sealion (rāpoka/whakahao) breed in moderate and large numbers respectively around the coast of the islands. The largest global population of the formerly endangered southern right whale (tohorā; *Eubalaena australis*) breeds in the waters surrounding the Auckland Islands.

*Table 3: Composition of known terrestrial lifeforms of the Auckland Island group*

| Life form | Number of known native species | Level of endemism (% of known species) |
|---|---|---|
| Vascular plants | 196 | 3 |
| Invertebrates | 280 | 30 |
| Land birds | 13 | 32 |
| Seabirds | 25 | 12 |

The flora of the Auckland Islands is strikingly varied, from the coastal swaths of the southern-most forest in New Zealand to dense scrub, tumbling tussock-fields and topped by stunted fellfield and meadows of megaherbs. There are at least five endemic vascular plants. In recognition of the richness, special forms and unique associations of the plant life, the International Union for Conservation of Nature (IUCN) has designated the NZSIA a World Centre of Floristic Diversity. The macroalgae and intertidal communities are notably dominated by brown and red algae, though remain understudied.

Vegetation cover is predominantly native with some notable exotic species cover including *Olearia lyallii (*Olearia*)*, *Sagina procumbens, Stellaria media* and fine grasses in sheltered passages between tussock pedestals[6]. Olearia is New Zealand native thought to have been introduced from mainland New Zealand. It prospers in canopy gaps in rātā (*Metrosideros umbellata*) forest and can outcompete megaherbs to dominate low stature coastal communities[6].

## 3.5. Land use tenure

The NZSIA is a World Heritage site, representing some of the world's most extraordinary natural heritage. The World Heritage status of the islands was conveyed by the United Nations Educational, Scientific and Cultural Organization (UNESCO) in 1998 under two criterion:

Criterion (ix): "…outstanding examples representing significant on-going ecological and biological processes in the evolution and development of terrestrial, fresh water, coastal and marine ecosystems and communities of plants and animals…"

Criterion (x): "Contain the most important and significant natural habitats for *in-situ* conservation of biological diversity, including those containing threatened species of outstanding universal value from the point of view of science or conservation".

Managed by DOC, the comprehensive application of legal, administrative and management systems in place, ensure the areas of the NZSIA have the highest level of protection under New Zealand legislation. All the island groups in the NZSIA, including their foreshores, are Nature Reserves under the Reserves Act 1977. Adams Island was protected as a Nature Reserve in 1910, followed by the remaining Auckland Islands in 1934. In addition, each has been identified as a National Reserve, which acknowledges "values of national or international significance" (Section 13, Reserves Act 1977). The Auckland Islands group is surrounded by an overlapping no-take Marine Reserve (established 2003) and Marine Mammal Sanctuary (established 1993) out to 12 nautical miles, complementing the protection afforded to the islands themselves.

## 3.6. Visitation

There are no permanent inhabitants anywhere in the NZSIA and access is by permit only, administered by the Department of Conservation. Five companies currently hold concessions for guiding tourists in the NZSIA. Visitation has averaged 824 tourists annually over the last 10 years. Concessionaires can land visitors at Enderby Island and 10 sites on Auckland Island[7]. Guidelines are provided in the Conservation Management Strategy (CMS) for Southland Murihiku[7] that limit the maximum number of visitors per day for most of the sites to 50 people. Two hundred visitors per day can land on Enderby Island and the former European settlement at Hardwicke and Terror Cove. Tourist vessels currently depart from, or may land at, several places before landing at the Auckland Islands. These departure/landing sites include Campbell Island, Macquarie Island, the New Zealand mainland, Chatham Islands, Ushuaia (Argentina) and Hobart (Australia). Other reasons for landing on the island are restricted to authorised research, maintenance purposes and Ngāi Tahu kaitiaki responsibilities or cultural activities.

## 3.7. Human history

The Auckland Islands have a history which dates to the great Polynesian voyages of the eastern and southern Pacific during the 13th to late 14th centuries AD. On Enderby Island there is evidence of Polynesian occupation in Sandy Bay occurring sometime in the late 13th to late 14th centuries AD[8] and today this evidence can be seen as exposed ovens. The Pākehā history begins on 18 August 1806 when the islands were first encountered by Europeans. Since this time Pākehā have occupied and used the island for a number of reasons including sealing and whaling, planned settlement, farming, scientific and astronomical surveys, military outposts, establishing castaway depots, with the islands also being the location of a number of historically significant shipwrecks[8]. Māori also occupied the islands early in its written history with Ngāti Mutanga and their Morori slaves arriving in 1842 and finally leaving in 1856.

## 3.8. Existing infrastructure

There are eight small field huts in the archipelago (Table 4). Only the field huts on Auckland Island are proposed for use during eradication operations because of the geographical isolation, biosecurity risk, and the potential for frequent wildlife disturbance on pest-free islands[7] (Table 4). There are several remnant historical structures on Auckland Island but none, other than the Coastwatcher's hut at Ranui Cove, could be made fit for use.

There are several short access routes to visitor sites on Auckland Island[7] (Figure 5). There is a route from Dea's Head hut to the Hooker Hills, a circuit on the southern side of Laurie Harbour, and some routes from the field camp at Smith Harbour (Figure 21). Historically several tracks were cut, and sites cleared and levelled for the establishment of settlements as well as for other purposes, including sealing, extraction of tonnes of rata wood (Erlangen Clearing) by a German steam ship at the start of World War II, several occupations by castaways, mineral surveys, scientific research and multiple attempts to locate the wreck of the General Grant and retrieve the gold supposedly within.

*Table 4: Existing infrastructure on the Auckland Islands*

| Site | Existing infrastructure | Proposed use |
|---|---|---|
| Auckland Island | • 1 x 6-person field hut at Dea's Head<br>• 1 x storage shelter at Dea's Head* | Support field team with minor modifications |

| Site | Existing infrastructure | Proposed use |
|---|---|---|
| | • 1 x 5-person field hut at Smith Harbour<br>• 1 x 2-person field hut at Smith Harbour<br>• 1 x storage shelter at Smith Harbour* | Support field teams, supplement main base facility at this site |
| | • 1 x historic Coastwatcher's hut at Ranui Cove | Mess (kitchen/dining) for a temporary field camp with moderate modification |
| | • Several dilapidated historic structures (boat sheds, shelters, etc) | No functional value |
| | • 3 x basic grassland helipads (Smith Harbour and Dea's Head) | Support helicopter use and medivac capability |
| | • 1 x storage shelter camp + camp sites Camp Cove | Temporary field camp to support field teams |
| Adams Island | • 1 x 6-person hut at Maclaren Bay<br>• 1 x 2-person bivvy at high altitude | Not proposed for use |
| Enderby Island | • 1 x field hut + 10-person accommodation block + lab.<br>• 1 x basic helipad and a small fuel store<br>• Several additional storage sheds | Infrastructure on Enderby Island not proposed for use; except the helipad and fuel depot (maintained by helicopter operators) for emergency purposes |
| Dundas Island | • 1 x 2-person fibreglass bivvy 'apple hut' | Not proposed for use |

* infrastructure installed during field trials 2018/19 and likely to be removed in 2020/21

## 3.9. Target species

### 3.9.1. Feral pig (*Sus scrofa*)

#### Arrival

Pigs were first introduced at Port Ross in 1807 and further liberations occurred in the 19th century[1]. They were well established in the north by 1840 and throughout the island by 1886[1].

#### Population density

There is limited knowledge of population size and habitat ecology. Data suggests that the population is at a low density. Extrapolating data from the summer 2018/19 trials on Falla Peninsula gives a population estimate of 917 pigs (0.02 pigs/ha[9]). However, it is likely that population densities are uneven across the island. Observations during winter 2007[10] and summer 2018/19 suggest that density is higher in the north[9]. Pig populations can respond quickly to changes in habitat quality/resource availability and to variation in weather. It is likely that the pig population on Auckland Island fluctuates[11].

#### Distribution

Pigs have been recorded through observations and global position system (GPS) collars across the whole of Auckland Island, except in inaccessible sections of the western cliffs[12]. There are no observed distribution patterns by sex or age, or seasonal movements[12]. Individual variation in habitat preference is likely. Distribution may also change with habitat quality, population size and resource abundance.

### Home Range

GPS collaring of pigs in 2007 gave home range sizes of 137 to 3280 ha, with males having larger ranges than females. Home range size increased with percent cover of tussock[12]. This variability is consistent with pigs inhabiting other highly variable environments[12]. Home ranges are likely affected by food availability, seasonal factors and individual preferences. Importantly, sows can reduce their normal range by up to 94% when farrowing[13].

### Diet

Chimera, Colman, and Parkes (1995) found pigs on the Auckland Islands relied on a small number of food items, determined by availability. The stomach contents of pigs foraging in the open alpine tops had a high proportion of earthworms and the roots and rhizomes of remaining herbs and tussock. Pigs foraging in the coastal zone had a more varied diet. Scavenged dead fish, birds, sealions, whales, penguins and invertebrates are a significant part of the coastal diet along with ferns, fungi and seaweeds.

### Behaviour

Most pigs encountered on Auckland Island are solitary, although mobs of up to 18 have been seen (A. Cox 2018, pers. comm.). Summer trials during 2018/19 revealed that pigs were not as naïve to hunting as assumed[9,13]. Pigs appear to use set routes when travelling within their home range. Harper (2007) noted pigs travelling 2 – 3 km while foraging along the coast. Interactions at bait stations demonstrated hierarchical behaviour with adult males and their mates being dominant over associated females and their offspring. Apparent subdominant males were seen to be evicted from groups of females and/or bait dumps by the dominant male[10].

### Lifecycle

Most feral pig populations breed all year round. Variation in the timing of breeding is likely to depend on location, habitat and resource availability[11]. High proportions of females were observed breeding between December and February 1972/73[4] and sows with litters or near farrowing in November and December 1989[13]. The portion of sub-adults is lower than in mainland populations, possibly because of lower survival due to climatic and dietary pressures.

## 3.9.2. Mice (*Mus musculus*)

### Arrival

Mice were first recorded on Auckland Island in 1840 but were likely to have arrived in the two decades prior[1]. Mice were first recorded on nearby Masked Island in 1907 and are presumed to persist there[1]. They were eradicated from Enderby Island and Rose Island in 1993 (Table 2)[1].

### Population density

There are large seasonal and annual variations in mice population densities that likely reflect patterns in food availability[1]. Forest and scrub habitat on Auckland Island supply a more stable food supply and mice population densities are more stable in these habitats than in tussock, which is subject to boom-bust population dynamics associated with seed mast events[14]. Mice population sampling has occurred in years prior to, during and post mast events, providing a range of population density estimates. The minimum of <1 mice/ha in forest was captured during a non-mast summer[15]. The highest density of 42 mice/ha was recorded in tussock in the winter following heavy tussock mast[14].

#### Distribution

Mice on Auckland Island have been detected at similar densities in all habitats across the latitudinal and altitudinal gradients[9]. Distribution is likely affected by seasonal fluctuations in food availability. Further south on Macquarie Island mice lived on the alpine tops suggesting that mice on Auckland Island are probably not limited by climate[16].

#### Home range

Capture-mark-recapture sampling of mice on Auckland Island showed that home range size varied inversely with population density and food availability but not by age and sex[9]. Average home range sizes [mean (95% CI)] were higher in forest [0.51 (0.33 – 0.77) ha] and scrub [0.46 (0.29 – 0.74) ha] were higher than in tussock [0.18 (0.13 – 0.25) ha][17].

#### Diet

Mice feed on invertebrates, seeds, other plant material and are occasionally predators of native fish eggs and the eggs and chicks of small bird species[18]. At extreme latitudes invertebrates are the most consistent and dominant component of mice diets, though seeds and fruit are important seasonal sources of food[19]. Mice have also been known to extensively prey on seabirds on islands in isolated situations where they are the only invasive mammal present (Figure 6)[20]. This behaviour has had catastrophic consequences for juvenile recruitment of affected species[20].

#### Behaviour

Mice behaviour will be influenced by predation by cats on Auckland Island[1]. Mice are mostly nocturnal and generally feed at dusk and dawn but will feed less intensively at other times[21]. Wild mice are generally non-territorial though strong territorial structure has been found in low-to-medium density populations[21]. Home ranges and social hierarchy are influenced by body size.

#### Lifecycle

Commensal mice in New Zealand reach sexual maturity at eight weeks. Gestation is 19 to 21 days and average litter sizes range between 5 to 7 pups[21]. The lifecycle of mice on Auckland Island is unknown. Breeding is thought to almost, if not completely, cease on other Subantarctic islands in winter[22]. In winter 2019 female mice were in good condition but not breeding following a significant mast event and male mice were beginning to show signs of coming into breeding condition (enlarged testes)[14].

### 3.9.3. Feral cat (*Felis catus*)

#### Arrival

Cats were first recorded on Auckland Island in 1840 at Terror Cove and were presumably introduced by sealers[1]. Cats and their impacts have been regularly observed on Auckland Island[1].

#### Population density

Extrapolating data from a camera grid run in the Dea's Head area during both summer and winter in 2019, the Auckland Island population is estimated to be 550 – 690 cats (1.1 – 1.5 cats/km$^2$). This is lower than the density inferred through trapping by Harper (2007) of 2.75 cats/km$^2$. Both studies give cat densities following tussock mast events and associated mice population spikes[23]. It is likely that population density is dictated by resource availability.

### Distribution

Cats are found on Auckland Island and nearby Masked Island and possibly other islets in the archipelago (Table 2)[1]. Trapping and tracking of cats during winter 2007 and throughout trials in 2018/2019 show that cats are using all habitats on Auckland Island, including steep terrain along the western cliffs[9,10] that is inaccessible to people.

### Home range

Female availability may primarily determine home ranges of male cats, whereas female distribution is determined by food resources[24]. GPS tracking of cats on Auckland Island revealed mean ±SEM (range) home range estimates for males of 1772 ±515 (176 – 6860) ha and females of 354 ±101 (116 – 654) ha[25]. Home ranges overlap between and within sexes. Home range sizes to date are large and comparable with cats from Rakiura/Stewart Island[26].

Ranging behaviour in mainland New Zealand is strongly influenced by changes in prey abundance[26]. Preliminary evidence from Auckland Island shows that some individuals appear to be cued into seasonal prey sources and abruptly move away from their core home range to presumably access these prey types[9].

### Diet

Three dietary studies of cats have been undertaken on Auckland Island. Their diet mainly comprises of small passerines, small seabirds and mice[27]. They also eat larger passerines, other seabirds e.g. shags and opportunistically forage on marine-derived food e.g. squat lobsters, squid, shellfish and seaweed. A cat was observed eating a deceased white-capped albatross fledgling at the South-West Cape colony during August 2019; it is unknown whether this bird was scavenged or preyed upon by the cat[14]. Cats on Auckland Island would likely eat the many extirpated seabird species now only breeding on pest-free islands in the archipelago, but diet studies are unlikely to show this. Observations suggest mice form a larger proportion of cat diet in winter following mast events when mice are abundant, than in non-mast years[27].

### Behaviour

Daily patterns of feral cat activity vary widely with site and prey type[10,28]. The majority (80%) of cat detections during the camera trial in summer 2018/19 occurred at night or during twilight hours[9]. Preliminary observations from tracking data collected since summer 2018/19 suggest that cat activity doesn't differ strongly between seasons or sexes[14,25].

### Lifecycle

Feral cats have litters of up to five kittens and can breed several times a year when resources are not limiting[29]. Spatial analysis of tracked breeding females may provide insight into timing, duration and frequency of kitten rearing on Auckland Island. Juvenile mortality is a significant restraint on population growth when prey is limited. Only one cat of the twenty caught during summer 2018/19 was a juvenile[9]. In winter 2019 two out of nine cats caught were juvenile[14]. The mice eruption following the tussock mast is thought to be driving higher juvenile cat survival.

*Plate 4. The Auckland Islands human history dates to the great Polynesian voyages of the eastern and southern Pacific during the 13th to late 14th centuries AD. Pākehā history begins in the early 19th century. Since this time Pākehā and Māori have occupied and used the island for a number of reasons including sealing and whaling, planned settlement, farming, scientific and astronomical surveys, military outposts, establishing castaway depots with fingerpost signs, with the islands also being the location of a number of historically significant shipwrecks. Photo credits: Canterbury Museum no known copyright and Rachael Sagar.*

# 4. Why do it?

## 4.1. Mandate

DOC is the lead central government agency responsible for the conservation of New Zealand's natural and historic heritage and for administering the Auckland Islands Nature Reserve (the highest level of protection under New Zealand legislation). The statutory provisions of the Conservation Act 1987 and the Reserves Act 1977 give the Minister of Conservation (MOC) and DOC the mandate to manage the Auckland Islands for the purposes set out in Section 6 of the Conservation Act 1987 and section 20 of the Reserves Act 1977.

One of DOC's primary functions is to preserve and protect plants, animals and ecosystems. Section 20 of the Reserves Act 1977 requires "the indigenous flora and fauna, ecological associations, and natural environment shall as far as possible be preserved and the exotic flora and fauna as far as possible be exterminated". Eradication of pigs, mice and cats will immediately halt the depletion of native wildlife and enhance and protect the internationally significant conservation values of the site, consistent with its status as a Nature Reserve, World Heritage area (UNESCO), Important Bird Area (Birdlife International) and World Centre of Floristic Diversity (IUCN).

The Auckland Island group is a priority ecosystem for DOC, ranked number 39 out of 766 ecosystems ranked to date (DOC Business Planning data 2015-2019; DOC-6060684). This project contributes directly to DOC's key intermediate outcome for natural heritage and two stretch goals (Figure 2). Eradicating pigs, mice and cats from Auckland Island completes the vision of a pest free NZSIA and is aligned with the PF2050 initiative, supporting the NZ Biodiversity Strategy (Figure 2). These objectives are reflected in the Southland/Murihiku Conservation Management Strategy (CMS) 2016[7]. The vision under section 2.10 of the CMS states "The islands within this place support thriving indigenous ecosystems that are free of pest mammals and wild animals and are havens for an abundance of endemic species"[7].

Under Section 4 of the Conservation Act 1987 the Department of Conservation Te Papa Atawhai is required to give effect to the principles of the Treaty of Waitangi. Ngāi Tahu ki Murihiku are tāngata whenua and kaitiaki of the Murihiku region, including the Subantarctic Islands. They have prepared a management plan: Te Tangi a Tauira—the Cry of the People (Ngāi Tahu ki Murihiku 2008), which consolidates Ngāi Tahu ki Murihiku values, knowledge and perspectives on natural resource and environmental management issues. Section 3.7.3 of the document states: "These islands represent the most untouched and unexploited areas of New Zealand. Ngāi Tahu ki Murihiku support the protection and enhancement of all Offshore Islands to ensure ecosystems remain intact and where appropriate eradication of pests and reintroduction of indigenous species are advocated...". Section 3.7.3 Nga Take – Issues and Kaupapa – Policies advocate for participation and "capacity building with respect to local rūnanga papatipu involvement with eradication and research programmes" administered by DOC.

## 4.2. Impacts of pests

Introduced pigs, mice and cats have inflicted severe damage on Auckland Island over the past 200 years[1]. The impact over this short timeframe compares with the millions of years of isolated evolution, which has shaped unique native wildlife at the Auckland Islands. It is difficult to accurately quantify the impact of pigs, mice and cats on Auckland Island as the majority of the devastation occurred before ecological observations began[1]. The islands within the Auckland Island group that have remained free of pests provide an invaluable reference for comparison. The impacts of pests on native species assemblages on Auckland Island may be inferred by contrasting analogous habitat on adjacent pest-free Adams, Disappointment and Enderby islands[1]. The presence of these pests continues to erode the ecological and cultural values of the island and exposes other globally significant pest-free islands to increased biosecurity risks. Arrival of pigs, mice or cats on Adams or Disappointment islands would have catastrophic consequences for native and endemic species.

### 4.2.1. Biodiversity

- Predation pressures, habitat loss, disturbance and competition from all three mammalian pest species have lowered the abundance and diversity of native bird species found on Auckland Island. Only 13 of 38 native species are known to breed on the island in the current state. The presence of pests has increased the wariness of the few remaining terrestrial bird species, which show a reluctance to forage on the ground[1]. Insectivorous birds are further limited by increased competition for prey with mice as indicated by a near absence of macroinvertebrate fauna and the altered invertebrate community structure.
- Pig rooting and mice predation of seeds and seedlings has resulted in grossly lowered vegetation biomass, altered community structure and succession regimes. The striking and unique megaherb group has suffered strong impacts and has been suppressed to near zero density, except on inaccessible, rocky cliffs (Figure 5; Figure 25)[1]. It is likely that mice further suppress megaherb recruitment by consuming their highly palatable seeds and seedlings.
- Invertebrate abundance and diversity have been drastically reduced by predation from all three pest species and the loss of invertebrates further impacts ecosystem health through the loss of their pollination and nutrient cycling services.
- The loss of millions of burrowing seabirds, the key ecosystem engineers in this environment through their importation of marine-derived nutrients and soil-turnover, has reduced primary productivity, disrupted nutrient cycling and ecosystem functionality[1]. Through continued predation this is a self-perpetuating cycle and has resulted in a dramatic loss of biodiversity. There are numerous records of cats and pigs efficiently extirpating colonies of seabirds over the course of a century, indicating that populations of seabirds on Auckland Island must have once been very large[1].
- Diminished populations of native and endemic species have very likely resulted in a loss of genetic diversity, which supports the resilience of a population to change[31]. Many species native to the Auckland Islands are impacted by threats in and away from their terrestrial habitat, including climate change, interactions with fisheries, disease and pollution. Additive impacts on their populations at their breeding sites through the presence of pests further reduces the resilience of these threatened populations[32].

### 4.2.2. Cultural heritage

- Degradation of archaeological sites caused by pig rooting and altered vegetation structure is a great loss because of the cultural heritage value and the enormous potential to reveal knowledge about the past for which little written history exists. Many of the sites are particularly significant in a national context because of the relatively undisturbed nature of the islands and the historical themes represented such as early Polynesian settlement, the sealing and castaway eras[8].
- The loss of biodiversity and inability for the island to support species that evolved there, including taonga species, has weakened the mauri (energy, power, life force) and mana (prestige) of the place.

## 4.3. Maintaining the status quo

If the status quo is maintained, then the ecological value of the site will continue to degrade. The risk of an incursion to Adams Island remains significant. There is recent evidence of cats swimming over 120 m from the main Auckland Island to Masked Island to prey on burrowing seabirds[14]. There is increasing evidence to suggest that mice can swim distances of over 500 m in cold waters[18]. The shortest direct distance between Adams and Auckland islands (548 m) is swimmable by pigs but often affected by strong tidal currents. Additionally, some small islets in Victoria Passage provide steppingstones to Adams Island less than 200 m apart (Figure 5). Floating debris can act as a raft, providing an incursion pathway for smaller pests[18]. An event such as occurred in Perseverance Harbour, Campbell Island, where flooding caused the harbour to fill with tussock shows how precarious the situation is (G. Taylor 2019, pers. comm.). The biodiversity impacts of any pest species establishing on Adams or Disappointment islands would be hugely significant and negative – the islands are the strongholds for numerous endemic species and are recognised as some of the largest unmodified ecosystems in the world.

Mice can have extensive detrimental impacts on islands (Marion Island, Gough Island, Antipodes Island, Midway Atoll), including the local extinction of some invertebrates and severe suppression of land birds (snipe, pipits)[18–20]. Worryingly, there are several examples where mice are the sole introduced predator on an island and have learnt to prey on seabirds, a behaviour rapidly spread through mice populations (Figure 6)[20,33–35]. An example of this is on Subantarctic Gough Island, where it is estimated that two million seabirds per year are lost to predation by mice resulting in zero recruitment for some species (e.g.Tristan's albatross)[33]. This is of particular concern for the pest-free islands of the Auckland Islands, which are a stronghold for Gibson's albatross/toroa (100% global population), white-capped albatross/toroa (99% global population), light-mantled sooty albatross/koputu (*Phoebetria palpebrata*; >25% global population), lesser fulmar prion (*Pachyptila crassirostris flemingi*; 100% global population) and Auckland Island shag (*Leucocarbo colensoi*; 100% global population).

*Figure 6. Juvenile grey-headed albatross (*Thalassarche chrysostoma*) with fatal injuries from being preyed upon by mice (*Mus musculus*) on Subantarctic Marion Island. Photo credit: Ben Dilley.*

In addition to the obvious impacts to biodiversity, an incursion on Adams, Enderby, or any other pest free island in the NZSIA would adversely impact economic, political, reputational, environmental and compliance factor. The cost of the required rapid response to an incursion on Adams Island would likely be tens of millions of dollars, if it could be enacted. Reputational impact would be international and likely detract from the PF2050 initiative. DOC would have failed its obligations under UNESCO and Nature Reserve legislation. Status quo would deprive the PF2050 initiative of an opportunity to create momentum, build capability and leverage large-scale conservation investment.

The ongoing presence of predators on Auckland Island limit the gains from the Crown's investment in seabird bycatch reduction, through negative impacts on the breeding success of already threatened species[1]. Accidental bycatch is highest in the Subantarctic region[36] and Gibson's albatross/toroa, white-capped albatross and white-chinned petrel (*Procellaria aequinoctialis*) in particular have been significantly impacted through bycatch[37]. The presence of pests on Auckland Island reduces the safe breeding habitat for these vulnerable species by 420%. The removal of pests from breeding sites has been shown to have the biggest positive impact for threatened seabird population trends, followed by bycatch reduction[32,38].


*Figure 7. Pig (*Sus scrofa*) rooting has almost denuded Auckland Island of native megaherb species (B) as exemplified by comparison with similar habitat on pest-free Enderby Island (A). At the single remaining colony of this declining species on Auckland Island a cat feeds on a freshly killed white-capped albatross (*Thalassarche cauta steadi*) chick (C) and a pig (circled; D) forages amongst nesting white-capped albatross. Pigs have been observed toppling nests and preying on both adult and chick albatross at this site and breeding success in pig accesible areas is zero. The impacts of cats on albatross breeding success remains unknown, though cats can access areas of the colony that pigs cannot. Photo credit: R. Sagar (A), F. Cox/DOC (B), S. Bradley (C), P. Sagar (D)*

## 4.4. Benefits

Despite covering only 5% of the world's surface, islands are home to 20% of the world's bird, plant and reptile species, and 40% of all critically endangered animals. Island dwelling species are disproportionately vulnerable to being wiped out; 80% of extinctions happen on islands. Fifty-four percent of the amphibians and mammals, 81% of the reptiles and 95% of the birds that have become extinct since the 16th Century lived on islands[39].

In an ever-changing world where species face threats posed by competition with humans for food and habitat, by climate change, by pollution and by accidental or over-harvest, pest free islands offer refuge and a source of resiliency to those that depend on them. In terms of conservation gain per dollar spent, islands are worth their weight in gold. Eradicating pigs, mice and cats from Auckland Island will achieve ongoing nationally and globally significant benefits, including conservation gains, large-scale DOC – Ngāi Tahu collaboration, capability development, leverage for landscape-scale conservation, increased public wellbeing, economic stimulus and fulfilment of statutory obligations. The proposed pest eradication requires a large upfront investment for permanent and internationally significant biodiversity benefits with low to zero ongoing costs to sustain.

Disbenefits, such as by-kill of native species and disturbance to vegetation from the infrastructure programme are expected to be minor and the latter expected to rapidly reverse over 5 – 20 years (demonstrated on Enderby Island). A complex benefits inventory captures the detailed measurable benefits that Maukahuka will achieve (DOC-6035663). Benefits are described in full below:

### 4.4.1. Biodiversity

Successful eradication will remove the predatory threat of mammalian pests and enable recovery of native species. This will help protect over 100 endemic[1] species from extinction. It will expand the area where native species can safely occupy free of mammalian pests by 420% (46 000 ha) in the Auckland Island group and by more than 250% in the NZSIA (76 000 ha). The eradication of all three pest species will enable:

- Recovery of more than 500 native species: 280+ species of native invertebrates (90+ endemic), 196+ species of native plants (6 endemic) and 38 native species of bird (9 endemic).
- Natural repopulation by 26 native bird species that currently only breed in significant numbers on pest-free offshore islands in the archipelago.
- Rapid recovery of invertebrate populations providing food for returning forest and ground birds, nutrient cycling and pollination services for plants.
- Importation of marine-derived nutrients from returning seabirds and invertebrate activity allowing recovery of nutrient cycling, increasing vegetation biomass and shelter for nesting birds.
- The expansion of native species populations in number and size, increasing ecosystem health and resilience to change (climate change, arrival of disease, etc).

### 4.4.2. Reduce biosecurity risk

Large and globally significant unmodified, pest-free islands exist adjacent to Auckland Island. Adams Island is recognised as one of the largest pristine islands in the world but is within swimming distance of Auckland Island for mice, pigs and potentially cats (see section 4.3).

[1] Endemic species in this context are those only found in the Auckland Island group.

Eradication of pests could be viewed as a proactive insurance policy. It will reduce the risk of incursion and its catastrophic consequences: large-scale biodiversity loss, reputational damage and the associated rescue response.

#### 4.4.3. Socio-economic

- Operated from a regional centre in Invercargill, Southland over a period of 10 years, this project will provide significant economic stimulus to both the region and nationally both via direct project investment and flow-on activity.
- Government funding is expected to leverage 1:1 investment from third parties (ca.$40 – $50m) that will be spent nationally, providing opportunities for participation by New Zealand businesses. Investment in research and development has high return on investment, estimated as 3:1 in efficiencies saving for the project alone (ca.$10m). This will also deliver improvements in efficacy and feasibility needed by other biodiversity projects particularly PF2050 objectives.
- Maukahuka would enhance the visitor experience for up to 800 high-value tourists who visit the NZSIA each year and promote opportunities for support of other conservation objectives.
- Increased transport to and from Auckland Island during the project and installation of infrastructure will provide ongoing opportunities to support other conservation work. Examples include improved heritage preservation and research opportunities.

#### 4.4.4. Development of capability

- The investment will increase operational skills and capability across DOC, Ngāi Tahu and associated industry. A big pool of skilled conservation workers and future leaders will emerge with experience in large-scale pest management and complex operations in a remote place.
- Improved and new, proven tools and techniques for landscape scale pest management (e.g. cat toxin, detection dogs, aerial hunting with thermal camera, trail camera data processing). This contributes to the achievability of New Zealand's PF2050 goal and other ambitious pest eradications nationally (e.g., Stewart Island/Rakiura) and internationally (e.g., Niau, Floreana, Socorro, Alejandro Selkirk[32]).

#### 4.4.5. Treaty Partners

For Ngāi Tahu the project is another vital step in restoring the mana and mauri of the whenua (land) they are kaitiaki (guardians) of and hold stewardship over. The commitment and mana Ngāi Tahu have brought to this project has had significant influence on decision makers to date. The project will:

- Enable engagement in the project and increased access to the whenua enabling Ngāi Tahu to exercise their customary rights of mahinga kai, mātauranga or traditional knowledge, tikanga and kawa.
- Enhance the mana of Ngāi Tahu and enhance DOC's relationship with their Treaty partner through participation and inclusion in the project governance, design and delivery and knowledge sharing to enable other sites (Rakiura, Tītī Islands) and future iwi-lead projects.
- Provide opportunities for Ngāi Tahu employment in a range of project and support roles as well as research opportunities
- Enable role modelling of a true Treaty Partners relationship and collaboration with partners (DOC-6262719)

#### 4.4.6. Partner collaboration

- Working with partners at this scale will provide important momentum for the PF2050 initiative.

- It will help leverage other large national and international conservation gains (inspire and inform further invasive pest projects), for example the concept of a global Subantarctic Alliance[40].
- Partner networks will extend outreach to promote the work and improve engagement with the NZSIA World Heritage site, the conservation story of the region and the skills of the Department.

### 4.5. All or nothing: multi-species eradication reasoning

This project is three successive eradication operations delivered in sequence to complement each other in operational efficiency, risk management and benefit realisation. The outcomes are more than the sum of their parts and cost less than if done separately and are more likely to succeed. To maximise benefits and reduce risk, we strongly recommend eradicating all three mammalian pest species in one project. Importantly, a three species approach also extracts the most value from the large investment in infrastructure and establishing logistics and a project team. Eradication of pigs alone, or pigs and mice are the only other scenarios that could be achieved but neither scenario are advised.

Removing only pigs or pigs and mice would drastically reduce the benefits due to the species and site-specific predator release dynamics and differing vulnerability of native species and habitats to these effects. For example, following the eradication of feral cats from Subantarctic Marion Island, the anticipated recovery of native species has been significantly impaired by mice. In the absence of competition and suppression by other mammals, mice have attained higher population densities, limiting vegetation, invertebrate and bird recovery, and risks to species and ecosystems remain high[34,35,41]. It is generally accepted that cats died out naturally on Campbell Island following the removal of sheep, likely caused by regeneration of vegetation and marginal habitat availability[42]. Natural attrition of cat populations on Auckland Island following the eradication of pigs and mice would be very unlikely to occur. Large swaths of coastal forest provide ample shelter and higher terrestrial bird species populations provide more stable food sources compared to Campbell Island. The continued presence of cats on Auckland Island would limit the recovery of the island, in particular preventing the return of key endemic terrestrial birds and burrowing seabirds, which are integral to ecosystem recovery through nutrient importation (see section 4.2.1).

There is a risk to feasibility if there are unplanned pauses between pest programmes. The large job of establishing a specialist project team, an island supply chain and ensuring continuity of knowledge and capability will be at high risk of being lost if one species only was targeted or there was a pause of years between successive operations targeting different species. Several years would be needed to rebuild capability. Maintenance of infrastructure is also demanding and expensive in remote locations and efficiencies are gained by continuous use for the successive target species. The mice and cat programmes should be initiated within three years of eradicating pigs as vegetation recovery will constrain travel for personnel ground hunting cats, particularly in forest and short tussock habitats (ca. 30% of the island; Figure 25) and make sign of target species difficult to be observed in these places[43].

*Key Risk:*

- *Not including all three eradications in the scope of a single project drastically reduces biodiversity benefits and risks disbenefits to native species, additionally it will cost more, take longer due to the effort and investment required to build and retain the required capacity and capability and the inability to benefit from efficiencies and interdependencies.*

*Plate 5. On Auckland Island a dense, woody scrub band extends from near the coast to approximately 300 m above sea level and significantly impedes travel. Tracks will be required for personnel to safely and efficiently carry out work on the island during an eradication project. The width/grade of a track will vary depending on purpose and location. Tracks were cut to facilitate field trials on Auckland Island during 2018 – 2019, and to understand the effort involved to cut tracks in this environment. Photo credit: Stephen Bradley.*

## 5. Can it be done?

In this section we assess the project objectives against current evidence and proposed methods.

The eradication of pigs, mice and cats from Auckland Island have each been assessed against the five principals of eradication and are found to be feasible. The step-change in capability required to eradicate pigs, mice and cats from Auckland Island is significant, but not unprecedented (Figure 8). Each island eradication success has refined the approach and allowed development of tools and technology that support efficiency and confidence in eradication success.

More than 1200 invasive mammal eradications have been attempted on islands around the world, with an average success rate of 85%[32]. In recent years the success rate of eradications has increased and larger, more remote and technically challenging islands are being cleared of pests[32]. There are precedents for the successful eradication of pigs, mice and cats from large islands (>10 000 ha) both globally and within the Subantarctic region (e.g. Santa Cruz, Marion Island, South Georgia, Antipodes Island; Table 5).

*Table 5. Island eradication with global and regional relevance to Maukahuka. Data extracted from the Database of Island Invasive Species Eradications* (DIISE 2018)*. TBC = to be confirmed (waiting for validation of results)*

| Target species | Islands successfully eradicated globally (attempts) | Islands successfully eradicated in Subantarctic region (attempts) | Largest island successfully eradicated* |
|---|---|---|---|
| Pig *Sus scrofa* | 52 (69) | 4 (4) | 57 515 ha Santiago Island |
| Mice *Mus musculus* | 104 (148) | 4 (10 incl. 2 TBC) | 12 900 ha Macquarie Island |
| Cat *Felis catus* | 58 (104) | 4 (8) | 29 541 ha Marion Island |

*Whole island eradication, as opposed to range-restricted species eradications on larger islands

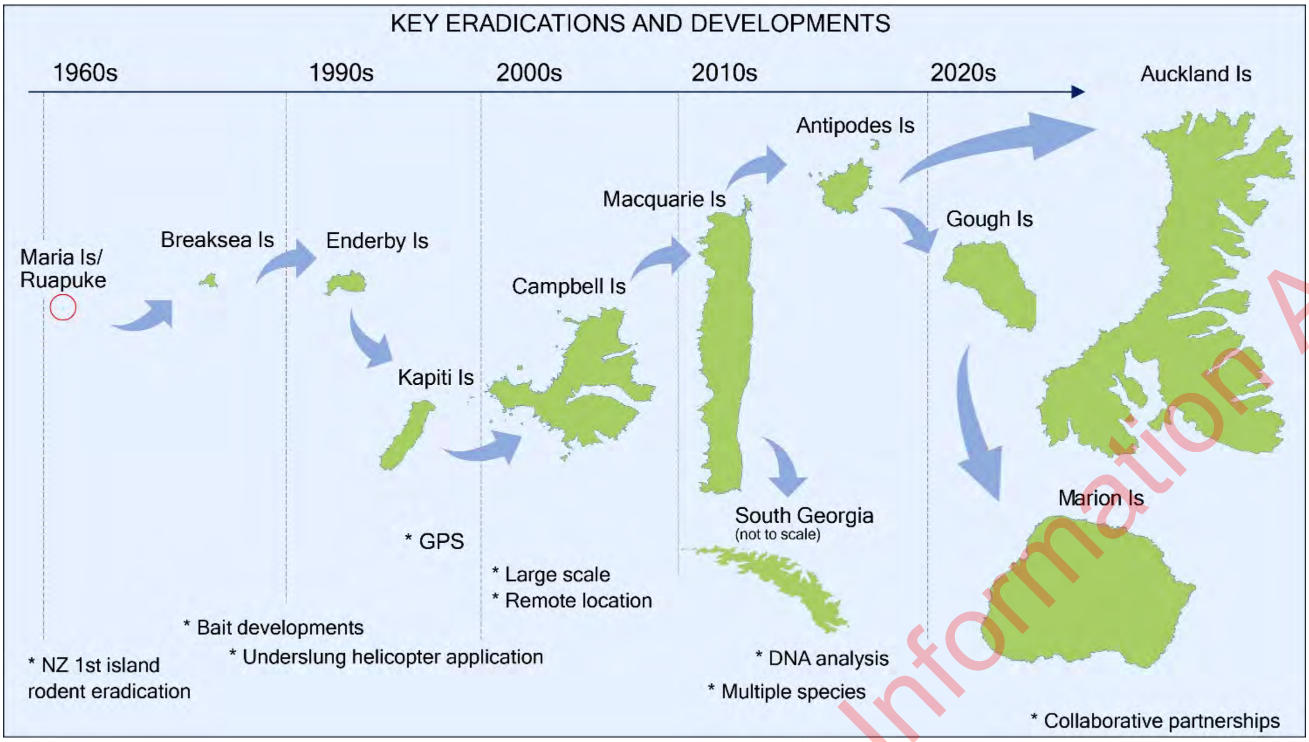



*Figure 8. Islands that have been or are in the planning stages of eradicating mammalian pests and were considered a step-change in capability during planning c.f. Auckland Island. * indicates key technological and methodological developments that have improved eradication operations.*

## 5.1. Technical approach

Eradication projects have a binary outcome: succeed or fail. Success demands the permanent removal of every individual of a target species; failure eliminates almost all benefits and can risk disbenefits. Usually money and resources are fully committed before failure is apparent. To minimise the risk of failure, eradication projects demand excellence throughout at all levels.

Eradications require that every individual be put at risk by an eradication tool. Accordingly, eradications must account for individual behaviours amongst the target species. It is difficult to detect animals in low densities, thereby confirming the removal of all targeted individuals. To increase the likelihood of success, and to ascertain when that has occurred, eradication projects should be designed to be strategic, systematic, intensive, skilled, disciplined, measured and analysed, and adaptive to the situational information.

Specifically, five principles of eradication have been identified that must be met in order to achieve eradication success:

1. All individuals can be put at risk by the eradication technique(s).
2. They can be dispatched at a rate exceeding their rate of increase at all densities.
3. The probability of the pest re-establishing is manageable to near zero (sustainability).
4. The project is socially acceptable to the community involved.
5. The benefits outweigh the costs.

The eradications of pigs, mice and cats on Auckland Island are discussed in this chapter, with assessment against the first and second principles of eradication (above) for each target species. The methods presented are based on evidence from previous eradications and trials on Auckland Island in summer 2018/19[9] and winter 2019[14]. An assessment against principles 3 (section 5.5.4), 4 (section 5.5) and 5 (section 4.4 and 5.5.3) are made elsewhere in the document. Key gaps in capability have been identified and required developments will be addressed through development of a Research and Development Plan and training plans for each eradication.

The eradication methods presented hereafter capture current thinking and available tools and technologies. These methods are intended to inform the decision of feasibility and the detail provides useful reference for initial operational planning. For such an isolated site, every visit is important to advance operational planning. Actual methodology will likely differ as we learn, adapt with site-specific knowledge, refine thinking, and new technologies become available. Where identified, next steps for quality project design have been stated for individual methods to guide operational planning.

### 5.1.1. Eradication strategy

Strategic eradication programmes involve a sequence of techniques that are often described as phases: knock down, mop up and validation. These phases are artificial constructs and depending on the target species they may overlap or follow sequentially at the completion of each phase. Depending on the target species, a phase may be achieved using successive deployment of tools that put all individuals at risk, or from the highly prescribed use of a single tool. For example, rodent eradications require precise planning prior to the operation commencing, and typically involves the one-off use of a single tool (aerial toxic bait spread) that exposes every individual over a short period (knock down phase), followed by a stand down-period that allows any survivors to increase to detectable levels (validation phase). As rodents have small home ranges there is no efficient means of detecting and eliminating survivors, and therefore no mop up phase.

In contrast, the phases during other mammal eradication programme often run as a continuum, using a suite of overlapping tools and techniques over a longer period to put all individuals at risk. Other mammal eradication programmes require flexibility to be able to adapt/develop as the idiosyncrasies of operating in each environment in different seasons are understood. As the eradication progresses, an understanding of change in spatial and temporal abundance of the target species and effort to detect survivors will inform when and what technique to deploy, as well as informing the probability of eradication once individuals of the target species are no longer being detected.

In both rodent and other mammal eradications, the inability to detect all target animals may mean either absence, or, that those still present were not detected. Animals can be hard to detect for two reasons:

1. The probability of detecting animals varies between individuals and techniques. No one technique will detect all individuals.
2. Compounding this, ineffective implementation can result in selection and/or learning within the population.

Care should be taken not to prematurely conclude eradication success. Past eradications have shown that these challenges may be reduced by strategic delivery of techniques. Planning should follow these guidelines to increase the likelihood of success as follows:

- Conservatively design the eradication methodology so that individual behaviours are accounted for, thereby increasing the likelihood that every individual is dispatched or detected;
- Designing programmes and using proven monitoring tools that provide confidence that zero detections indicate absence;
- Target the last individuals efficiently;

- Ensure data collection during eradication operations is of high enough quality to reliably inform decision making
- Regular evidence-based reviews and updates of plans;
- Team morale with a strong, eradication mind-set is maintained;
- Communications that articulate purpose and progress to internal and external audiences.

The size of Auckland Island combined with the other constraints (remoteness, poor weather, areas of difficult terrain, lack of pre-existing infrastructure) means innovative improvements of current tools and developing new capability for detection and dispatch will save money and time.

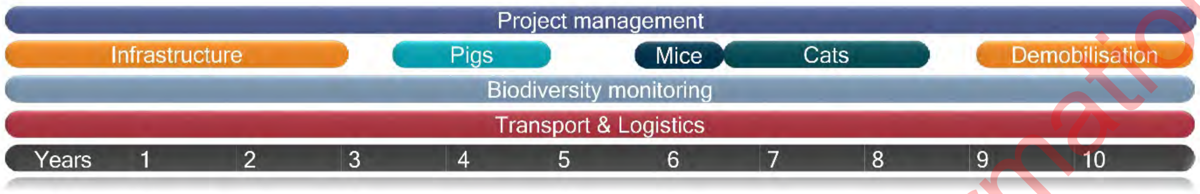



*Figure 9. An overview of the timing and sequence of programmes to eradicate pigs, mice and cats from Auckland Island*

### 5.1.2. Eradication timing and sequence

Pigs must be eradicated first as their presence would compromise an attempt to eradicate mice and cats by consuming baits, resulting in gaps in coverage and failure to put every mouse and cat at risk as well as interfering with traps targeting cats. Mice should be eradicated second as baiting for mice will benefit the operation to eradicate cats via secondary poisoning and removing mice as a food source for cats.

Pig operations should start in winter, when pigs on Auckland Island are more likely to cue into feeders[14]. The mice programme should only start the summer after the pig programme is completed to allow time for shipping bait and setting up bait load sites in the winter between the pigs and mice operations, and avoid a clash in case the pig eradication takes longer than expected. The cat programme should begin eight weeks after the initial mice baiting operation to capitalise on the knockdown of cats through secondary poisoning and increase the likelihood of cats consuming toxic meat baits due to removing mice as a food source. The mice and cat programmes should be initiated to keep the project running continuously but preferably within three years of eradicating pigs.

The relative timing of operations targeting each species will be subject to seasonal considerations and final eradication methodology and is discussed in more detail below. The timing and duration of techniques is indicative only as it is based on estimates from previous operations and current understanding. Ultimately knowledge of some of the variables including animal behaviour and the idiosyncrasies of operating at Auckland Island will only be gained as each programme is delivered. Each programme will refine the planning for the subsequent operations. For example, extensive hunting for pigs will identify caves for baiting during the mouse eradication and improve knowledge of cat activity and detectability with thermal camera technology.

Methodologies that were considered and discounted for the eradication of pigs, mice and cats on Auckland Island can be found in the appendices.

### 5.1.3. Weather and operating conditions

The weather patterns at Auckland Island are typical of the Southern Ocean around 50°S, with a consistent westerly flow. Weather data from the Auckland Islands are limited, with most data collected from a Metservice New Zealand automatic weather station installed on Enderby Island or geo-referenced time-lapse photo sequences[45].

Based on knowledge from previous eradications and site-specific knowledge gathered during summer 2018/19, flyable conditions for baiting and aerial hunting are defined as a maximum daily wind gust of <33 kt and cloud base >600 m. Flyable conditions for passenger transport on island are defined as a maximum daily wind gust of <33 kt and cloud base >400 m. The proportion of time flyable by helicopters for baiting, aerial hunting and passenger transport were estimated from the Enderby data (Table 6)[45]. Approximately one in five days is suitable for aerial baiting or hunting. Findings highlight that helicopter operations should be ready to take advantage of more frequent shorter weather windows to make progress.

Daylight hours and weather have been factored into estimates of duration for each operation. The assumption was made that small boat operations will be possible 40% of the time. Understanding the influence of weather constraints on helicopter operations will be refined with more time spent on the island and collection of weather data during the planning phase and each eradication.

*Table 6. Percentage of time (95% confidence intervals) estimated to be flyable to support eradication operations on/around or passenger transport to/from Auckland Island, based on weather records from Enderby Island and known operating conditions for these activities.*

| Operations requiring flyable time | Upper | Mid | Lower |
|---|---|---|---|
| Baiting and aerial hunting | 24% | 20% | 16% |
| Passenger transport | 38% | 32% | 27% |

*Next steps for quality project design:*

- *Measure swell data over time to inform planning and future go/no-go decisions, for safe and efficient boating operations.*
- *Monitor visibility conditions at key locations to better estimate the impact of low cloud on helicopter operations.*

## 5.2. Pigs

### 5.2.1. Overview

Pigs can be eradicated with current technology. To put all pigs at risk a suite of overlapping techniques is proposed (Figure 10). Independently each technique will not remove the whole population but collectively the sequence will put every individual at risk, and simultaneously allow validation of success across temporal and spatial scales.

The proposed methodology commences with automated pre-feeding then trapping selected sites where multiple pigs are visiting. Aerial hunting aided by thermal camera technology would start as traps are rolled out to reduce pig population to low density. Ground hunting will then be used to identify, and dispatch remaining individuals during a full island sweep and validate eradication with a second full island sweep. The release of Judas pigs and continued aerial hunting throughout the programme will provide additional confidence during the validation phase.

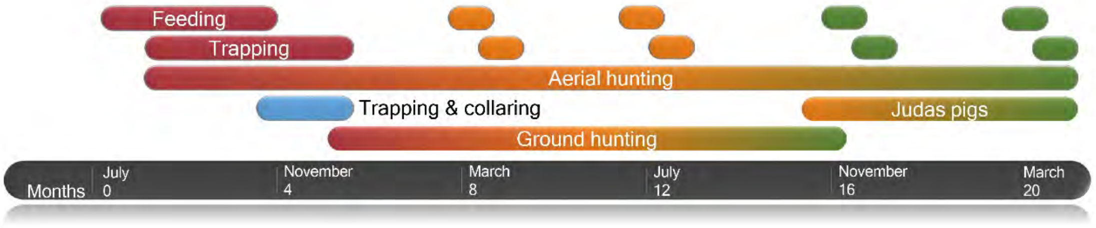



*Figure 10. Proposed sequence of techniques to eradicate pigs from Auckland Island. Red = knockdown; orange = mop-up; green = validation*

The island will be divided into three smaller management units (Figure 21). Implementation of eradication techniques will methodically progress through these independent blocks from south to north – working from the most difficult terrain and vegetation to the easiest. Working south to north also reduces the risk of pigs attempting to swim to Adams Island (or other islets) during pursuit.

An important theme for the sequence of techniques is that every engagement with a pig must be lethal. Not every encounter is an engagement. For example, if an aerial shooter is not confident that all the pigs in a group can be dispatched, because of group size and distance from cover; the helicopter crew will waypoint the location and not engage until there is a high probability of dispatching all the animals in the group. This may mean targeting them with a less aggressive tool such as traps. Attention to detail and eradication mentality will be an important component of successful delivery.

The proposed method was successfully trialed (excluding trapping) on Falla Peninsula, Auckland Island (ca.1000 ha) in summer 2018/19[9]. Aerial hunting using thermal cameras effectively reduced the pig population before intensive ground hunting was used. All remaining pigs were efficiently dispatched in a single ground hunting sweep. The result was validated by a second ground hunting sweep.

The effectiveness of aerial hunting with the thermal camera applied island-wide, reduces the area to be ground hunted by ca.12 000 ha per sweep (Figure 25). Without thermal camera capability three ground hunting sweeps of a greater area would be needed (3 x 38 000 ha = 114 000 ha without thermal cf. 2 x 26 000 ha = 52 000 ha with thermal). Lack of thermal camera technology increases the risk of failure via increased risk of leaving individual animals in difficult terrain and the programme running longer.

Field trials had better success with automated feeders in winter than summer, although were less effective on exposed tussock sites regardless of season. Beginning the pig operation in winter and using this tool in selected sites, which are logistically sensible, will maximise the efficacy of this tool.

### 5.2.2. Proposed methodology and supporting evidence

#### 5.2.2.1. Fences

Two fences will be installed that will split the island into three management blocks (Figure 21) and will facilitate other eradication techniques, such as a holding Judas pigs (see section 5.2.2.5). The fences are not intended to be impervious to pigs and will enable monitoring of migration between blocks. Fences will improve operational efficiency by increasing security of treated blocks by minimising migration from an actively treated adjacent block. Fences will be visually inspected for evidence of migration when required and game cameras may be used to monitor possible pressure points.

#### 5.2.2.2. Feeders

Feeders that attract pigs to an area where they can be targeted with trapping or shooting have been successfully used for initial knockdown and ongoing surveillance in previous large-scale pig eradication programmes [e.g. Santa Cruz[46]]. Feeders and trapping have been important tools for putting family groups and nocturnal pigs at risk on other eradications with high pig population densities[46].

Feeders holding a large supply of kibbled corn that release some on an automated timetable will be utilised on Auckland Island. All feeder sites should be large, flat and vegetation cleared enough to install a trap and enable shooting and resupply from the air. Feeders will be monitored with game cameras to refine their use and guide how detected animals will be dispatched or trapped. Multi-catch traps should be installed at sites visited by several pigs, (see section 5.2.2.3). For sites with only individual pigs visiting it will be more efficient to dispatch pigs with aerial or ground shooting when they come to feed.

Trials on Auckland Island showed that feeders were more effective in sheltered sites in winter where fresh pig sign was present and the pig population density was higher[14]. Although helpful for trapping, habituating pigs to visit at 'mealtimes' by regular feeding will also be critical for attracting and dispatching individual pigs.

Anderson et al. (2010) suggested that to put all animals at risk, the distance between devices should approach the radius of the smallest home range. Home ranges measured for pigs on Auckland Island are 1.37 – 32.8 $km^2$ (see section 3.9.1), which suggests the spacing of devices could be as tight as 700 m. Given that this is the first technique in the sequence, the proposed spacing for pig auto-feeders in the tussock grasslands is 2 km apart and 1 km apart along the perimeter of the forest and scrub vegetation strata. These locations are based on coarse analysis of a digital elevation model and will be further refined with on ground investigations by skilled operators. Flexibility of placement for location of feeders will improve efficacy allowing installation of additional feeders where pig sign is observed. Deciding on the number of feeders and their distribution across the island will need to balance the effort (installation, management and extraction) with the expected return and the use of more aggressive eradication tools.

*Next steps for quality project design:*

- *Assess the biosecurity risks and non-target impacts associated with large scale use of kibbled corn (as part of Assessment of Environmental Effects during operational planning) to ensure benefits outweigh costs and consider other contingency options.*

#### 5.2.2.3. Traps

Live-capture traps will be targeted at feeder sites that are regularly used by multiple pigs, pigs at night and/or to facilitate the capture of Judas pigs (section 5.2.2.6). Live traps are essential for targeting mobs of pigs to ensure the engagement is lethal for all members of the mob. They can also target piglets, which can be more difficult for aerial shooting and dogs to detect. Other advantages are that traps work 24 hours a day, seven days a week and can target pigs at night.

To enable the capture of multiple pigs, traps will likely be a walk-in corral design, utilising a one-way gate system. The frequency of trap-checks will comply with legislative requirements (e.g. within 12 hours after sunrise, the day after they are set unless all necessities are provided). Traps can remain open until pigs are comfortably using them then set live when a suitable weather window is forecast to allow helicopter/boat access to check traps. Keeping the trapping strategy simple will be important, given the scale. Up to 30 traps may be utilised in a rolling front and will be kept in place until no longer effective at each site.

Results from a trapping study in Australia suggests an efficiency of 62% of pigs exposed to traps being captured[47]; and in another study an 83% reduction of a population was achieved using this method[48].

*Next steps for quality project design:*

- *Refine trap design to suit the conditions, to reduce the risk of pigs escaping and to improve portability and ease of set up.*

#### 5.2.2.4. Aerial hunting

Aerial hunting assisted by thermal camera technology is considered an effective tool to achieve eradication of pigs on Auckland Island. This tool would reduce the risk of non-lethal engagement and increase confidence in eradication success. Aerial hunting is particularly effective in tussock, low scrub and other low-density vegetation. Aerial hunting will proceed in a rolling front through the three fenced management blocks (Figure 25) to minimise ground hunting effort.

A trial of thermal camera assisted aerial hunting on Auckland Island during summer 2018/19 showed that detection probabilities differed between habitat strata (Table 7) and that non-target species could be reliably identified in all[9,49]. Pigs could be driven from one habitat to another to increase confidence in detection and subsequent dispatch. Table 7 presents detection data from trials on Falla Peninsula, showing how many passes in each habitat type would be required to be confident no pigs were present in the area. Based on relative vegetation composition, we estimate the minimum total distance to fly at 2750 km to achieve coverage of Auckland Island. Conservative flight times that consider all variables (non-target interactions, daylight hours, chase time and number of passes by vegetation type)[9] it will take approximately 500 hours to complete this coverage, which could take up to 344 days to achieve (Table 8) depending on weather (see section 5.1.3). Spatial data and field observations are integral to an assessment of confidence in aerial hunting as a detection tool.

Effort estimates assume high resolution thermal camera assisted hunting, and this technology is not currently available in New Zealand. Currently available thermal camera technology in New Zealand is one generation behind that tested on Auckland Island during summer 2018/19 and capability limited to one or two operators. This project has engaged with the research group Zero Invasive Predators (ZIP) and commercial operators with the idea to develop and build a fit for purpose camera for operators to purchase and operate for the project (DOC-6214883).

Capability to support an eradication operation on the scale of Auckland Island does not currently exist. Two to three cameras and at least two aerial hunting teams experienced with thermal camera capability are needed to support deployment of two teams on the island at any one time. Efficacy of the aerial hunting teams (pilot, shooter and camera operator) is dependent on experience working together. Adequate lead-in time will be required to build this experience (estimated at a minimum of 60 hours operating). Early identification of the helicopter supplier for the pig programme will provide greater opportunity for involvement in camera development and for the aerial hunting teams to work together and hone skills before deployment.

*Table 7. Detection probabilities by vegetation type using thermal camera on Auckland Island during summer trials 2018/19, which informed the number of passes to ensure confidence all pigs in the area have been detected. The number of passes to ensure confidence is the total number of times*

*an area needs to be covered with the thermal camera to have confidence that all animals in an area could and/or have been detected by this tool.*

| Vegetation type | Approx. area (ha) | Detection probability thermal camera (%) | Number of passes to ensure confidence |
|---|---|---|---|
| Open tussock | 10 000 | >99% | 2 |
| Tall tussock with low scrub | 12 000 | ~80% | 3 |
| Tall and/or tight scrub | 20 000 | ~60% | 4 |
| Tall and/or dense forest and coast | 6000 | <30% | 6 |

*Table 8. Time required to acheive 500 hours of flying time under possible weather scenarios affecting helicopter operations for thermal camera assisted aerial hunting on Auckland Island during spring-summer. Average daylight of nine hours per day has been assumed.*

| Operable daylight hours | 24% | 20% | 16% |
|---|---|---|---|
| Time to achieve 500 hours flying | 229 days | 275 days | 344 days |

On the island of Santa Cruz, 77% of pigs were dispatched by standard aerial shooting[46], indicating that despite differences in vegetation between Santa Cruz and Auckland Island, aerial shooting unassisted by thermal camera technology could still be an effective tool on the open tops (ca.10 000 ha). However, the detection probability for aerial hunting of pigs in tight scrub or forest on Auckland Island without thermal camera technology is near zero. The detection probability without a thermal camera in tussock is low enough to warrant double the number of passes in this habitat compared to hunting with one[9,49]. Thermal camera technology currently available would greatly improve the feasibility of pig eradication compared to aerial hunting without any thermal capability. It would also reduce costs through reduced effort and increases potential for early completion. Significantly increased ground hunter effort would be needed to ensure confidence of eradication without thermal camera technology and is not considered feasible (see section 5.2.2.5).

The utility of any aerial hunting will be informed by how long it continues to be effective, i.e. until it is not detecting pigs anymore due to low population density. Environmental changes will need to be considered when assessing whether to use the tool as they may result in changes in animal behaviour. For example, a rare sunny day will encourage more animal activity on the tops, increasing detectability.

*Key risk:*

- *The pig eradication is dependent on timely development of thermal camera technology and experienced aerial hunting teams.*

*Next steps for quality project design:*

- *Ensure the tactics used to eradicate pigs minimise the risk of pigs swimming to Adams Island when hunting adjacent land.*

### 5.2.2.5. Ground hunting

Aerial hunting in tussock grasslands has a high detection probability so the main ground hunting effort will focus on scrub and forest strata (ca.26 000 ha). Ground hunting is the most aggressive technique proposed. A 'detection line', team hunting approach[9] will be used to ensure that coverage is comprehensive. A detection line approach increases the likelihood that piglets, which have less scent and make less sign, will be detected[9]. It will use a team methodology, with teams of hunters each working one dog. Skilled operators and a well-coordinated, systematic delivery with good communications are essential to maintain the team approach and give confidence that if pigs are present, they will be detected. Every engagement must be lethal. The number of pigs that ground hunters detect and dispatch will depend on the efficacy of aerial hunting. Ground hunting will progress through blocks south to north to reduce the risk of pigs swimming to Adams Island (or nearby islets) when pursued.

Field trials on Auckland Island show that if thermal camera technology is available for aerial hunting then ground hunters would only need to cover the island twice to be confident that pigs are absent. A proposed hunting team of 12 personnel (two teams of six) optimises the logistics of two helicopters of AS350 Squirrel size or equivalent being based on the island. Summer trials in 2018/19 showed one hunter (and dog) covers 40 ha per six-hour hunting period (Table 9). Based on these assumptions and including weather contingency, it would take a minimum of 119 days for 12 hunters to cover the island twice (Table 9; Table 10).

Collecting data on hunter and dog coverage, pig sign, interactions, kills and effort will help build confidence in detection sensitivity and guide decisions on adapting effort and technique. On the ground knowledge of terrain, conditions and dog and hunter performance will support these decisions[43].

Helicopter are essential to support ground hunting. Helicopters will allow positioning hunters to the scrub line from where they will hunt down to the coast and will be able to respond to pig pursuits if required, reducing the risk of non-lethal engagement. Small boats will complement helicopters to limit the impact of weather on operations. Boats can be used for hunter drop offs and pickups at the coast and must have capacity to relocate each hunting team in one trip. Approximately 80 km of proposed tracks would provide contingency access for ground hunting teams to get to trap sites and hunting areas when conditions are not suitable for helicopter or boat operations (Figure 21). Additional tracks for cat eradication will also benefit pig hunting if cut in advance for this programme.

Individual pigs may be pressured to the coast, and aerial or boat shooters may be used to complement ground hunting teams. On two occasions during summer trials, dogs nearly went over coastal bluffs while holding/bailing pigs. Minimising the number of dogs in pursuit avoids over-exciting the dogs, reducing this risk[9]. Ground hunting should only commence when the pig population is low to avoid having to engage multiple pigs at once with a higher risk of failure or scattering dogs. Small boat support along the eastern coast will help reduce the risk of losing dogs if a dog chases a pig into the water.

If aerial hunting with thermal camera technology is not available and standard aerial hunting is used it is anticipated ground hunters would need to complete a minimum of three sweeps of the island to have confidence eradication was achieved. The area to be ground hunted for each sweep would increase to 38 000 ha to include tall tussock/scrub habitat (12 000 ha; Table 7). Based on the effort recorded during the field trials[9] (Table 9) and excluding weather contingency it would take a minimum of 353 days to cover the island three times (Table 10), compared with 119 days for two sweeps with thermally aided aerial hunting. Attracting hunters and maintaining the motivation of hunters and dogs for three full sweeps over a minimum of 12 months is unlikely and could jeopardise the programme through insufficient people or poor quality of applicants. Productivity and attention would also reduce, increasing the risk of failure. This option is not considered feasible.

*Next steps for quality project design:*

- *Identify how small boats and helicopters can best support ground hunting safely.*
- *Define rules of engagement in vicinity of cliffs.*

*Table 9. Mean effort (±SEM) to cover Falla Peninsula (956 ha) twice by a ground hunting team of five plus dogs during summer trials 2018/19*

| | Effort (ha per hunter per hour) |
|---|---|
| Sweep 1 | 6.6 |
| Sweep 2 | 7.9 |
| Scrub | 6.9 ± 4.9 |
| Forest | 6.5 ± 3.6 |
| Tall tussock with low scrub | 10.2 ± 2.6 |

*Table 10. The minimum number of days for a 12-person hunting team, each covering 6 ha per hour for six hours, to complete two or three sweeps of the forest and scrub areas of Auckland Island, under scenarios that may affect operating conditions.*

| Operable days# | 100% | 70% | 50% | 33% |
|---|---|---|---|---|
| Time for two sweeps 26 000 ha (days)* | 119 | 170 | 238 | 360 |
| Time for three sweeps 38 000 ha (days)^ | 353 | 629 | 830 | 1193 |

#Assumes that hunters can be transported via helicopter or small boat, or on foot to hunting locations

*Total area for two sweeps is 26 000 ha and excludes tall tussock/scrub habitat under the assumption thermal camera assisted aerial hunting would cover 20 000 ha tussock habitat.

^Standard aerial hunting without high resolution thermal camera aid would only cover 10 000 ha short tussock and total ground hunting area would increase to 38 000 ha.

### 5.2.2.6. Judas pigs

Judas pigs are proposed to compliment aerial hunting to confirm pigs are absent from an area. This technique capitalises on the social nature of pigs by releasing radio-collared pigs back into an area that has been hunted and using them to seek out surviving pigs. After a period of time hunters can track the Judas pig and dispatch any other individuals associated with them[46].

Judas pigs will be live-captured progressively through the three fenced-blocks in traps or through aerial hunting[46]. Captured pigs will be de-sexed and fitted with VHF-GPS transmitters so they can be found. Judas pigs are then relocated into a different block not being hunted so they are less likely to be dispatched when eradication techniques are implemented in their 'home' blocks. Once a block has been covered by aerial and/or ground hunting, Judas pigs previously caught in the area are recaptured and returned to their home block. Here they are monitored to find surviving pigs, indicate locations for resurvey and provide insights into pig behaviour at the time. Judas pigs are more effective in areas where there have been more pigs such as the northern end of the island due to the greater likelihood of undetected individuals[50]. Pig capture and releases will be coordinated to ensure there are enough taken from and returned to each block and area.

Two fences create three independent operational areas and negate the need to manage large numbers of pigs in a pen or offshore island for the Judas programme. The integrity of fences will need to be regularly checked with the additional pressure put on fences by Judas pigs. It is possible pigs may return to their original home range unassisted. This is acceptable provided a means of locating and identifying Judas pigs is reliable.

*Next steps for quality project design:*

- *Define and test procedure, permissions, ethics approval and handling requirements for Judas pig programme.*

##### 5.2.2.7. Validation

Confidence in pig eradication will compound as each tool is sequentially deployed and reaches near-zero detections for the more passive tools (fences, feeders, trapping) then zero detections for the more aggressive tools (aerial and ground hunting, Judas pigs). It is not proposed to setup and use the camera grid, proposed for cat eradication, during the pig eradication due to servicing costs and the efficacy ofother tools available. Confidence that pig eradication has been successful will be achieved when there have been no new detections across multiple overlapping tools. Additional confidence will be achieved by subsequent years of occupation, helicopter activity for mice and extensive hunting (including cameras) activity for cats. A decision to stop should be made with the aid of technical advice, which is a function of DOC's IEAG. The combination of overlapping tools increases confidence in pig eradication success during the final phases of ground hunting.

## 5.3. Mice

Aerial spread of cereal baits containing rodenticide is currently the only technique capable of putting all mice at risk and eradicating them from Auckland Island. Trials have shown the proposed method can eradicate mice from Auckland Island[51], despite some deviation from current best practice[52] required to make the logistics feasible. It is imperative that pigs are eradicated before the mice baiting begins as pigs will eat bait, creating gaps in bait distribution and increasing the risk of failure.

The logistics of eradicating mice at the scale of Auckland Island are challenging. The proposed prescription is for two comprehensive treatments using a minimum of 4 kg/ha of rodent baits (cf. existing best practice of two treatments at 8 kg/ha; Table 11). The only bait registered for targeting mice with aerial bait spread in New Zealand is Pestoff Rodent Bait 20R® (pelletised 2 g cereal baits). It contains 20 ppm of the toxin brodifacoum, a second-generation anticoagulant and is a proven product for eradicating mice from islands[18].

For logistical reasons, baiting should be timed for summer instead of the usual winter timing for rodent eradications in temperate climates (Figure 11). Results from the bait uptake trial on Falla Peninsula, Auckland Island conducted in summer 2018/19 provide confidence the method can put all mice at risk, despite mice breeding in summer[51]. Critically, comprehensive bait coverage must be achieved over the entire treatment area to succeed. Summer timing (100% more daylight hours than winter) and two bait applications give the best chance to achieve this.

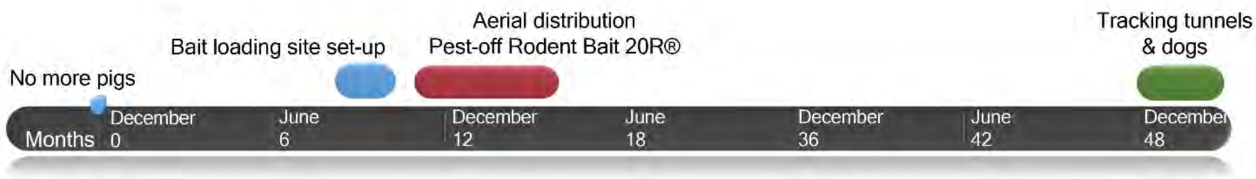



*Figure 11. Proposed sequence of actions to eradicate mice from Auckland Island. Red = knockdown; green = validation*

### 5.3.1. Proposed methodology and supporting evidence

#### 5.3.1.1. Baiting prescription

Bait is applied using helicopters guided by Global Positioning Systems (GPS). Helicopters will carry specialised under-slung bait buckets with motorised spinners that throw bait in a wide arc below the helicopter. Standard buckets used for across island bait spreading, throw bait in an arc of 360°. Directional buckets limit throw to 180° and will be preferred for baiting coastal perimeter and cliff areas. Bait will be applied in two comprehensive treatments, a preferred minimum interval of 14 days apart. The minimum bait application rate for a single treatment is 4 kg/ha over a treatment area of approximately 46 000 ha**.** Additional bait will be applied to steep slopes and other special areas to increase certainty (~10 900 ha; Figure 12; Figure 13; section 5.3.1.2). For example, the coastal boundary where pilots manually open and close the bucket at the start and end of flight lines during across island baiting requires additional baiting to ensure adequate coverage. Accordingly, the total area for bait spread is approximately 56 760 ha per treatment. Each treatment requires 225 t of bait, plus contingency bait to be applied if available (total 504 t including 12% contingency; appendices Table 29).

Aerial bait spread will be supplemented by bait stations and hand spreading of bait in and around operational infrastructure, existing historic structures (e.g. Tagua, Ranui, Waterfall Inlet, etc) and accessible caves above mean high water spring.

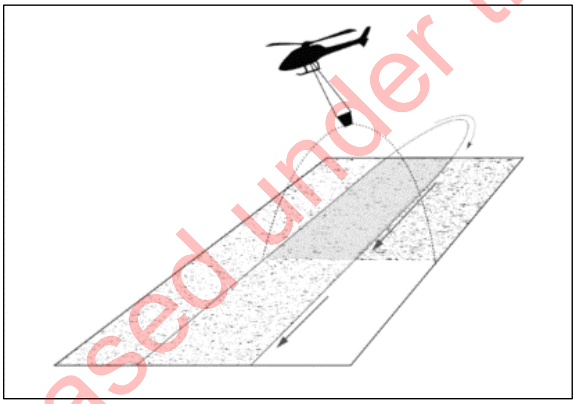


*Figure 12: Bait spreading pattern illustrating 50% overlap of bait swaths (Broome et al. 2017)*

Bait treatment should commence by November to be completed by March (~120 days; Figure 11; section 5.3.1.2).

The proposed method was tested using a single minimum application of 4 kg/ha on a 953 ha trial site (Falla Peninsula) at Auckland Island in summer 2018/19. Productivity of 0.8 t/hr was recorded for standard broadcast and 0.5 t/hr for coastal deflector bucket work[51]. Smaller volumes of bait were loaded into each bucket than is normal resulting in lower productivity than could be expected. Using these conservative rates, distributing 504 t bait for the minimum proposed treatment is estimated to take 668 hours of helicopter flight time (Table 11).

Bait and fuel should be positioned on the island prior to the initiation of the mice programme so baiting operations are not delayed or helicopter resources diverted to unloading ships. Approximately 181 hours are estimated to be required for the site set up and 121 hours for demobilisation, depending on final bait storage and transport options (Table 11). The proposed bait application rates result in a very large but feasibly manageable quantity of bait considering manufacture (section 5.3.1.4), transport (section 6.4.2.1), storage (sections 6.3.8 and 6.4.2.1), handling and aerial bait spread using six helicopters (section 5.3.1.3).

Baiting swaths will overlap by 50%, in line with best practice[52] (Figure 12). This effectively doubles the flight distance or area to be covered for bait spread (e.g. 46 000 ha treatment area becomes 92 000 ha for each treatment; Figure 12). In this way, bait is applied everywhere twice during each treatment to reduce the risk of gaps. This means the nominal or target bait application rate on the ground (4 kg/ha) is achieved with a flow rate of bait out of the bucket that is half the target rate (2 kg/ha). Overlapping bait swaths is a critical part of the prescription design to minimise the risk of gaps in coverage to put all mice at risk. The importance is particularly significant for completing baiting on a very large Subantarctic island where bait application will be disrupted. The generally poor weather conditions will adversely affect the continuity and accuracy of bait spread so bait should be incrementally spread whenever short weather windows make it possible.

There is increasing risk of interruption to bait flow out of the bucket at lower flow rates due to the bucket mechanism[18]. This is currently a limiting issue for the proposed flow rate of 2 kg/ha. Bait flow was interrupted four times from 17 bucket loads during trials in summer 2018/19[9]. With current helicopter GPS an interruption to bait flow caused by a blockage would not be detected or recorded as a gap in coverage, which is a potentially fatal point of failure for eradication[18]. Improved bucket design to facilitate reliable low flow rate of bait is considered integral to mice eradication success and is a key development dependency to be pursued (section 6.1.2). Consistency of bait size and weight also becomes increasingly important at lower flow rates to ensure bucket flow is not interrupted.

Mice have been eradicated from 104 islands globally[44]. Six mice eradications have occurred on islands at high latitudes and with cold climates, including the eradication of mice from New Zealand's Subantarctic Antipodes Island (2045 ha) in winter 2016 [53]. The largest successful eradication of mice to date was from Macquarie Island (12 800 ha) in 2011 (Figure 8), in the presence of ship rats (*Rattus rattus*) and rabbits (*Oryctolagus cuniculus*). Auckland Island is nearly four times larger than Macquarie Island. Other nations are planning to eradicate mice from large islands at this latitudinal range and feasibility studies have progressed to operational planning for Gough Island (6500 ha; in 2021) and Marion Island (29 000 ha; date unconfirmed). In New Zealand, 28 islands >1 ha have been cleared of mice from 36 attempts[18]. Success has been greater than 90% where current agreed best practice used in New Zealand has been applied[18].

Mice have been eradicated from other islands using bait application rates lower than 8 kg/ha. In 1993 mice were eradicated from Enderby Island in the presence of rabbits using two applications of bait at 5 kg/ha[54] and from Adele Island (87 ha) in New Zealand's Abel Tasman Park in 2017 with one application at 3 kg/ha (C. Golding 2019, pers. comm.). Recently mice have also been eradicated from Maud Island (309 ha) using two applications of 4 kg/ha in winter 2019[55].

*Key risks:*

- *The proposed bait prescription is dependent on improved bucket technology to sow bait at 4 kg/ha (2 kg/ha flow rate and 50% overlap) with 100% reliability. Investment in this development is required to ensure it is proven and ready in time.*

*Next steps for quality project design:*

- *Confirm size of treatment area with a boundary flight early in planning phase – the treatment boundary should be the coastal edge of continuous rodent habitat (see helicopter recommendations – Antipodes After Action Review DOC-2928572).*
- *Review bait application rate once a ship, cargo and helicopter capacity are known, and increase sowing rate if logistics allow.*
- *Understand reliability and points of failure for any new bucket design.*
- *Plan contingency options with shipping capacity if 4 kg/ha cannot be achieved.*

*Table 11. Comparison of New Zealand current best pratice bait application rate[52] for mice eradication and proposed minimum bait application rate for mice on Auckland Island (46 000 ha) and the effects on logistics. Assumes flight lines at 45 m to achieve 50% overlap of bait swaths and additional baiting around higher risk areas to increase certainty (total treatment area for single application = 56 760 ha).*

| | **Best practice** | **Proposed** |
|---|---:|---:|
| Season | Winter (general preference) | Summer |
| Treatment 1 (kg/ha) | 8 | 4 |
| Treatment 2 (kg/ha) | 8 | 4 |
| Bait (t) | 900 | 450 |
| 12% contingency (t) | 108 | 54 |
| Total bait (t) | 1008 | 504 |
| Bait pods | 1440 | 720 |
| Fuel drums | 2000 | 1000 |
| Flight time set up (hr)# | 362 | 181 |
| Flight time baiting (hr)# | 1336 | 668 |
| Flight time demobilisation (hr)# | 242 | 121 |
| Total flight time (hr)# | 1940 | 970 |
| Total flight distance (km) | 10 200 | 10 200 |

# Figures are based on a conservative estimate that good visibility, rain and wind conditions occur 15% of the time (upper value for days with wind gusts >24 kt) and 75% of daylight hours are productive flying (allowing for daily set up, preparations and pack-up procedures).

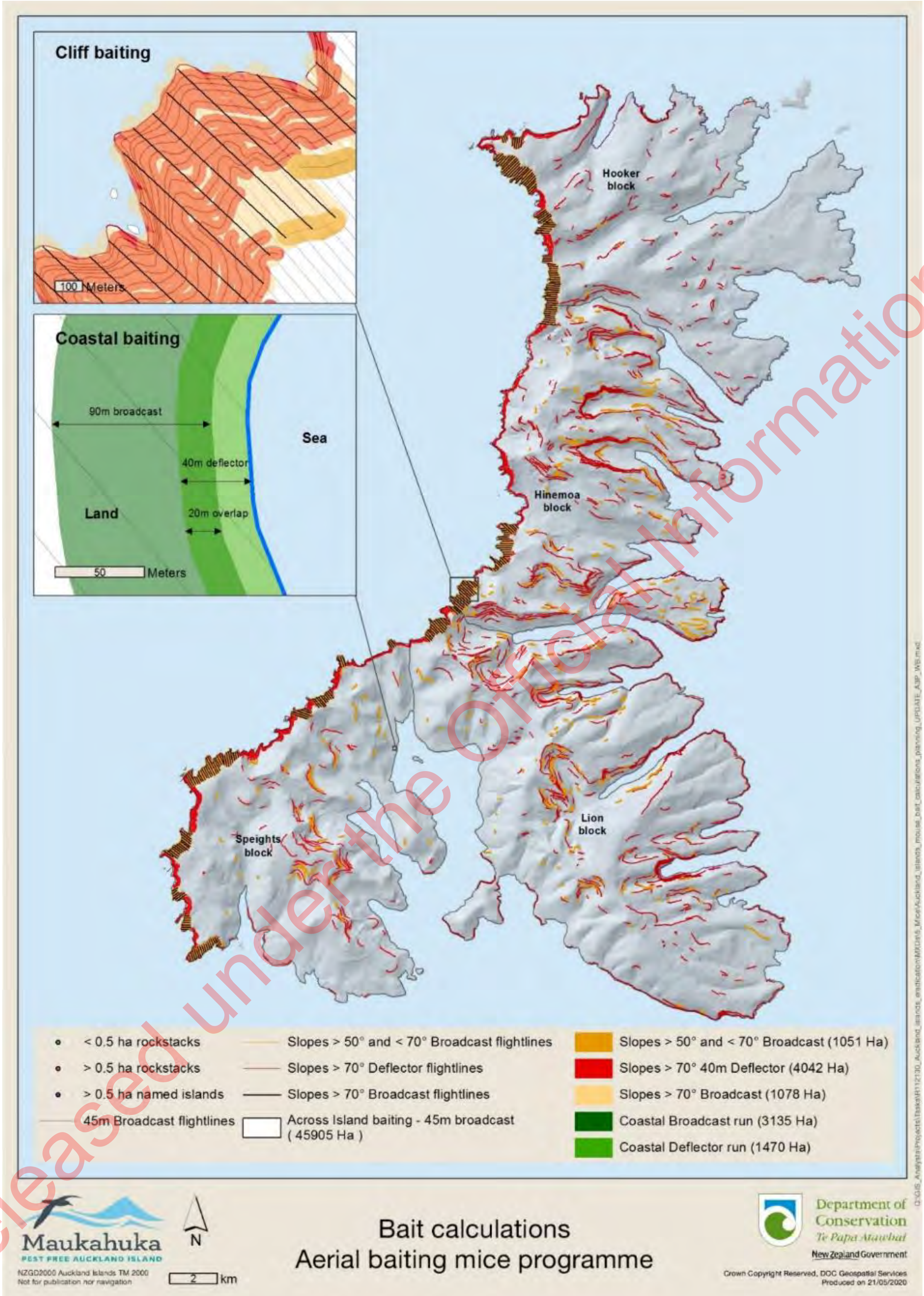



*Figure 13. Proposed bait application method for the eradication of mice on Auckland Island*

#### 5.3.1.2. Bait availability

##### Coverage

Evidence supports that the proposed minimum application rate (4 kg/ha) will put all mice at risk on Auckland Island[51]. Applying bait in two treatments with a minimum interval of 14 days between treatments (best practice)[52] is designed to extend the period of bait availability so every mouse can access bait. Eradication relies on every mouse encountering bait and consuming a lethal dose. An extended period of bait availability is important because mice can be light and erratic feeders[56]. Most die about five days after bait application, though some survive for long periods before succumbing and some require significantly higher doses than others[18]. The second treatment is also designed to mitigate the risk of juvenile mice emerging from the nest after bait from the first treatment is no longer available. For a smaller site, baiting would normally cease between treatments to achieve a minimum interval of 14 days between treatments. Baiting will be continuous at Auckland Island because it will take more than 14 days to complete each treatment (~335 hr flight time per treatment; Table 11).

Mice have small home ranges and a potentially smaller foraging area while bait is available[18]. Female mice range less when breeding and young mice have a very small range[19], suggesting less tolerance for gaps in bait spread in summer when mice are breeding than in winter when there is no breeding. The smallest home range (0.13 ha; lower 95% confidence interval[17]) measured in tussock habitat on Auckland Island would theoretically receive 260 baits per 4 kg/ ha application, more than enough for every mouse to encounter a lethal dose (approx. 0.5 bait). This assessment is supported by positive results from the bait uptake trial of a single application of 4 kg/ha at Auckland Island in summer 2019[51]. Only two mice of 232 sampled in the treatment area had not consumed bait. Both were small juveniles (<10 g) and it is believed they would have been vulnerable to a second application of bait a few weeks later, once mature[51].

Bait spread to cover the whole of Auckland Island is expected to be sporadic, completed over weeks as weather allows. Each period of baiting activity will build on previous work to progress bait coverage along the treatment area in a 'rolling front'[52]. Some baits will inevitably be exposed to degrading conditions a short time after application. The durability of Pestoff 20R® during bait uptake trials on Auckland Island in summer 2018/19 is encouraging. Bait remained available to mice and in generally palatable condition after nine nights despite significant rainfall (138 mm) during that period. Availability reduced from 4 kg/ha to a minimum of 0.6 kg/ha after nine nights[9]. This lower estimate equates to availability of 39 baits within the lower 95% confidence estimated home range of 0.13 hectares[17].

##### Steep slopes

There are ca.4042 ha of slopes greater than 70° (cliffs) where additional bait is to be applied using directional buckets (Figure 13; section 5.3.1.1). Altitude gains of approximately 40 m (approximate swath width of directional bucket) should be used per flight line until the area is covered with confidence that baits have reached all vegetated areas. Photo analysis of coastal cliffs (Maukahuka Western Cliffs Tool) reveals several places where flying parallel with cliffs may not be possible (e.g. deep gullies and tight turns involved). This should be confirmed by a boundary flight. Additional bait application with the helicopter flying inland towards and overtop of such areas should be considered. This has been estimated at 1078 ha and accounted for in bait volume calculations.

### Non-target species

The pig eradication must be completed before the mice eradication can commence. Pigs were temporarily eradicated from the mouse bait uptake trial treatment site on Falla Peninsula on the assumption they would consume cereal baits and create holes in the bait distribution[9]. One pig was known to have broken through the exclusion fence and faeces with tracer dye were found (away from the mice trapping grids[8]), indicating consumption of baits. Bait uptake trial results indicate that cats did not create gaps in bait availability[9]. Some level of population reduction of cats from secondary poisoning is expected and will aid the subsequent cat eradication (section 5.4.1.1).

No other showstoppers have been identified for mice baiting relating to non-target species. No native species that may widely consume and/or significantly impact bait availability have been identified (section 5.5.3). An assessment of environmental effects of island-wide bait distribution will be investigated in the planning phase (section 5.5.3).

*Next steps for quality project design:*

- *Plan for a one-year gap between pig and mice programmes to allow the pig eradication to run longer if necessary and avoid preparing for mice programme while pig hunting is ongoing.*
- *Work out details of what needs extra baiting and how it can be achieved during operational planning.*

### 5.3.1.3. Seasonal timing

### Coverage

Bait application on Auckland Island is planned to occur between November and March (austral summer) and trials support that this timing will allow all mice to be put at risk. Baiting could start earlier but should be completed by the end of February before tussock seed matures and becomes available in March. An attempted eradication will fail if bait spread cannot be completed across the whole island at least once. Summer timing instead of the usual winter timing will improve the probability of completing the broadcast of minimum 504 t of bait in the generally inclement weather (section 5.1.3). A summer operation is recommended as there are around twice the number of daylight hours (max. 16.5 hr) than winter (max. 8 hr) for helicopter operations (Table 12). The proposed timing is a balance between the risk of not completing bait coverage in the winter due to operational constraints (Table 11; Table 12), helicopter availability, increased risks in summer of alternative food sources and the presence of juvenile mice, which may not immediately eat bait.

A logistical comparison between winter and summer timing (Table 12) shows that nine helicopters would be required to complete two bait treatments in 90 days in winter for the assumed conditions, compared to six helicopters in summer. Sourcing and supporting up to nine helicopters for a winter operation (Table 12), for remote deployment is not feasible. The pool of baiting pilots with the required skills is small and unlikely to meet the needs for remote deployment to service nine helicopters for several months. Sourcing up to six helicopters is feasible but challenging, requiring the right incentives, personnel and personal motivation.

The total area for bait spread over the two treatments has not yet been achieved in a single season for any rodent eradication to date. Considering the average weather at the site and its unpredictability in any given season or year, the uncertainty is too great to confidently predict completion of bait spread in the winter season at this scale. Therefore, it is recommended that an operation is timed for summer. Six helicopters could advance baiting progress rapidly (4 to 5 t of bait per operating hour) when conditions are good.

The weather for baiting is expected to be generally poor (sections 3.3; 5.1.3), increasing the risk of long interruptions or washouts of bait. Experience on Auckland Island in summer 2018/19[9] and baiting on Antipodes in winter 2016[18,57] support the notion that bait spread on Auckland Island will be sporadic. It will require utilisation of short weather windows (productive time of >1 hr depending on the situation). To increase efficiency, multiple bait loading sites should be used to reduce helicopter transit time for reloading (Figure 21). A total of nine load sites are proposed based on a 5 km radius for transit, and approximate location based on topography to improve likely access in low cloud conditions (Figure 14). Final locations of bait loading sites will be informed by site knowledge during the infrastructure and pig programmes. 'Pop-up' loading sites could support pre-established loadsites where required.

Interruptions to baiting of more than three days will require application of additional bait at boundaries between treated/untreated areas, depending on the duration of the interruption and condition of bait. This is to mitigate the risk of mice migrating to areas where viable bait is not available and is an important use of contingency bait.

Poor weather can inhibit the completion of bait spread on large islands. For example, in 2010 on Macquarie Island (12 800 ha) only 8% of the island could be baited in two months due to low cloud and high wind[43]. A second attempt the following winter in better conditions completed baiting of 330 t over 12 800 ha (2 full + 1 part treatments) in less than three months using four single engine squirrel helicopters (BA and B2 models[43]). If extremely poor weather restricts baiting on Auckland Island to one treatment rather than the planned two, the programme would still have a chance of success (e.g. mice phase South Georgia Eradication[58] and summer trials Auckland Island[9]). Planning should allow for flexible decision making.

Mechanised bait loading using conveyors transportable by helicopter should be considered at the main base sites. These won't speed up bait loading but will decrease the time bait loading personnel spend working near a hovering helicopter. High-speed refuelling will be important to reduce downtime. Pilot downtime due to weather counts as duty time unless the pilot had pre-rostered time off. Pilot fatigue is a priority risk to manage. Logistics management software such as 'Air Maestro' (Adelaide, Australia) is available to help manage duty and flight time for operations involving multiple pilots. Helicopter operations at Auckland Island during summer 2018/19 identified difficulties in balancing pilot availability with rapidly changing weather forecasts. With only one pilot doing passenger flights and baiting, several additional days off were needed to reset the 7-day duty period every 3 – 4 days to avoid missing a weather opportunity for baiting in the longer-range forecast (seven days ahead). It is recommended that two pilots only are rostered on at a time to conduct passenger transfers.

*Next steps for quality project design:*

- *Understand how flight and duty hour regulations will structure pilot rosters for baiting work (Part 137 operations -CAA regulations). Monitor changes to the regulations during operational planning.*
- *Consider how to react in case the first treatment is delayed beyond the time where a second treatment could be attempted.*

*Table 12. Comparison of helicopter baiting between winter and summer on Auckland Island, assuming the same weather conditions apply to each season*

| | **Winter** | **Summer** |
|---|---|---|
| Months | May – Aug. | Nov. – Feb. |

| | | |
|---|---|---|
| Approx. daylight hours | 1058 | 1864 |
| Estimated productive flight time needed (hours) | 668 | 668 |
| Helicopters needed to complete baiting in 120 days# | 7 | 4 |
| Helicopters needed to complete baiting in 90 days# | 9 | 6 |

# Figures are based on a conservative estimate that good visibility, rain and wind conditions occur 15% of the time (upper value for days with wind gusts >24 kt) and 75% of daylight hours are productive flying (allowing for daily set up preparations and pack-up procedures).


*Figure 14. Proposed bait loading sites for mice baiting operations on Auckland Island with relevance to altitude and operating areas*

## Eradicating breeding mice

Results from the bait uptake trial in summer 2018/19 show all mice can be put at risk on Auckland Island from bait application in summer when mice are breeding, especially if a second treatment is completed several weeks after the first[51].

Expanding populations of mice have been eradicated from islands previously. Mice were eradicated from Maud Island in winter 2014 using best practice (2 x 8kg/ha)[18], and again in winter 2019 (2 x 4 kg/ha) after an incursion event led to a population of mice re-establishing[55]. In winter 2017 mice were eradicated from Adele Island (87 ha) in the Abel Tasman, in the presence of abundant natural food and using a single application of 3 kg/ha of Pestoff Rodent Bait 20R® (C. Golding 2019, pers. comm.). The mice eradication on Subantarctic South Georgia occurred with bait spread during the autumn (March to May), when mice numbers were highest, but the breeding rate was beginning to decline[58].

Apart from weather and daylight conditions, summer timing with completion by March is recommended instead of autumn or winter to avoid tussock grasses in mast years potentially providing a large alternative food source, widely available across ca.10 000 ha of habitat. Mice can breed all year round if high quality food is available but generally have distinct breeding seasons on cool climate islands and stop breeding in winter[53]. Mice were recorded breeding on Auckland Island in winter 2007 following a large tussock seeding event (mast) in 2006/07[59]. Population density and abundance were significantly higher in winter 2019 than summer 2018/19 due to a tussock mast in autumn however, no breeding was detected in winter despite mice being in excellent condition[14].

Results from the bait uptake trials in summer 2018/19 show that mice eradication timed for summer can occur in a masting season if baiting can be completed before seed ripens in autumn[51]. The population density of mice on Auckland Island was elevated in the summer following the large tussock mast (2019/20) relative to results from the masting summer (18/19) when bait uptake trials occurred[60]. Bait availability at 2 x 4kg/ha would still provide enough bait for the highest population density recorded. Timing an eradication for the summer following a large tussock mast warrants further consideration. In this event, possible actions would be to proceed as planned; increase bait quantity to match the logistical capacity once a ship has been identified; or delay mice baiting and subsequent cat eradication by a year.

#### 5.3.1.4. Bait production

The quantity of bait required to eradicate mice from Auckland Island can easily be produced. Pestoff Rodent Bait 20R® is the only bait registered in New Zealand for aerial distribution to target mice. Orillion, based in Whanganui, New Zealand, is the only manufacturer of Pestoff Rodent Bait 20R® and can produce the required volume of bait (J. Quigley 2019, pers. comm.). One month of production time should be allowed for production of 500 t using both plants, or a maximum of 100 days using only the smaller C-Plant. A lead-in time of six months between order and production is required to ensure availability of raw materials. This becomes a decision milestone for the mice operation as the bait has a shelf life of 12 months according to the label. Working back from baiting starting in November, the island set up should occur no later than September to give time to prepare the arrival of the baiting team. Bait production should be completed, and bait delivered to port of departure in July to allow re-manufacture of part or whole order in case of problems. Confirmation of the bait order would be required in December of the year prior to production.

#### 5.3.1.5. Validation

Validation of the eradication of mice would preferably occur a minimum of two mice breeding seasons following bait application to determine success[52]. A limited range of detection devices, (largely reliant on only two tools: inked tracking cards in tunnels and rodent detection dogs, to avoid confounding results), will be deployed across the island in areas considered to be the most likely refugia for mice.

Result monitoring should be undertaken towards the end of the cat programme when helicopters and field huts are still present. Waiting longer than two years would increase confidence for less effort but monitoring should be completed before removal of base and helicopter facilities in case of failure. Timing the monitoring for when helicopter support was present would facilitate efficient island-wide monitoring to increase confidence of validation. Intensive monitoring for survivors during the two years post baiting is not recommended with current knowledge, due to the scale of the island and the low likelihood of detection or ability to respond. A well-timed sampling approach is achievable.

The island-wide network of cameras deployed to detect cats could give early indication of failure to eradicate mice. Absence of mice detection on cameras would not be definitive as the camera network will not be targeting mice, which move much faster than cats and may be undetectable at low numbers. If mice are detected then physical evidence is required to compare DNA with voucher samples to rule out incursion, as opposed to eradication failure[61]. Nuclear DNA samples from Auckland Island mice show the mice population originates from America and are genetically distinct from mice on mainland New Zealand[62]. Verification of whether a mouse caught after the baiting operation is a survivor or from an incursion should therefore be easily determined. Voucher samples of Auckland Island mice for reference are held by Te Papa Tongarewa (Dr Colin Miskelly) and University of Auckland (Dr James Russell).

*Next steps for quality project design:*

- *Use site knowledge gained throughout programmes to inform surveillance sites for mice eradication validation*

## 5.4. Cats

Trials on Auckland Island in summer 2018/19 and winter 2019 have greatly informed the feasibility of eradicating cats and reduced uncertainties. We are confident cats can be eradicated with the proposed method (Figure 15). No single tool is available that can put all cats at risk, but a suite of tools has been identified that can target every individual. Tools will be implemented from the most passive to the most aggressive over time (Figure 15). Combined with intensive monitoring, this approach gives the best chance to conclude eradication.

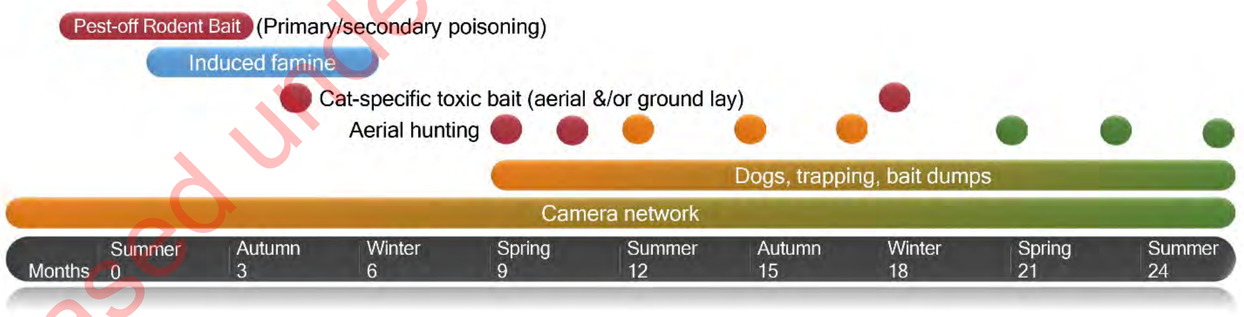



*Figure 15. Proposed sequence of methods to eradicate cats from Auckland Island. Red = Knockdown; orange = mop-up; green = validation. Blue indicates state induced by eradication tools.*

Knockdown will be achieved primarily through both primary and secondary poisoning. Secondary poisoning of cats from mice baiting operations is considered critical for cat population knockdown. The cat specific toxic bait currently being developed by the DOC Biodiversity Threats team, supported by the Maukahuka team (DOC-6214883), will greatly increase efficiency and the likelihood of eradication success. Aerial hunting assisted by thermal camera technology (see section 5.2.2.4) will be used for knockdown in light vegetation and inaccessible areas.

The operation will be continually assessed, and the approach adjusted based on information from multiple monitoring tools. An island-wide camera grid installed before baiting begins, targeted trapping, trained cat dogs and bait dumps will provide means of detecting and targeting individuals while simultaneously providing a means of validating eradication across temporal and spatial scales once known individuals are (presumed) dispatched. Multiple detection tools will increase confidence in success.

Island-wide surveillance using trail cameras is logistically achievable with installation of tracks, and helicopter and boat support. Automated image processing software (see section 6.1) is needed to make data management feasible and a rechargeable battery pack would greatly improve camera maintenance.

#### 5.4.1.1. Brodifacoum poisoning

The cat operation should be timed to follow immediately on from the aerial distribution of Pest-off Rodent Bait 20R® to eradicate mice on Auckland Island. Cats are not the target species of this toxic bait but previous projects have reported knockdown of cats following rodent eradications using brodifacoum ranging from <50% to 100% of the population[29]. Achieving 100% knockdown of cats on large islands from aerial baiting for rodents is unlikely. We therefore assume that there will be some, but not total, population reduction of cats following a mice eradication through primary and/or secondary poisoning.

It would be beneficial for the camera network (see section 5.4.1.3) to be operational prior to commencing the mice baiting programme. This would allow the trend in distribution and abundance of cats to be followed pre and post mice baiting to ascertain the level of knockdown achieved and to provide a reference for change in behaviour as the population is affected. This additional monitoring adds costs that would be re-cooped if the operation could be concluded earlier as a result.

#### 5.4.1.2. Cat specific vertebrate toxic agent (VTA)

Aerially applied toxic baits for cats is preferred as an additional knockdown tool for this eradication due to the scale and terrain of the island (Table 13). Aerial application would allow bait to be efficiently broadcast across the island and delivered to steep slopes (>70°), where people can't access (ca. 4042 ha). Additionally, bait could be hand laid to target known individuals during the mop-up phase (see section 5.4.1.6).

All successful cat eradications on islands >2500 ha, bar one, have used primary poisoning for knockdown[29]. The use of toxic bait may be more efficient than trapping for knockdown and mop-up, though the use of both methods should be considered to account for individual behaviours[29,63]. The likelihood of bait uptake by cats is increased by bait being palatable (preferably fresh, not dried), one bait being a lethal dose and bait being delivered when natural prey sources are low[63].

The eradication of mice on Auckland Island may impact the cat population through the removal of a food source. Prey diversity appears to be fundamental to cat survival on Auckland Island and evidence shows that cats there are adaptable, opportunistic hunters[27]. The impact of losing mice as a prey source is dependent on the availability of alternative food sources. There is uncertainty on Auckland Island about how the bird populations will respond to the removal of mice and the distribution of marine-derived food. The absence of mice is expected to change the distribution of cats by pushing some remaining cats into the coastal areas where they can access marine-derived food and/or increase their consumption of alternative food sources, including poison baits.

To increase the likelihood of cats on Auckland Island encountering fresh bait on this complex landscape, we propose to apply one sausage bait every 40 m with flight lines 500 m apart (1 $kg/km^2$) in winter. Each cat would have access to between 77 and 3561 baits, based on current home range data from Auckland Island cats[25]. An additional application around the perimeter of the island would concentrate bait in the area where cat population density is highest (rātā forest and steeper coastal habitat where seabirds reside), based on GPS tracking data to date[25]. Total helicopter flight lines for this bait application rate are 1219 km, taking approximately 45 hours of flying. This is at least double the prescription previously used during the successful eradication of cats from Dirk Hartog Island in Australia, a simple, arid landscape[63].

Second and third applications of bait should be resourced and applied as required. This would be considered if detection methods show that cat distribution changes following knockdown and/or if some cats were unlikely to have encountered bait because of poor bait availability (rapid degredation) or alternate prey source availability. For example, a few collared cats appear to access Antarctic prion/totorore (*Pachyptila desolata*) fledglings in the western cliffs during late summer but move back into their eastern coastal territories over winter[9,14,25].

There are currently no cat-targeted toxic baits registered for aerial application in New Zealand (Table 14). Registered ground-laid baits are based on sodium fluoroacetate (1080) and unencapsulated para-aminopropiophenone (PAPP). DOC's Biodiversity Threats team is developing an encapsulated PAPP-based toxic bait for aerial distribution to target stoats and cats (Table 14). Sausage and 'meat glue' blocks from Connovation (Auckland based provider of pest animal control products) have been developed. A non-toxic field trial of these meat baits showed they were highly palatable to cats on Auckland Island[14]. Toxic bait development is at the pen trial stage but trials of toxic versions have to date proven unsuccessful and much work remains to realise this tool.

Registration of a new toxic application in New Zealand is hugely complex and time consuming. It follows a prescription regulated by the Environmental Protection Agency and the Ministry for Primary Industries. The steps for toxic bait development are:

- develop a bait matrix that is palatable and logistically suitable
- select a toxin and determine the most appropriate toxin concentration and formulation
- test efficacy and degradation properties
- assess environmental impacts and degradation
- develop appropriate baiting procedure
- consultation
- registration

Failure at any of these steps could halt the process, requiring redesign and associated delays, or abandonment. For example, the recent registration of Cholecalciferol for rodent bait application in New Zealand took 10 years[64]. Operational planning will proceed with decision points and contingencies in place. Should an aerially applied VTA for cats not be available, trapping would be relied upon as a knockdown tool for cats on Auckland Island and greater hunting resource would be required. A registered and proven bait would need to be available by the end of the pig programme to secure supply in time and train additional cat hunters if the bait in this case. This is still considered feasible, though with a lower confidence in the result due to the increased time scales involved, and potentially a much greater effort to achieve success.

*Table 13. Advantatges and disadvantages of the use of an aerially applied vertebrate toxic agent (VTA) to target cats for eradication on Auckland Island*

| Advantages | Disadvantages |
|---|---|
| • Passive technique<br>• Accessibility – aerially applied VTA can be efficiently delivered to all habitats and terrain, including the scrub zone and the western cliffs. Ground applied VTA requires less effort than ground-based trapping.<br>• The logistics and resources for bait spread are feasible, easily repeatable in any season and minor compared to ground-based trapping or hunting.<br>• The registration of PAPP encapsulation in meat bait for aerial distribution is underway<br>• Beneficial for projects across New Zealand | • Costly and time consuming to develop and to register with many uncertain steps and timeframes<br>• Unproven – needs to be tested to ensure that bait is palatable to cats and show that most cats will consume a toxic dose<br>• Developing a cat specific VTA may have low level of social acceptability, especially if 1080 is used. |

*Table 14. Potential options for cat specific vertebrate toxic agent (VTA) to facilitate the eradication of cats from Auckland Island*

| VTA | Current status | Development and registration requirements for aerial application | Cost (NZD) & timeframe |
|---|---|---|---|
| Feral Cat Polymer bait[1] | Registered for bait station and hand laying | • Field efficacy trial<br>• Specific bait breakdown data<br>• Registration variation | $250 – 300K<br>3 years |
| 1080 solution in bait | Not Registered | • Bait development<br>• Bait palatability<br>• Pen and field trials<br>• Specific bait breakdown data<br>• New registration | $400 – 500k<br>5 years |
| PAPP PredaStop in bait | Registered for bait stations. | • Bait development<br>• Bait palatability<br>• Pen and field trials<br>• Specific bait breakdown data<br>• New registration | $400 – 500k<br>6 years |
| 1080 encapsulated in bait | Not Registered | • Bait development<br>• Bait palatability<br>• Encapsulation development<br>• Pen and field trials<br>• Specific bait breakdown data<br>• New registration | $400 – 500k<br>5 years |
| PAPP[2] encapsulation in bait | Not Registered | • Bait development<br>• Bait palatability<br>• Encapsulation development<br>• Pen and field trials<br>• Specific bait breakdown data<br>• New registration | $400 – 500k<br>6 years |

[1]ACP 1080 Fishmeal polymer feral cat bait is perceived as inefficient. The palatability of a non-toxic fishmeal polymer bait was trialed during winter 2019 and found to be significantly less palatable than sausage or meat glue baits[14]. Field trials showed the toxin quickly degraded in the damp environmental conditions on Auckland Island[14].

[2] Non-toxic field and pen trials showed these baits to be highly palatable. Toxic baits are in the pen and field-based trial stage.

*Key Risk:*

- *An attempt to eradicate cats from Auckland Island using currently available tools, whilst feasible carries a significant risk of failure as well as higher costs and longer duration. Development and registration of an effective toxic bait registered for cats that can be aerially applied would greatly enhance confidence and reduce eradication timeframes.*

*Next steps for quality project design:*

- *Ensure decision points for contingency planning are integrated into operational planning, in case a bait is not available.*

#### 5.4.1.3. Camera detection network

Eradicating cats on this scale and in a logistically feasible way relies on high confidence in the ability to detect cats. Following advances in quality, affordability and longevity, camera traps are becoming an increasingly common tool for large scale, remote wildlife monitoring[63]. Trials showed that currently available game cameras with a meat lure are an effective tool for detecting cats on Auckland Island in all seasons and a camera grid can provide data to enable targeting of individuals[9,14]. Moreover, a camera detection network negates the need to collar and follow individual cats through the mice baiting to monitor knockdown. This is particularly important as trapping cats to collar them introduces a risk of educating individuals immediately prior to the implementation of eradication tools.

Spacing of devices should be based off the smallest known home range across the year (currently 154 ha)[25]. Using a camera grid that is as tightly spaced as logistically feasible will increase detection probability and likely reduce the duration of an eradication. Camera spacing of 500 m x 500 m (or one camera per 30 ha) was effective in detecting the cat with the smallest known home range twice during the summer 2018/19 trial (ca.27 days)[9]. One camera per 30 ha equates to a grid of approximately 1530 cameras across the island.

An on-island cat detection team of 20 is proposed, with the whole team installing the camera grid, then half the team servicing the cameras and the other half being mostly dog handlers and some ground hunters without dogs who will monitor and respond to cat detections from all tools (see section 5.4.1.4). Installation is estimated to take 24 days by a team of 20 and servicing the grid should take 20 days by a team of 10 (with boat and helicopter support; Table 15). Additional cameras could be deployed in areas where cat density may be higher, e.g. in areas of high prey availability.

Servicing cameras will progress along the island, with field teams systematically visiting each camera in an area before moving on. A range of lures (food, visual, social or audible) pulsed through the camera network can be useful to increase interest of individuals[9,63] but are not essential as cameras on active game trails can detect cats without a lure[9]. It is generally acknowledged that careful placement of cameras at each site and within a landscape are of primary importance to the success of these tools[63]. Building capacity and capability of a skilled team with an eradication mind-set is also essential to ensure the success of this tool. The preferred frequency of camera checks would be approximately monthly but subject to battery life, lure life (if necessary) and the need to target individuals. Lithium batteries have performed well in the Auckland Island climate and battery life is not considered a limiting factor for the camera network. The cost and logistics associated with large volumes of lithium batteries required for 1500+ trail cameras over several years supports investigation of rechargeable battery packs or an energy supply.

Camera detection trials on Auckland Island highlighted that processing photos and data from landscape-scale camera networks is prohibitively labour intensive[9] and thus at the proposed scale for this project is not feasible, nor would it allow rapid detection and response to target individuals. To feasibly manage data from the proposed surveillance, automated processing of image data is required to triage falsely triggered images (no animal present) as a minimum and preferably identify images where cats are present. Software and coding to support the initial sorting/triage of images are available and becoming increasingly reliable (DOC-6238927). The Maukahuka team has engaged with various organisations that are working on developing Artificial Intelligence (AI) systems for automated recognition of species from camera footage and thermal detection cameras (DOC-6238927).

Automated detection of cats using a camera that can capture imagery and identify a cat through thermal sensing technology would again reduce data management. If such a detection device could be coupled with a remote camera network that instantly reports detections to a base computer, these technologies could save an enormous amount of labour. More importantly they could enable rapid response, potentially shortening the time to conclude eradication. Small-scale nodal remote camera networks are currently in use in New Zealand for various conservation programmes (e.g. Glenfern Sanctuary, Aotea/Great Barrier Island). Trials of thermal cameras built by the Cacophony project were initiated on Auckland Island in August 2019[14]. Thermal cameras are currently ten times the cost of trail cameras but have the potential to save money by minimising data processing and enabling rapid response to a detection. While these technologies are not essential to eradication success the Maukahuka team has engaged with groups leading these developments (DOC-6214883) to understand the potential and status.

*Key risk:*

- *Utilisation of trail cameras at this scale is not feasible unless automated image processing software to label and triage imagery from the camera network is available and reliable. This must be manageable and aimed at optimising the time between a cat being caught on camera and responded to.*

*Next steps for quality project design:*

- *Complete analyses of detection probabilities with different camera spacing, cat home range data and maintenance effort to inform the prescription.*
- *Development of a reliable long-life lure to compliment remote camera network.*
- *Seek improved battery pack options for cameras.*
- *Investigate advances in remote sensing technology during project planning and perform a cost benefit analysis for their use on Auckland Island.*

*Table 15. Effort to install and service camera network on Auckland Island based on findings from on-site summer trials 2018/19*[9]

| Activity | Effort measure |
|---|---|
| Installation of cameras on 500 m grid, limited tracks | 4 cameras per person per day |
| Maintenance of cameras on 500m grid, limited tracks | 10 cameras per person per day |

| Activity | Effort measure |
|---|---|
| Installation of whole grid (n = 1530 cameras): 20-person team with 20% redundancy (days off, injury, weather etc), | 24 days |
| Maintenance of whole grid (n = 1530 cameras): 10-person team with 20% redundancy (days off, some data management, injury, weather, etc) | 20 days |

#### 5.4.1.4. Dogs

Dog teams are proposed as a complimentary detection technique to run alongside cameras throughout the mop-up and validation phases. Dogs will help target effort including the placement of traps or other detection tools and locate dead cats, scats, etc. A systematic grid search is not proposed. Dog handlers and dogs will be used to identify areas of fresh sign and sweep areas where cats are most likely to persist such as places with localised and/or seasonal prey sources. By virtue of working alongside other detection methods, dog teams may effectively cover the island up to two times during the mop-up and validation phase. Dog team effort will be like the camera team effort, as teams will be working alongside each other to target cats. Detection dogs have been used during previous eradications to search for cats during mop-up and validation phases[63]. Dogs were found to be particularly effective at identifying fresh cat sign and buried scats on Auckland Island during summer 2018/19. Currently there are insufficient cat-dog handler teams to meet the needs of the project. However, with adequate lead-in this can be addressed through a training programme.

#### 5.4.1.5. Trapping to target individuals

Most successful cat eradications have relied heavily on leg-hold traps during the mop-up phase[63]. Leg-hold traps serve a dual purpose of detecting and capture of remaining individuals. Leg-hold trapping guided by trail camera footage and dogs is proposed as the primary method of targeting cats in the mop-up phase. Leg-hold traps were used successfully during recent trials on Auckland Island and trapping efficiency was greatly increased when cameras were used to target trap placement and design the trap set[9,14].

Evidence supports the use of a range of lures for trapping, including food, visual, social or audible lures, to increase interest from individuals[63]. The density of traps used in cat eradications varies widely due to a range of factors such as terrain, home range size of cats, ability to cut tracks, and variation in the sequence of techniques etc. Trap spacing will be informed by analysing home range and habitat use data and can also be tailored to individuals based off data from other tools such as camera footage. A team of 10 people will be responsible for running a trapping programme by responding to detections and targeting effort to catch known individuals, managing a skeleton network of traps in high likelihood areas and assisting with camera network data management. Most of this team should be dog handlers. Currently this capability does not exist, and a training programme will have to be implemented ahead of the programme initiation to meet personnel requirements.

To account for individual behaviour of surviving cats during the mop-up phase, additional trap types are considered for occasional or targeted use. Cage traps are used effectively in cat control operations around New Zealand and have been used in successful island eradications e.g. Tasman Island, where 20 of the last 28 cats were caught in cage traps[65]. At Macraes Flat, cages catch as many cats as leg-holds and all age-classes and sizes of animals are caught (P. Liddy 2018, pers.

comm.). The literature supports a period of familiarisation with open cage traps and food bait to increase their successful use in feral cat populations. A significant advantage of cage traps over leg-holds is that there is a smaller risk of a cat escaping from a cage trap and becoming educated. Cage traps have already been adapted to remote monitoring with remotely monitored networks of cage traps using low-frequency radio technology currently in use at Macraes Flat and on Aotea/Great Barrier Island.

A small number of kill traps could also be used for medium and longer-term surveillance monitoring in areas thought to be free or almost free of cats and places that are difficult to access. Kill traps have an advantage over both leg-holds and cage traps in that they do not need to be monitored daily so can be 'left behind' in blocks that have been worked through. Important caveats to using kill traps are firstly, the surety that any kill traps will function perfectly and have low risk of escapes. Secondly, a suitable long-life lure is available that will reliably attract cats over a period of weeks to months. Thirdly, risks to non-target species need to be understood and be acceptable.

Again, careful placement of traps at each site and within a landscape are integral to the success of these tools[63]. Traps carry a risk of educating animals if an escape occurs[63]. For example, it took 10 months to re-capture a cat that escaped from leg-hold traps during the Raoul Island cat eradication[66]. The risk of escapes can be mitigated to a large extent by using experienced trappers, care in selecting sites and setting up and maintaining trap sets.

*Key risk:*

- *Cat detection dog and handler capability, critical to the success of the programme, is not available at the scale required for Auckland Island. A selection and training programme with adequate lead-in time is needed to build the capacity and capability for a skilled trapping team with an eradication mindset.*

*Next steps for quality project design:*

- *Investigate advances in remotely monitored trapping technology during project planning phase and perform a cost benefit analysis for their use on Auckland Island.*

#### 5.4.1.6. Food dumps to detect and target individuals

Food dumps successfully and repeatedly lured cats on Auckland Island during trials in winter 2019[14]. It is likely that cats on Auckland Island scavenge significantly more in winter than in summer, feeding on coastal detritus such as dead marine mammals. Data from collared cats on Auckland Island[25] and high catch rates in coastal forest in winter 2007[10] suggests that more animals utilise coastal habitat during winter. Strategically placed dumps of food, for instance large amounts of fish or mammal carcasses, can be monitored with trail cameras. If cats are detected at these sites and activity patterns are noted, a shooter stationed at the site can dispatch the animal when it returns or set traps. Animal carcasses (e.g. sheep or pig) are an effective lure and should be placed in covered habitat to limit non-target species (e.g. giant petrels *Macronectes* sp.) consuming bait dumps, increasing the longevity of this lure[14]. Careful placement and/or light vegetation clearance will be required to ensure food dumps will allow shooters a clean shot.

#### 5.4.1.7. Aerial hunting

Aerial hunting assisted by thermal camera technology has been shown to be an effective tool for detecting cats and kittens in tussock and light scrub on Auckland Island[14]. Applications of this tool in thick scrub and forest appear to be limited for cats. Sporadic searching for cats using aerial thermal imaging in alpine areas and inaccessible terrain would be beneficial through the mop-up phase.

Searches along the steep terrain of the west coast could be timed to coincide with petrel fledging as collar data has already shown that some cats make large movements to exploit these resources[9].

*Next steps for quality project design:*

- *Aerial hunting effort will be informed by lessons on the detectability of cats from extensive aerial work during the pig programme. With this information, analyse the costs and benefits of applying this tool for cats on Auckland Island.*

#### 5.4.1.8. Targeted hand-laid toxin

Hand-baiting is an option as a response to a detection on camera (aerial or trail camera). It provides an opportunity to put an animal at risk over a relatively large area quickly and to rapidly target sites where cats are likely to frequent (habitat boundaries, animal tracks). Baiting cameras with toxic bait will provide data to increase the confidence of targeted individuals encountering and consuming toxic bait. Registration and a good understanding of efficacy will inform the use of this tool.

#### 5.4.1.9. Seasonal timing

Targeting mice in summer would mean the mop-up phase for cats can commence in early winter (April onward). In winter temperatures are colder, food is less abundant which will be enhanced by the eradication of mice. For this reason, it is important that the mop-up operation for cats commences as soon as practicable following the mice operation. Bait uptake by feral cats in Australia was seasonally variable but more consistent in late summer and early autumn as prey availability and minimum overnight temperature decreased[67].

*Next steps for quality project design:*

- *Retrieve GPS collars from cats on Auckland Island to understand variance in habitat preference and movement to inform spacing and delivery of eradication tools.*

#### 5.4.1.10. Validation

Validation for the cat eradication will involve a combination of presence/absence data from:

- A network of trail cameras to identify live cats and in some cases to match dead ones with previously collected images.
- Cat detection dogs to search for both scent and scats
- The use of a DNA database to identify individuals and their removal
- The use of aerial thermal cameras to search inaccessible areas

Cat DNA will be collected and analysed following the mouse eradication to help confirm cat presence/absence on Maukahuka. Primarily DNA will be sourced from scats, which can be collected by field staff who record a date and location for each sample. Detection dogs will be used to facilitate collection. Samples will also be collected from cat carcasses located during eradication operations and compared against the database and camera footage to ascertain the likely number of individuals that remain. The turnaround time will be a constraint as samples need to get from the island to a lab on mainland New Zealand to be analysed. The turn-around time will relate to resupply runs, approximately every 3 to 6 months. Ultimately this information will be important at the end of the operation to confirm eradication success and that a decision to stop is appropriately timed.

Presence/absence data collected with the methods described above will be modelled and used to provide a high level of confidence that eradication has been achieved before success is declared.

## 5.5. Acceptability

There is strong support for the project from a range of stakeholders, including the New Zealand public, Treaty partners, concessionaires, Government, potential suppliers, potential partners and internal DOC whanau. No significant negative issues regarding acceptability that may impede feasibility have been identified to date.

### 5.5.1. Socially acceptable

There have been high levels of support for the proposed project to date. Ongoing advocacy and engagement are critical to initiating and funding the project (see section 6.6.4).

#### 5.5.1.1. Treaty Partner support

As tāngata whenua, Ngāi Tahu have a long history and connection with Maukahuka/Auckland Island and the Subantarctic Islands. They have a shared vision to remove mammalian pests from the island. The strong commitment, leadership and support provided to date has been noted both within and external to the Department. Ngāi Tahu is an active member on the Governance Group to ensure hapū and whanau perspectives are embedded in the decision-making process. Nga Papatipu Rūnanga ki Murihiku have provided strong support with involvement of leading Ngāi Tahu kaumatua Ta Tipene O'Regan and the Deputy Kaiwhakahaere supporting the mahi. Ngāi Tahu have clearly stated this place and this project are important to their future.

As the project develops, the opportunity for a true Treaty partnership is emerging, one that allows iwi aspirations to be incorporated in the project design and delivery. Together, DOC and Ngāi Tahu stand shoulder to shoulder, encouraging potential investment partners to share in the vision and commitment to success. A relationship vision document has been drafted to inform project design (DOC-6262719).

#### 5.5.1.2. Public support

The Maukahuka Project has widespread public support to date, which is expected to continue. DOC's programme to rid Antipodes Island of mice in 2016 (Million Dollar Mouse) achieved significant recognition and public support, which could be emulated and expanded upon. For the Maukahuka Project to be well-accepted socially the hugely significant benefits need to be well communicated locally and internationally. The ethical treatment of cats and pigs is likely to be an emotive issue for some members of the public, especially regarding the use of toxins for cats, but can be addressed through engagement and communications.

An important opportunity exists to better connect people to the NZSIA and socialise the stories of its history, value and the great conservation achievements and ambitions for the place. Technology such as live webcams, interactive web pages, citizen science contributions and crowdfunding (e.g. 'sponsor a hectare' campaign) all hold great potential for this project. The networks of project partners locally and internationally offer an opportunity to maximise outreach and engagement with a range of audiences and leverage larger conservation gains.

Initial external communications include articles targeted at key audiences such as Predator Free New Zealand (PFNZ) and Forest and Bird and presentations were given to interested community and business groups. A hui with key potential partners was jointly hosted by Ngāi Tahu and DOC in May 2019. Newsletters and meetings have been used to keep these organisations up to date. A summary of the major feasibility work undertaken between November 2018 and November 2019 was shared with interested parties (Maukahuka Year in Review) at the end of 2019.

There have been challenges with sharing information in a variety of formats through the DOC website. A project website managed in association with a project partner and supplementing the DOC website was a successful strategy for the Million Dollar Mouse project (website hosted by the Morgan Foundation), which could be used again.

The proposed eradication has had support to date from:

- Budget 2018 funding, International Visitor Levy funding and support from MOC and Ngāi Tahu
- Promotion by Predator Free New Zealand Trust
- General public enquiries from individuals, groups and businesses re. donating, volunteering, in kind support, work opportunities, presentations etc

*Next steps for quality project design:*

- *Pursue the development of a project website as an accessible platform to inform and engage public.*
- *Resource the project team with appropriate skills and capacity to undertake advocacy and engagement work reflective of the project size and complexity.*

#### 5.5.1.3. Pig specific interests

Living Cell Technologies conduct medical research on a privately held herd of Auckland Island pigs and have previously stated that they may wish to harvest approximately 10 more pigs from the island, subject to trial results. They hold a current concession to take pigs from Auckland Island. A second company NZeno, established in 2018, have indicated interest in accessing Auckland Island pigs. They are aiming to establish research into pigs as possible kidney donors for humans. They currently hold no concession. The potential medical value of the pigs is not genetic but due to their long isolation from disease, an important factor for research involving animal tissue being used in humans. The research means that there may be a wider public interest in the project, so further engagement and relationship management will be required. The Rare Breeds Society may also be interested in more pigs, having removed 17 pigs in 1999.

*Next steps for quality project design:*

- *Maintain communication with medical research company(s) interested in obtaining Auckland Island. pigs and address future needs to avoid risking delays. Engage with key contacts during planning phase. Removal of further pigs should be completed as early as possible.*

#### 5.5.1.4. Tourists and concessionaires

Auckland Island is uninhabited and visitor numbers are carefully controlled by a permitting system managed by DOC's Permissions team. The tourist season runs from mid-November through to mid-March with 750 – 850 people visiting Auckland Island annually. Several tourist operators hold concessions from DOC to take tourists to the island. The project objectives are aligned with the values of these operators who are supportive of the project.

It will not be possible to suspend tourist activity on the island during the proposed eradication. Good communication with concessionaires is required to manage potentially competing activities on the island (e.g. use of anchorages), and hazards associated with operations. Some infrastructure, and from time to time helicopter and shipping activities will also be visible, altering the wilderness experience for tourists. If managed well there are also benefits to be gained such as better access and visitor experience to heritage areas (e.g. installation of boardwalks and vegetation clearance), and opportunities for storytelling and personal connection with the project via staff representatives on board. Nearby Enderby Island offers a site for visitors to appreciate the natural and historic heritage without compromising eradication efforts. The restoration of native flora and fauna following eradication on Enderby Island provide a tangible taste of the benefits of eradication for visitors to the islands. With good communication the concessionaires will be valuable advocates and have been strong supporters of the initiative to date.

#### 5.5.1.5. DOC internal support

Support will be required from across the Department to deliver this ambitious project, regardless of the final operating model established to govern, manage, control finances and deliver it. For the project to be initiated and sustained, buy-in is needed across the Department, from the top down, with local and national service support critical to success. Working with many internal teams to establish feasibility (Table 16) has highlighted the extent of support required and the capacity pressures facing many teams. Internal communications to create awareness and support for the project within the Department, have occurred throughout the Feasibility Phase.

Technical developments required by the project are being worked on in collaboration with other teams (see section 6.1). Co-ordination and integration of the Maukahuka Project's objectives into these work streams is needed for efficient use of resources and to ensure timely delivery.

*Table 16. Internal DOC teams substantively contributing to Maukahuka Pest Free Auckland Island. See footnotes for abbreviation definitions.*

| Internal Team | Work stream | Collaboration/support provided |
|---|---|---|
| Biodiversity | • Survey and sample design for monitoring | • Technical advice<br>• Financial contribution |
| Business Assurance Unit | • Business case development | • Assurance and technical advice. |
| Customer Engagement Unit | • Communications | • Technical advice<br>• Operational support |
| Finance | • Business case development<br>• BAU | • Technical advice |
| IEAG | • Project design<br>• Quality assurance | • Technical advice |
| ISS | • Image recognition for trail cameras<br>• Mass data storage requirements<br>• Connectivity | • Technical advice<br>• Operational support |
| Operations | • Project delivery | • Operational support<br>• Technical advice |
| Outcomes Management Office | • GIS | • Operational support<br>• Technical advice |
| Partnerships | • Funding<br>• Business model research | • Relationship development |
| Planning Support Unit | • Business case development | • Strategic advice |
| Procurement | • Business case development<br>• Sourcing suppliers<br>• Contracts | • Technical advice |
| Biodiversity Threats | • Thermal camera development<br>• Cat VTA development | • Technical advice<br>• Co-ordination with other invested projects.<br>• Financial contribution. |

DOC = Department of Conservation; IEAG = Island Eradication Advisory Group; ISS = Information Shared Services; BAU = business as usual; GIS = geospatial information services; VTA = vertebrate toxic agent

### 5.5.2. Politically and legally acceptable

The current Minister for Conservation (MOC) strongly supports the project and has acknowledged the strategic alignment between the Maukahuka Project and PF2050. This support was exemplified by the award of funding from International Visitors Levy Fund in 2019 for initial planning, approved by the Minister of Tourism, MOC and Minister of Finance. The strong and visible support from Ngāi Tahu has had a significant positive impact on the MOC's support.

The project must adhere to a variety of legislation, regulations, procedures and codes of practice, overseen by agencies including Maritime NZ, Civil Aviation Authority, Ministry of Primary Industries, WorkSafe and DOC. A compliance register is stored at DOC-6040470 and will evolve with the project. Uncertainties that have been identified and may have an impact on planning are summarised in the appendices (Table 30).

Applicable legislation is the Wildlife Act 1953; the Wild Animal Control Act 1977; the Resource Management Act 1991 (RMA); the Animal Welfare Act 1999, the Marine and Coastal Area Takutai Moana Act 2011; the Marine Mammals Protection Act 1978; the Fisheries Act 1996 and Heritage New Zealand Pouhere Taonga Act 2014. A Regional Coastal Plan for Kermadec and Subantarctic Islands (Coastal Plan) is a requirement of the RMA and became operative on 15 September 2017. It mainly manages the risks of oil spills and marine biosecurity breaches. The Southland Murihiku Conservation Management Strategy 2016 (CMS) is a statutory document prepared under the Conservation Act 1987 that aims for integrated management of the natural and historic resources and specifies what activities are considered appropriate. A Resource Consent will be required for the related infrastructure and these will be covered by the Infrastructure and Logistics Operational Plan. Resource Consent is not required for the application of brodifacoum (Regulation 5, Resource Management (Exemption) Regulations 2017). A compliance register is stored at DOC-6040470 and should evolve and be reported on as the project progresses. Uncertainties that have been identified and may have an impact on feasibility are summarised in the appendices (Table 30).

Semiautomatic firearms are needed for effective aerial hunting in this eradication situation. The ban on semiautomatic firearms will affect future procurement. Dispensation to purchase and hold will be required, and firearms will likely need to be imported as New Zealand suppliers will no longer stock them. Permission to import restricted firearms will need to be acquired. Secure firearms and ammunition storage on the island and during transit will either need to be inspected by the police or dispensation from an in-person inspection gained and standards considered during infrastructure design.

*Key risk:*

- *The duration of this project will span several election cycles and may be subject to varying levels of support. Strive to secure Crown investment for the life of the project to minimise impacts of external disruptions. Use a collaborative approach to ensure Government and partners hold each to account.*
- *Changes to protocols, permissions and legislation are likely to occur over the life of the project, with potential to increase complexity and cost which could impact feasibility. For example, DOC is currently reviewing the helicopter operating protocols and project feasibility is dependent on positioning single engine helicopters onto Auckland Island by direct flight. Good relationships with external regulatory bodies and internally within DOC are vital to proactively manage project*

*risk. Potential exemptions or grandfather clauses may mitigate some of the effects for changes introduced during the project.*

*Next steps for quality project design:*

- *Understand how changes to the Regional Coastal Plan, CMS and DOC's Helicopter SOP may impact project activities and plan contingencies.*

### 5.5.3. Environmentally acceptable

No significant negative impacts that may impede feasibility have been identified to date. All infrastructure installed for the project will be removed upon successful completion of the pest programmes, unless district or national Departmental need directs otherwise. No population of non-target native species present on Auckland Island or other islands in the archipelago are considered at risk. Past eradications and recent on-island trials provide an indication of potential environmental effects, including but not limited to non-target species impacts, soil and vegetation clearance and disturbance, increased biosecurity risks, change to weed species distributions or abundance, waste management and transport, storage and use of toxins and fuels. For example, disturbance to vegetation from the infrastructure programme are expected to rapidly reverse over 5 – 20 years (demonstrated by vegetation recovery on Antipodes Island after temporary infrastructure setup for the mouse eradication was removed; and Enderby Island after rabbits and cattle). The successful eradication of mammalian pests is likely to generate overwhelmingly positive changes for the Auckland Islands (see section 4.4).

Some individual mortality of gulls species (*Larus* sp.), skua/hākoakoa (*Catharacta antarctica lonnbergi*), northern giant petrel/pāngurunguru (*Macronectes halli*), falcon/kārearea (*Falco novaeseelandiae*), Auckland Island pipits/pīhoihoi (*Anthus novaeseelandiae aucklandicus*), Auckland Island dotterels/tūturiwhatu (*Charadrius bicinctus exilis*) and non-native bird species is expected. Secure reservoir populations of native species exist on pest-free islands within the archipelago and could support a low to moderate level of reduction in breeding populations.

Release from browsing by pigs and mice, and soil disturbance may result in an increase in abundance or distribution of weed species. Lessons from Antipodes Island show the value of follow up weed surveys at infrastructure sites, where introduced weed species have been removed despite the intensive pre-departure quarantine that was in place[57]. The locally exotic New Zealand native Olearia was introduced to Auckland Island and has the potential to expand and compete with native plants, particularly in disturbed coastal areas. No other significant weed issues have yet been identified and impacts will likely be manageable with operational biosecurity and a commitment to post-operational surveillance to detect and stop weeds establishing. An updated weeds survey and management plan is required in the short term and falls under the mandate of the Southern Islands team, Murihiku.

Working dogs will be present on the island following toxic bait applications. There is a risk to dogs from primary poisoning, eating baits, and secondary poisoning through scavenging carcasses. Handlers and staff must be vigilant to this risk and mitigations used as required (e.g. use of muzzles, removal of poisoned carcasses from high risk areas, etc).

A register of known heritage sites exists (DOC-5457949) and all site works will comply with required permissions (see section **Error! Reference source not found.** and Table 30). As part of operational planning, the Maukahuka Project will undertake an assessment of environmental effects (AEE) to assess the actual and potential effects of eradication activities and mitigations in accordance with best practice and meeting legislative requirements (see section **Error! Reference**

**source not found.** and Table 30). The monitoring plan will account for the benefits and impacts of the project (see section 6.6.6).

*Next steps for quality project design:*

- *Overarching site management plans including NZSIA Biosecurity Plan, Subantarctic Research Strategy and a Subantarctic Strategy should be updated/completed by the relevant district and national teams to guide project design and ensure strategic alignment.*
- *Engage with Murihiku team to ensure coordination and alignment of strategy and programmes.*

#### 5.5.4. Outcome is sustainable

If eradication can be achieved, it is highly likely that the island can remain free of introduced pest mammals. The isolation and remoteness of the site offer inherent protection. There are no islands with pest mammals within swimming distance of Auckland Island; following eradication the nearest cats and rodents will be on Rakiura/Stewart Island, nearly 400 km away, and the nearest feral pigs will be 500 km away on mainland New Zealand.

Incursion pathways to the island are largely controlled by DOC through permitting or management of its own activities. However, fishing vessels shelter inshore; and unpermitted visitors probably stop at the island occasionally. Engaging island users through targeted advocacy is recommended to expand surveillance and reduce negligence. An overarching biosecurity plan for the NZSIA is outdated and requires review with consideration of future pest-free status on Auckland Island. Sound local systems are in place, but a biosecurity plan should be created for Maukahuka for all phases of the project including preparations in the planning phase and demobilisation. This will help design the mainland supply chain and manage the large and extraordinary movements of goods and people to a low impact site. Significant planning and investment are required as soon as the project is initiated to establish fit for purpose facilities and manage biosecurity to the standards and capacity require.

*Next steps for quality project design:*

- *Increase advocacy with concessionaires, permitted visitors and the fishing industry to increase biosecurity awareness and surveillance.*
- *Ensure NZSIA biosecurity plans are reviewed and specified actions can protect the investment.*

# 6. What will it take?

## 6.1. Research and development

Several developments for improved tools and capabilities are essential to ensure feasibility: the development of high-resolution thermal cameras and operator teams, reliable low sow-rate bait buckets, enough dog handler teams and software to triage imagery from the network of trail cameras. Additionally, the availability of a cat vertebrate toxic agent (VTA) and better batteries for trail cameras are highly desirable and would significantly improve likelihood of success. All new tools must be rigorously tested and proven to be reliable and effective with contingencies available for critical elements (best practice). The Maukahuka project has engaged with relevant DOC teams and suppliers to understand how and/or drive tool developments and timeframes with respect to project requirements. With seed funding and adequate planning, it is possible to drive and/or support these developments ahead of project initiation. Feasibility will need to be re-assessed if key tools are not available prior to programme initiation. Planning should consider options if preferred tools cannot be made available.

The development of new tools requires support across DOC (see section 5.5.1.5). Outputs will significantly support additional conservation work including other PF2050 objectives.

### 6.1.1. High-resolution thermal imagery camera and operator capability for aerial hunting of pigs

A development programme is required to make high-resolution thermal imagery cameras (n = 3) and operator teams (n = 3; each consisting of camera operator, shooter and pilot) available for the pig eradication. This capability is essential to the feasibility of the pig programme (see sections 5.2.2.4 and 5.2.2.5) and operational delivery will be delayed until this capability is available. Analysis by ZIP and DOC suggests the market alone won't be able to provide the solution. A development project is proposed to produce cameras fit for purpose that can be made available to operators. Helicopter operators for the pig programme will need to be engaged early to aid development of this capability. DOC plans to undertake an average of 5000 hours hunting pest ungulates annually (DOC Business Planning data 2015-2019; DOC-6060684), and could assist by identifying and providing opportunities to committed suppliers in the lead up to the eradication. However, DOC's Biodiversity Threats team have no current need or intention to invest in this tool for national purposes (P. Jansen 2019, pers. comm.). Therefore, development would need to be led and funded by the Maukahuka project.

### 6.1.2. Better bait bucket

Current bait bucket technology doesn't reliably deliver bait on the ground at 4 kg/ha as desired. The development of a reliable low sow-rate bait bucket is critical to the feasibility of eradicating mice from Auckland Island (see section 5.3.1.1). GPS-metered seed-spreading technology from the agricultural industry has been identified as a probable solution to incorporate into bait bucket design. The Maukahuka team has engaged with commercial operators driving this work. Distribution and flow rate trials for new bucket designs are in development. It is recommended to test a final product in several operations (e.g. Tiakina Nga Manu or similar). If a reliable low-sow bait bucket is not available, an increased sowing rate is possible using current bait bucket technology, but feasibility is subject to shipping logistic. However, more bait equates to increased logistic needs and increasing risk of not completing bait spread.

### 6.1.3. Detection dog team

Cat detection dog handler teams are required to eradicate cats from Auckland Island (see section 5.4.1.4). Only four cat detection dogs are currently certified as part of the Conservation Dogs programme. Developing the capacity for detection dogs and handlers will need to be planned and instigated early to ensure capacity is available when required e.g. a dog training programme will need a two-year lead in. It is proposed to start by training two handlers and four dogs in the first two years to initiate a programme and determine exactly what dogs would need to be trained for (scent, scats etc). Handlers could work as part of landscape-scale cat control at the Te Manahuna Aoraki Project (TMA) in the Mackenzie Basin (or at other DOC led cat control work) and costs shared, benefiting both. Professionally training dogs to provide to selected handlers with training time in the lead up to eradication would be the most efficient means of building capacity. If detection dogs and handlers are not available the eradication will take longer to achieve, which will cost more and increase the risk of failure. Confidence in the result relies on more than one type of detection tool.

### 6.1.4. Trail cameras

Software that automatically labels and accurately triages imagery/false triggers is required for a camera grid covering the whole island to ensure the feasibility of eradicating cats from Auckland Island (see section 5.4.1.3). Delivery of the operation would be delayed until this capability is available. Development of the requirements are staged. As priority, Maukahuka has engaged with the market to determine what software capability is currently available. Hardware developments that improve maintenance requirements or enable remote data transmission are a secondary priority. For example, a rechargeable battery pack would avoid the use and cost of vast quantities of AA lithium batteries running more than 1500 cameras over 2 to 3 years; automated alerts sent from cameras is a more uncertain opportunity at this scale but could save the need to physically visit every device to download data and improve response time.

#### 6.1.5. Cat Vertebrate Toxic Agent

An aerially distributed cat VTA is the preferred knockdown tool for cat eradication on Auckland Island and would reduce risk to the programme by removing the reliance on trapping as the primary knockdown tool (see section 5.4.1.2). DOC's Biodiversity Threats team is developing a VTA for aerial distribution to target mustelids and potentially cats. The Maukahuka team is supporting the development and registration of this VTA. In winter 2019 the palatability and degradation of four possible bait matrices were tested on Auckland Island[14]. Subsequent pen trials of toxic versions of the bait have not been effective enough at killing cats. Further testing is being planned and separate cat and mustelid baits are likely to be needed. However, timeframes could be tight to be ready for the cat eradication and contingency options should be explored in case development stalls. Future analysis of GPS data from 31 collared cats on Auckland Island[25] will also improve the understanding of how essential an aerially distributed VTA is for the cat programme. If a cat VTA is not available, trials support the feasibility of using the camera network and targeted trapping as a knockdown tool[9,14]. However, tracking data shows a small number of cats utilise areas that may be inaccessible to people (cliffs) or areas where detection devices have proven problematic (tussock)[9,14,25]. Further data are required to understand whether these movements or habitat preferences are seasonal in order to understand what and how much time would be required to target these cats. This means this approach would need to run for much longer to give confidence in eradication and carries greater risk of missing individuals and failing than if a VTA was available as well.

*Key risk:*

- *Lack of strategic alignment across the organisation risks pre-requisite improvements to tools and technologies not being developed in time. Prioritisation of the project's research and development objectives needs to be articulated throughout DOC and supported by management.*

*Next steps for quality project design:*

- *Develop a Research and Development Plan that outlines pathways and milestones for tools development.*
- *Understand how to react if a cat VTA is not available. Plan the training programme with enough lead-in time to train a greater number of cat-trappers and dog handlers in this case.*

### 6.2. Affordability

The proposed pest eradication requires one-off investment for permanent and internationally significant biodiversity benefits with low to zero ongoing costs to sustain. While full investment may not be required upfront, a strategic investment strategy spanning the life of the project is required.

Purchase of a vessel would provide a desirable level of certainty for required transport capability but, is considered unfeasible at this time due to cost and the complexity and risks of ownership models, vessel survey and maintenance requirements. This should be reassessed as part of future discussions with project partners in conjunction with expert industry advice. In the interim, engagement with the shipping industry should be undertaken to determine the feasibility of a long-term lease. Viability of both these options is dependent on project initiation and a long-term funding commitment.

Investment in developing better eradication tools enables feasibility and delivers greater benefits (to project and beyond) and has potential to significantly shorten the delivery timeframe, realising large cost savings.

Estimates (November 2019; DOC-6208649) to deliver the project under the preferred option are $80m total of operational costs and $4m depreciation costs over 10 years (Figure 16). This is based on a nominal 50/50 Crown/Partners investment model and equates to an average $4.2m per annum for each party with significant peaks and troughs over the programme (Figure 16). Budget and financial management implications of different partnering models and investment scenarios need to be understood in greater depth and optimised when developing partnership agreements (e.g. it may be more cost effective for partners rather than DOC to hold capital, DOC operational costs subject to corporate overheads). Estimates for inflation, DOC corporate overheads and contingency may amount to as much as $27m but are likely to be underwritten by DOC national funding pools (Figure 17).

The cost per hectare for Maukahuka is not dissimilar to other Subantarctic island eradications, despite the complexities of the remote situation, the logistical requirements and the inclusion of three operations and a large infrastructure programme in the project scope (Figure 18). The Macquarie Island rodent and rabbit eradication was budgeted at and cost $25m (AUD). This was a baiting operation and 3-year hunting programme on an island a quarter of the size of Auckland Island, with infrastructure and pre-existing services and logistics in place.

Opportunities exist for direct cost savings to the project (in the order of millions of dollars) via sponsorship, in-kind support, volunteers and efficiencies from research and development (Table 17). Other DOC programmes would additionally benefit from the capability development.

### 6.2.1. Budget uncertainties

The costing models are increasing in detail and certainty as planning progresses and should be updated to reflect current thinking once operational plans are drafted. Four clear areas of uncertainty remain: shipping, helicopters, staffing requirements and research and development of new tools. These should be the focus of next steps to refine the project plan and costings. Weather will remain as a variable outside the control of the project that will have a large impact on operational efficiencies and final cost. The level of contingency required is likely to decrease significantly as key costs such as transport and logistics solutions become more certain.

#### Shipping

This is a major uncertainty, complex to model, with a large dollar range heavily influenced by home port location, size and function of the vessel and availability year to year. A clearer understanding of market options is now needed and requires input by industry expertise. The risk imposed by limited availability also needs to be accounted for. Not being able to source or pay for large shipping services would delay or stop the project.

#### Helicopters

Helicopter options need to be better understood. For example, there are potentially about $8m of standby costs for helicopters for the operation's period, if normal fees are applied. However, bespoke options we cannot yet rely on could result in significant savings, e.g. purchase or lease of two helicopters could save between $4 and $5 million in standby fees. Embedding aviation and creative, competent procurement expertise in the project team would enable a new procurement paradigm. Shared financial risk with key suppliers could lead to better pricing and fairer contracts which might attract stronger competition.

### Staff

Staff rotation and contract structure will be largely dictated by available transport solutions. There are large effects on budget and logistics of teams rotating on and off the island for different durations (e.g. 6-week cf. 3 to 6-month rosters and associated contract structures).

### Research and development

The benefits of upfront investment now in new technology and capability are immense (see section 6.1). Importantly for the project these developments will ensure feasibility, reduce risk and complexity, and increase chances of success. Additionally, they will shorten delivery time by months, and provide the opportunity to conclude pig and cat programmes quickly if detection tools provide strong confidence in validation of eradication success. They also provide extensive strategic and national benefits (e.g. PF Rakiura, PF2050) and a high return on investment (Table 17).

*Table 17. Potential project savings resulting from investment in research and development (NZD) under the preferred funding plan*

| Development | Investment | Saving | Description |
|---|---|---|---|
| Thermal camera development and availability of capable operating teams | $2m | $4.6 - $6m | Reduce the duration of the pig ground hunting programme by up to 40% |
| Mice bait bucket development and purchase of 8 buckets | $0.4m | $1.4m | Reduced bait volume, associated logistics and bait spreading costs relative to best practice by being able to sow bait at low sowing rates reliably thereby increasing the likelihood of success |
| Trail cameras with automated imagery processing software and remote sensing network | $1m | $4.8m | Reduced data checking costs and staff time from greater efficacy. Faster response time to cat detections and significantly increased confidence in absence and eradication result. |
| Total | $3.4m | $10.8 - $12.2m* | |

*note the anticipated savings from research and development investment are included in forecast operating budget

*Next steps for quality project design:*

- *Review project cost estimates once operational plans are drafted.*
- *Budget and the financial management implications of different partnering models and investment scenarios need to be understood in greater depth and optimised when developing partnership agreements.*

- *Embed shipping and helicopter industry expertise into the project team to design procurement and manage complex compliance and contract scenarios. Ensure contract management capacity is resourced appropriately.*
- *Explore option to purchase/lease two helicopters to remain on island.*

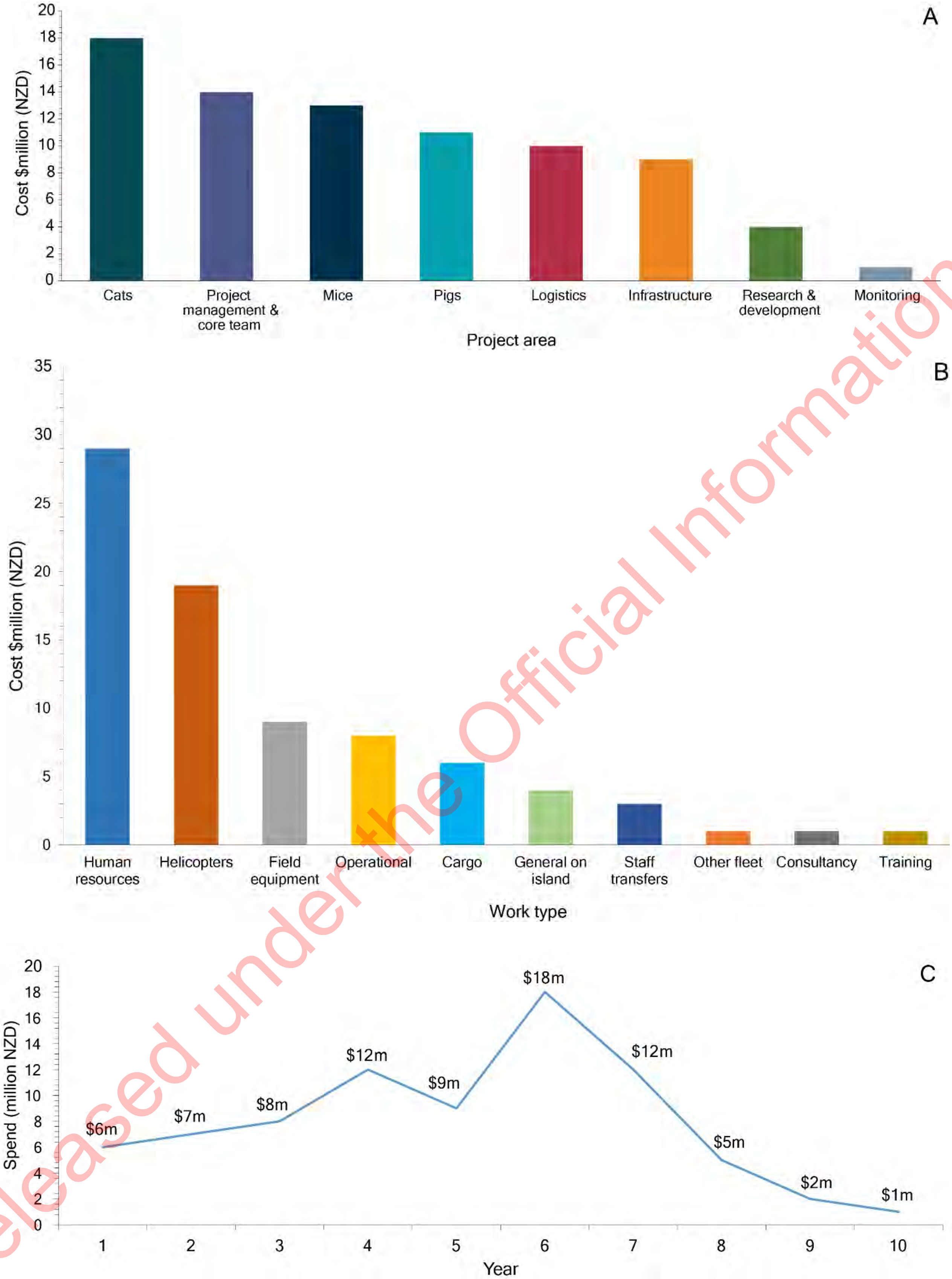



*Figure 16. Estimated operating budget (NZD) to deliver Maukahuka by project area (A), work type (B) and year (C). R&D = research and development; NZD = New Zealand dolllars*

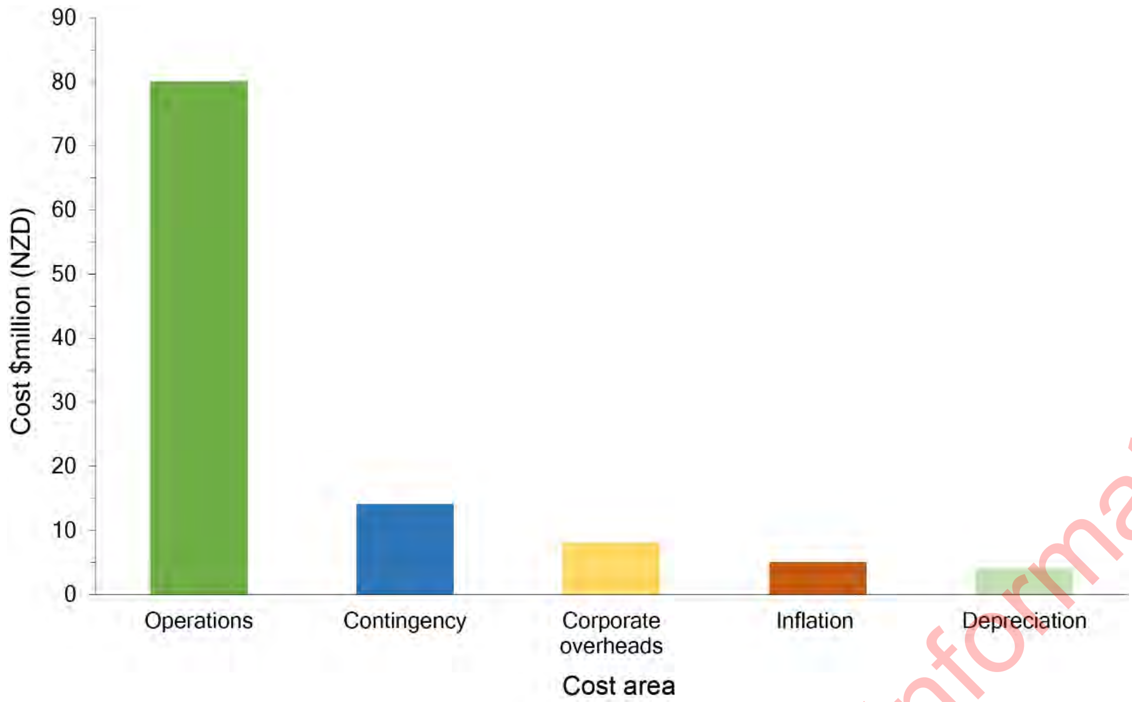



*Figure 17. Estimated total budget (New Zealand Dollars) to deliver Maukahuka. These figures are based on a nominal 50/50 Crown/Partners investment model. Contingency averages 15% operational expenditure and 20% capital expenditure and reflects uncertainty in shipping and reliance on good weather conditions. Corporate overheads of 15% are only applicable to the Department of Conservation's 50% contribution. Consumer price index inflation of 1.5% pa from 2021/22 has been applied to operating expenditure and operating contingency.*

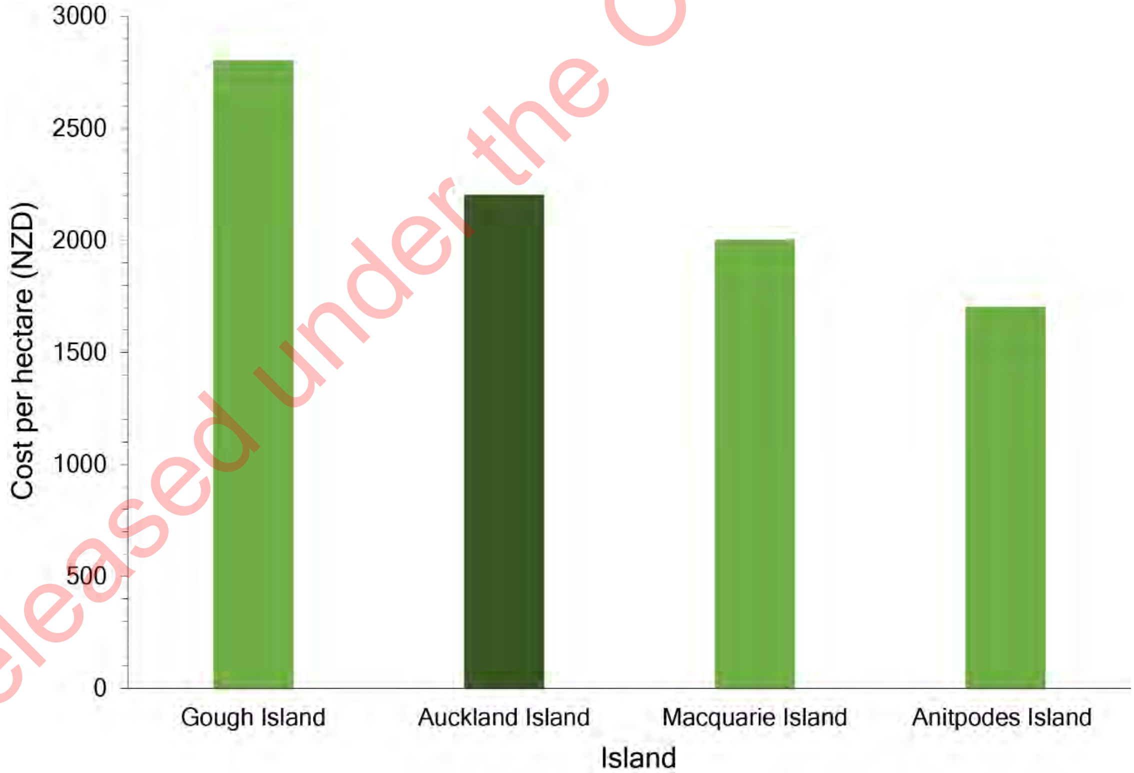



*Figure 18. Cost per hectare (NZD) for eradication projects on similar Subantarctic islands*

### 6.2.2. Funding

During the Feasibility Phase, DOC's preferred funding strategy for the project was a split between Crown and private contributions via partner organisations and individual donations. A commitment from Government is required to provide confidence to interested partners and warrant their active involvement. A strategic investment plan is required to enable project initiation.

Potential sources of funds identified to date are the International Visitors Levy Fund (IVL), Treasury funds and private investment. DOC funding decisions are dependent on DOC's optimisation of landscape scale projects framework as well as economic recovery activity.

### 6.2.3. External partners

DOC's Partnerships team has worked closely with the project team to develop relationships with potential partners. There has been significant interest from major national and international philanthropic organisations. These organisations have indicated comfort with the proposed budget and operations but require a commitment from Government to fund a share of the project to provide the confidence required to invest. In effect, Government funding could leverage large investment in national biodiversity gains from both local and international donors. Success would similarly encourage growth in philanthropic funding streams.

*Next steps for quality project design:*

- *Continue engagement with potential funding partners and stakeholders to facilitate better understanding of relative costs, wider benefits, stopping points, complexities, and opportunities.*
- *DOC should lead with a commitment to the project by securing the Crown investment and articulating an investment strategy for the life of the project, this will provide investor confidence enabling the required third-party contributions.*


*Plate 6. The Maukahuka Pest Free Auckland project will require infrastructure where the rugged environment, flexibility and transportability drive design. Custom-built field huts were installed at Smith Harbour, Auckland Island during field trials in summer 2018/19. Huts were transported to the island by cargo vessel (MV Searanger – Seaworks) and were lifted into position by a B3 Type Squirrel helicopter (Southern Lakes Helicopters). Photo credits: James Ware/DOC and Finlay Cox/DOC*

## 6.3. Island infrastructure

The eradication operations will be land based requiring installation and later removal of extensive infrastructure at strategic locations across Auckland Island. Basing all operations from land is a feasible option that has been done before for numerous island eradications.

Required infrastructure includes accommodation, bait staging and delivery sites and fuel storage (Figure 21). Infrastructure design should be flexible enough to support all three programmes, which may require some rearrangement/relocation of structures. For example, sites designated for bait loading during the mice or cat programmes could serve as trapping and staging sites for pig operations and extra hangarage for the mouse programme provides dry storage and recreation space during the pig and cat programmes.

It is expected that a period of 12 to 18 months spread over two to three years (activities focussed in summer) would be required to install necessary infrastructure before pest operations commence. Initially, the infrastructure programme will require considerable boat-based support until facilities can support land-based teams across the island.

Ship-based operations were considered but discounted due to high costs (several tens of thousands of dollars per day) over the life of the project. If a ship was owned, the project would also own the risk if it became unserviceable with limited ability or funding to source an alternate option compared to a company contracted to supply shipping services. The main efficiency gained through ship operations would be logistical with a reduction of ship-to-shore transfers for operational supplies such as food and fuel and associated back loads of fuel, empty containers and waste etc. Financially this does not equate to ongoing costs associated with crewing a ship, maintenance and daily running costs. Even if a ship were purchased (as opposed to leased), minimum operating costs are estimated at $3.1m per annum. Moreover, significant investment in land-based infrastructure would still be required to support the number of helicopters required for operations during the mice programme; and the ground hunting phase of the pig and the cat programmes due to weather restricting reliable access to the island (Table 6). Buildings and anchoring systems should be designed for efficient installation and removal unless others user groups justify retention of some assets beyond the life of the project.

### 6.3.1. Accommodation and operational support facilities

Operating from one central site or several sites was considered. Set up and demobilisation effort and time are greatly reduced by installing one central base (cargo and passenger transport, biosecurity, total infrastructure requirements). However, an assessment of flyable weather and operating experience from summer and winter trials 2018/19 across multiple sites on Auckland Island supports the concept of a main central base, coupled with two subsidiary bases, one at each end of the island to service Carnley Harbour and Port Ross. Working from multiple sites increases productivity as local boat or aerial access is greater than whole-island access across mountain passes or long distances around the coast. (Figure 21; Table 6;Table 18; Table 19). Low cloud and rapidly changeable weather, risks teams and helicopters getting caught out or unable to access sites without local retreats. Subsidiary bases support the rolling front operating model for pig and cat programmes and will allow satellite crews for mice baiting to be stationed efficiently when required.

Infrastructure requirements for each programme differ and change over time (Table 19). Modular facilities are proposed to increase flexibility. For example, once the operations requiring a larger base set up are complete (pigs, mice, cat aerial baiting), the extra accommodation huts can be flown to field locations as required for the dispersed cat hunters. Further benefits of separate buildings include safety. Infrastructure design needs to consider the needs of reverse quarantine for goods and supplies that arrive on the island.

*Table 18. Proposed facilities to support pest eradication operations on Auckland Island*

| | **Main Base** | **Subsidiary base** | **Field huts** | **Bait loading sites** |
|---|---|---|---|---|
| Number of units | 1 | 2 | 17* | 9* |
| Location | Smith Harbour | Port Ross Carnley Harbour | Island-wide and mobile | Island-wide |
| Construction year | 2, 3 | 2, 3 | 1, 2, 3 | 1, 2 |
| Beds | 24 | 20 | 2 – 6 | Fields huts catering for 6 |
| Catering | Large kitchen | Large kitchen | Benchtop cooker | Benchtop cooker |
| Sanitation | Shower, toilet and laundry facilities | Shower, toilet and laundry facilities | Basic toilet and shower facilities | Basic toilet and shower facilities |
| Office | Yes | Desk area | - | Set up for GIS |
| Communications | Satellite internet and VHF | Satellite internet and VHF | VHF | Satellite internet and VHF |
| Hangarage | 6 | 2 | - | - |
| Heli pad with tie-down | Yes | Yes | - | Yes |
| Fuel storage capacity | ca. 50 000L | ca. 50 000L | - | 5 – 20 000 L |
| Bait storage | Pods | Pods | - | Pods |
| Boat shed | Yes | Yes | - | - |
| Dog kennels | Yes | Yes | - | - |

*Field huts will have capability to be shifted by helicopter depending on the needs of the programmes, e.g to bait loading sites during mice baiting. Field huts will have storage sheds associated with them.

*Table 19. Use of proposed facilities by programme during eradication of pigs, mice and cats from Auckland Island*

| **Facility** | **Programme** | **Use** |
|---|---|---|
| Main base | Pig | • Main accommodation for aerial hunting team.<br>• Accommodation for ground hunting teams in adjacent blocks.<br>• Accommodation for support staff. |
| | Mice | • Accommodation and main loading/refuelling site for all staff. |
| | Cat | • Accommodation and main loading/refuelling site for all staff for aerial baiting.<br>• Accommodation for support staff during ground phase |
| Subsidiary bases | Pig | • Refuelling and accommodation for aerial team whilst working in adjacent blocks.<br>• Accommodation for ground hunting team whilst in adjacent blocks. |
| | Mice | • Loading and refuelling sites. Accommodation as weather dictates. |

| | | |
|---|---|---|
| | Cat | • Loading and refuelling sites. Accommodation as weather dictates during aerial phase.<br>• Accommodation for staff during ground phase. |
| Field huts | Infrastructure | • Main accommodation to support build and track cutting teams<br>• Additional accommodation at base sites as required. |
| | Pig | • Daytime shelter and emergency accommodation<br>• Additional accommodation at base sites as required. |
| | Mice | • Accommodation for bait loading teams, GIS support at bait loading sites, daytime shelter and emergency accommodation.<br>• Additional accommodation at base sites as required. |
| | Cat | • Day time shelter and main accommodation for ground phase field staff.<br>• Additional accommodation at base sites as required. |

*Key risk:*

- *There will be a significant lag between a decision to proceed and being ready to implement the infrastructure programme due to the requirements to establish a project team, do building design work and undertaking procurement. The lag time will increase with time between the feasibility phase and project initiation (if initiated) as knowledge and team capability disperse.*

*Next steps for quality project design:*

- *Project infrastructure is intended to be temporary. A DOC district team decision is required if any buildings are to be retained long-term so they can be designed with that in mind.*
- *Design and test construction and function of a prototype flat-pack modular field-hut to inform further building design.*

### 6.3.2. Power

Reliable high capacity power sources will be required at the three base sites. The main base will be running approx. eight large chest freezers, refrigerators, general household electronics (lighting, computers, wireless networks), washing machines, tumble dryers and other high draw devices like power tools. Contingency power generation will need to be planned for. Longevity and maintenance of power solutions for the 10-year life of the project will need to be factored into power system design.

Options for the main base are a larger generator, hydro schemes, solar panel banks or wind (Table 20). The former three are used at the Whenua Hou field base, which has >30 people at high use times. There are significant creeks next to the Smith Harbour and Port Ross base sites. It is unknown what the solar capacity would be like, especially in the winter. Generators used on Whenua Hou and Anchor Island had issues with reaching their end of life faster than expected due to the maritime environment. Wind power generation is untested in the NZSIA but experience on Macquarie Island suggests a lot of maintenance is required in the corrosive and extremely turbulent/gusty environment. To date, small petrol generators (2 kW) have been used to power the much smaller scale field trials on Auckland Island, which will suti field huts but will be insufficient for the base sites during main operations.

*Table 20. Power source considerations for the main base on Auckland Island to service eradication operations*

| | Generator | Hydro | Solar | Wind |
|---|---|---|---|---|
| Weather dependant | No | Yes | Yes | Yes |
| Fuel required | Yes | No | No | No |
| Battery storage required | Optional | Optional | Yes | Optional |
| 24-hour supply | Yes | Yes | No | Yes |
| Mechanical skills required | Yes | Yes | Yes | Yes |
| Environmentally low impact | No | Yes | Yes | Yes |
| Resource consent required? | No | Yes | No | Yes |

### 6.3.3. Tracks

Access tracks are needed to increase travel efficiency, productivity, safety and morale and were proven to do all these things during trials in 2018/19. Tracks and the associated hut network will allow access to the tops when weather conditions do not allow flying, thereby limiting the negative impacts of non-flyable days on productivity (Figure 21). Tracks will be particularly important when weather constrains retrieval by helicopter and hunters need to access the coast for boat pickup or return via foot.

Approximately 80 km of access tracks through tight scrub and forest is required to facilitate the pig programme (Figure 21). Only minor tracks will be required to access load sites and operational areas for a mice operation (Figure 21). Approximately 440 km of track is needed to support the cat programme (Figure 21) to facilitate implementation and servicing of detection devices, enable devices to be checked in all weather and allow quicker response to animals detected. The width/grade of a track will vary depending on purpose and location. For example, standard tracks on key access routes and main ridgelines and minimally modified routes are required for the detection network. Installing this entire network of cut routes during the infrastructure programme would benefit the pig programme.

The vegetation forms several distinct zones, which vary with regard to their ease of travel without a track (Table 21; Figure 25). Vegetation lanes predominately align with the prevailing wind direction (westerly). Pig damage increases the ease of travel in areas of higher vegetation but increases the risk of travel in dense vegetation where footfall is hidden. Careful placement of tracks will reduce the amount of vegetation to be cleared and the effort to establish. Trials revealed the importance of planning routes with satellite imagery[9,14]. Generally, vegetation to be cleared is of a stem diameter less than 5 cm and an average of 500 m per day can be cut by two people[9,14].

*Table 21: Summary of vegetation strata, coverage and ease of travel without tracks on Auckland Island*

| Land cover type | Area (ha) | Approx. altitude range (m) | Ease of travel on foot without tracks |
|---|---|---|---|
| Rātā forest and coastal rock and sand | 5054 | 0 – 50 | Generally easy |

| | | | |
|---|---|---|---|
| Low scrub and tussock lanes | 20 070 | 0 – 400 | Moderate; lanes of scrub with often low vegetation between. |
| Tall or dense scrub | 11 621 | 60 – 300 | Very difficult. Wind-shorn faces especially difficult. |
| Alpine and tall tussock | 9621 | >300 | Easy to moderate – can be boggy in places |
| **Total** | **46 366** | | |

### 6.3.4. Communication devices

Communications are essential for health and safety, operational planning and liaising with mainland support. The remote location limits options and how communication devices may be serviced. Inconsistencies with performance of some devices have highlighted the need for multiple forms of communication both for island-based and island-mainland operations (Table 22). Satellite internet connection has functioned well at three sites spanning the length of the island in winter and summer. It provides landline style capability (Voice Over Internet Protocol), capacity to send and receive images and stream video, a slow connection to DOC server via Amazon Workspace; and important access to weather forecasting services. Connection between field staff and family is also an important function.

### 6.3.5. Fences

Fencing is required to divide the island into three blocks to facilitate the pig programme (see section 5.2.2.1; Figure 25). The fences will be based on the netting and barbed wire design proven by Hone and Atkinson (1983). Fences will be constructed by hand, similar to those used for sheep control and eradication on Campbell Island in the 1970s and 80s[69].

Fence line investigations carried out in summer 2018/19 found that valleys are a more efficient location for fences than ridge lines due to the less challenging vegetation[9]. The vegetation clearance required for fences will be factored into the access track network. The western cliffs provide a secure end point at the western extreme, though the generally soft and shallow ground at the eastern coastal end with large tidal flux poses a design challenge.

### 6.3.6. Hangarage

Damage to helicopters due to prolonged exposure in a marine environment was identified as a critical issue by suppliers during the Antipodes Island mouse eradication[57]. During the summer trials on Auckland Island in 2018/19, helicopters stationed outside had to relocate to Enderby Island for better shelter three times to avoid potentially damaging weather. A network of four hangars at base locations and anchored tie down points at baiting load sites are required to support helicopter operations (Figure 21; Table 18). This will remove the need to fly to pest-free Enderby Island and reduce risk for helicopter operators. It will also reduce the risk of delay or failure from damage to sensitive and critical equipment.

Four temporary tent-style hangars, as proven on the Antipodes Island (rated for 190km/hr winds), will be manually erected at the base sites at the beginning of the infrastructure phase (Table 18). Each will store two to three helicopters plus tools and provide workshop space. That way all helicopters present at any one time could be secured under cover. Additional tie down spots will be set up at bases and loading sites in case helicopters can't return to base. Each hangar will take ~210 person days to install.

*Figure 19: Temporary helicopter hangar, Antipodes Island 2016*

*Table 22. Anticipated means of intra- and off-island communcation required for operations during the Maukahuka Project*

| Method | Use | Current state | Development needs |
|---|---|---|---|
| **Satellite internet** | • Communication between teams and with mainland<br>• Voice over internet protocol (VOIP) landline phone<br>• Operational planning<br>• Weather report access | • Installed at Dea's Head, Smith Harbour, Adams Island and Camp Cove during 2018/19<br>• Excellent speed and connectivity during summer 2018/19<br>• Issues with reinstallation at Dea's Head August 2019<br>• Initial install very precise – tricky to acquire signal<br>• Only works when power is on at camp<br>• Excellent clarity on VOIP phone – no charge for calls to/from NZ | • Training of staff on installation and problem solving – operating manual<br>• Weather proofing of dishes and connectors for long term deployment<br>• Setup dish and stand at all field huts and move up to 10 modems around the island. |
| **Very high frequency (VHF) radio** | • Communication between field teams on island, shipping and helicopters | • Simplex used, some issues with connectivity due to terrain<br>• Testing of portable repeater units to increase local signal summer 2018/19 and winter 2019<br>• Whip antennae installed at Dea's Head, Smith Harbour and Camp Cove winter 2019 to increase reception at base sites | • Installation of large repeaters and portable repeater units to allow island wide radio communications<br>• Lanyard attachment to prevent loss of handsets |
| **Personal locator beacon (PLB)** | • Emergency communication.<br>• Communication between mainland and field teams. | • Project mostly use standard PLB for emergency response<br>• InReach devices used for intra- and inter-island communication between teams (messaging)<br>• Always on | • Procure enough units for future operation. |
| **Satellite phones** | • Communication between field teams and with mainland. | • Borrowed from Southern Islands team<br>• Some issues with reception – very unclear<br>• Can only contact other units if both switched on | • Almost superseded in function by InReach devices and internet set up but useful in emergency kits |
| **High frequency (HF) radio** | • Back up communication with mainland | • Not suitable for short distance communication on island<br>• Capable of receiving weather reports via grib files if internet not working | |

### 6.3.7. Fuel storage

The main fuel storage required on island is Jet A-1 fuel (Class 3.1C) for helicopters (Table 23). Smaller volumes of petrol, diesel and LPG will be required at accommodation and work sites. The mice programme will be the most intensive period of helicopter fuel use. Approximately 25 000 L will be used for cargo unloading and island set up for the mice eradication. In the months that follow approximately 134 000 L will be used for bait spreading. This is the storage capacity needed on island if resupply partway through mice baiting was unaffordable or no vessel was available. The bunkered or cargo volume on-board an available ship will determine the number of voyages needed for delivery.

*Figure 20. Drummed Jet A-1 fuel in bunding, Smith Harbour, Auckland Island, February 2019*

Traditionally Jet A-1 has been drummed for transport and storage at remote sites (Figure 20). For the mice programme this would require about 700 drums during the baiting phase and nearly 400 m² of bunded area for storage spread over several sites. Bunds at dispersed sites would need to be covered to avoid filling with rain. Bulk storage (e.g. collapsible double skinned 50 000 L PVC rubber fuel bladders, flyable tanks) located at each base site would make more efficient use of space and reduce handling costs compared with drums. These double skinned vessels require no additional bunding/secondary containment. Island storage could be resupplied by transferring drummed fuel ashore or decanting bunkered fuel from a ship into smaller bladders for flying ashore. Dispersed fuel supplies for bait load sites will need small vessels with secondary containment (e.g. drums in bunds or double skinned small tanks) or placement of smaller bladders (1000 L) for pumping out of.

Establishing additional fuel depots on Auckland Island (a fuel store for emergency response exists on Enderby Island) is currently outside the CMS directive. Fuel certification normally requires monitoring to be stationed on site. Having fuel in dispersed locations and likely periods of de-staffing the island (between mice and pig programmes) raises issues around fuel management.

*Table 23. Total estimated flight time and associated Jet A-1 fuel quantity by programme*

| Operation | Infrastructure | Pigs* | Mice | Cats | Contingency (10%) | Total |
|---|---|---|---|---|---|---|
| Flight time (hours) | 110 | 1030 | 800 | 680 | 262 | 2882 |
| Fuel estimate (litres) | 19 800 | 185 400 | 160 000 | 122 400 | 48 760 | 536 360 |
| Fuel drums (200 litres) | 99 | 927 | 800 | 612 | 244 | 2682 |

*Assuming thermal camera assisted aerial hunting

*Next steps for quality project design:*

- *Engage industry expertise with compliance knowledge to design a supply chain solution. This should include collaboration with regulatory authorities for site certification and developing protocols for managing of fuel in remote locations without personnel present.*

### 6.3.8. Bait storage

More than 500 t of bait will need to be stored, transported and kept dry at every stage before use. Wooden plywood boxes or 'pods' with a plastic liner were used to transport and store 65 t of bait for the Antipodes Island mice eradication and have been proven to protect bait during transport to and storage on island. Over 300 t of bait was also successfully transported and stored this way for two years on Macquarie Island. Pods were recently designed to fit into shipping containers for Gough Island. Over 730 pods may be required to store the bait for this operation, requiring at least six months lead-in for manufacture. Additional pods will be required on site as a contingency in case of damage. They have the benefit of being discrete, secure and relocatable storage units, designed to be shifted by forklift and lifted by helicopter. They are collapsible once no longer needed. They also provide a stable bait loading platform when placed on relatively level ground.

The total footprint of pods containing bait is over 1000 $m^2$ so bait would have to be offloaded directly from the ship to the three base locations and several dispersed load sites (nine proposed). The distances mean the ship will need to relocate several times, extending a charter period.

Bait will be transported to the island and bait loading sites set up as a discrete task in winter (Figure 21) before starting bait application in November. It is preferred that bait for both treatments is on site before baiting commences to avoid using potential baiting time to unload a ship. Some bait may need to be stored in pods exposed to the island's weather for up to six months before application (September to February), so pods need to be well made.

Toxic sausage style bait for the cat programme will need to be frozen until ready for use (ca. 2.6 t for three applications incl. contingency). Sausage baits will be stored in chest freezers (max. 6 x 520 L chest freezers). Design the power supply with this load in mind.

### 6.3.9. Small boat support

Small boats will supplement helicopter support for operations, dropping off and retrieving teams at coastal sites where helicopters are unable to, or it is inefficient to do so. This will allow operations to continue when low cloud inhibits flight, but sea state allows. Boats should be capable of facilitating water rescue during helicopter operations. Two rigid hull vessels with inflatable tenders for rocky-shore landings are a likely solution. As a minimum, they must be capable of transporting a pig team of six personnel and dogs. Boatsheds and sheltered moorings will be needed at each of the three base sites to support vessels and allow independent operations.

Maritime New Zealand support the opinion that the operation of boats at Auckland Island is consistent with DOC's Marine Transport Operator Plan (MTOP; DOC-5464383).

### 6.3.10. Aerial support

Helicopters are essential to deliver the project and an estimated 2882 hours of flight time will be required during the project (Table 23). Auckland Island is within flying range from mainland New Zealand for some larger models of helicopters; e.g. the common and reliable AS350 squirrel (112 B2 and B3 models on register in New Zealand). Popular hunting helicopters, MD Hughes 500 model or smaller are unlikely to be positioned by direct flight and would have to be shipped. Direct flight enables specialist aerial support for various elements of the project for $20 000 to $30 000 per return trip from a lower South Island base. For example, specific long-lining skills or large lifting capacity can be obtained when required for ship unloading stages.

AS350 helicopters are proven for aerial baiting and passenger transfer. They also proved to be a stable platform for aerial hunting in windy conditions at Auckland Island and recommended by operators following summer 2018/19 trials, despite previous preference for more nimble hunting helicopters.

The duration of each eradication operation will be largely determined by suitable operating conditions for helicopters. Low cloud (below 400 m 27% of the time; Table 6) will restrict helicopter movements over ranges, particularly constraining access to the western edge and south to Carnley Harbour. The three proposed helicopter base sites (with hangarage and fuel) located at the north, middle and south of the island (Figure 21), will minimise the impact of low cloud as operations at Falla Peninsula showed that local helicopter operations could often still occur to some degree, when long range work wouldn't be considered. This will enable a rolling front approach for pigs, detection and response during cat eradication and efficient access to dispersed load sites for mice.

*Key Risk:*

- *Helicopters, pilots, and engineers will be difficult to secure. Suppliers should be identified early to build trust and help design solutions. Contracts for helicopter supply should include pilot and engineer resources and the requirement for backups.*

### 6.3.11. Maintenance and field equipment

Facilities, tracks and equipment will need to be certified and maintained throughout the operation. Complex biodiversity huts require a baseline then four-yearly inspections by an engineer and annual inspections by an approved hut inspector. Other DOC structures must be inspected once every two years. LPG fixtures require biennial inspection by DOC and inspection by a registered gas fitter at a period no greater than six-yearly.

Technical and mechanical skills must be present within the island team to ensure the reliable functioning of commodities such as power and communication systems as well as maintenance of outboard motors and track maintenance including chainsaw use. A diesel mechanic may be required if larger diesel generators are to be used. Specialist electronics/technician skills may be essential to support technology, for example a remote sensing network connected to cameras. At least one helicopter mechanic will be present on the island while helicopter operations are being carried out.

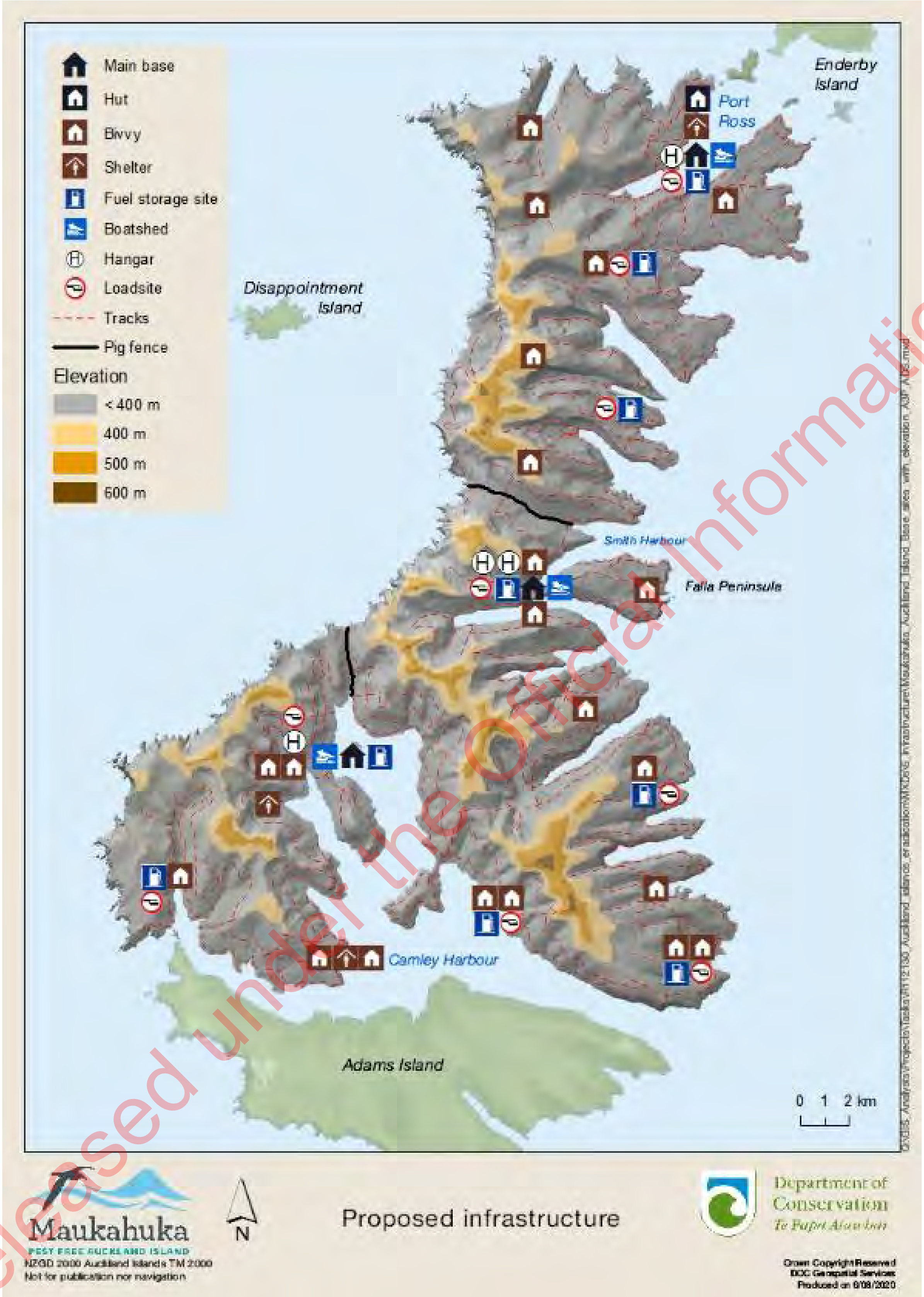



*Figure 21. Proposed infrastructure to support the eradication of pigs, mice and cats from Auckland Island. Elevation ranges relevant to weather and helicopter operations are shown in shading.*

## 6.4. Mainland infrastructure

### 6.4.1. Fuel transport and storage

The large volumes of fuel will trigger the need for managed storage as part of the supply chain. Certified storage is needed in the port of departure to ensure fuel supplies are on site and containerised before loading on board a ship. If containerised fuel is loaded into a hold then access to a hazardous goods wharf will be required until departure with crew on board so charter rates will apply. Larger ports have better access to fuel supplies and supporting storage. Drummed Jet A-1 fuel for the Antipodes project and summer trials on Auckland Island in 2018/19 was sourced from Auckland and loaded at Timaru and Wellington ports respectively. If drummed fuel is used extensively, then a plan is needed for managing empty fuel drums. Empty drums have previously been returned to the supplier.

### 6.4.2. Bait transport and storage

#### 6.4.2.1. Mice Bait

Over 504 t of Pestoff 20R Rodent Bait ® will need to be made and shipped to Auckland Island. Orillion can make the bait quantity in a manageable timeframe but does not have room to store it. Depending on whether both production plants are used and whether the bait is packed in 25 kg double-skinned paper bags or otherwise, bait will need to be removed from the factory every 4 (quickest production: both plants; 600 kg bags) to 13 days (slowest production: one plant; 25 kg bags). Manufacturing will take between 33 days (both plants; 600 kg bags) and 100 days (one plant; 25 kg bags). Bait will need to be stored in a bio-secure location elsewhere until a shipment is ready. Packaging in 25 kg bags is most efficient for trucking from the factory to port. Approximately 30 truck loads are required to move all the bait to port from the factory if bait is packed in 25kg bags. Calculations are based on the current capacity of the sole trucking company (JJ Nolan) who have trailers modified for the efficient loading and a total bait volume of 650 t instead of 500 t in case additional bait is required if bucket improvements can't reliably deliver bait at 4 kg/ha. The recommended shelf life of bait (12 months) and contingency for manufacture and transport needs to be built into planning to ensure bait quality. Pre-departure storage would be secure, quarantined warehouses at the port of departure (Table 24).

*Table 24. Potential transport options for shipping bait and ports of departure for 650 t of Pestoff 20R required for mice eradication on Auckland Island. Minimum total trucking distance scenario: tight packing of bait in 25 kg bags; maximum trucking distance: optimal packing of bait in 600 kg bags.*

| | **Wanganui** | **Wellington** | **Lyttelton** | **Timaru** | **Bluff** |
|---|---|---|---|---|---|
| Distance from factory (km) | 1 | 206 | 640 | 786 | 1210 |
| Inter-island travel required? | No | No | Yes | Yes | Yes |
| Rail freight possible? | No | Yes | Yes | Yes | Yes |
| Total trucking distance (min; thousand km; return) | 0.04 | 7.8 | 23 | 30 | 46 |
| Total trucking distance (max; thousand km; return) | 0.11 | 23 | 66 | 86 | 133 |

Bait will likely be stored and transported inside weatherproof 'bait pods'. Other options include cardboard pods, which were used on South Georgia to manage large volumes of bait. However, corrugated cardboard can pose an additional biosecurity risk and wooden pods provide greater security if baiting was delayed and on-island storage required for longer than expected. Bulk bags or pods directly placed in a shipping container and craned onto a barge for bait loading would avoid flying bait pods ashore, hugely reducing handling and helicopter time. However, large barges are difficult to source and risky to secure near the coast for a place with such severe weather. Biosecurity cleaning a large barge would also likely be prohibitively expensive and a vessel capable of moving a barge would most likely be required to remain with the barge. One shipping container will fit approximately 13 t of bait in pods. If not being offloaded to a barge or unless it was a necessary part of the cargo shipping solution (e.g. deck storage), containerisation of bait pods is a complicating addition.

#### 6.4.2.2. Cat Bait

The proposed sausage-style bait are manufactured by Connovation in Auckland and would be frozen until application. Sausages weigh approx. 20 g, with 25 sausages taking up 1 L. They could be transported on the mainland in wooden pods, frozen before departure then transported to the island in the chest freezers (ca. 2.6 t; maximum 6 x 520 L chest freezers for three applications incl. contingency).

### 6.4.3. Office and operational support infrastructure

Office space for 15 – 25 staff will be required over the course of the project. New space within the existing DOC building or a new location will be required. The Murihiku district office is planning to move buildings within the next three years and the expanded project team will need to be factored into investigations. Office accommodation for distributed staff will need to be secured in other hub offices e.g. Christchurch.

Workshop space will be required for storage of equipment and materials, working under cover and vehicle storage. The Murihiku workshop is at capacity with district work needs. A location nearby would be advantageous. The project currently uses vehicles from the Murihiku fleet pool. At pinch points these can lead to shortages both for the project and the rest of the Murihiku staff. Additional fleet vehicles will be required for the project, including a car for office staff and a ute for transport of equipment and supplies from the first year of the infrastructure programme. A DOC covered trailer and large flat-deck trailers are available locally and current usage can be absorbed but additional trailer(s) are likely to be needed during early operational stages onward. Large and small trucks are available to be hired as required locally, including trucks with heavy lift Hiab, as used to load field huts onto a vessel at Bluff in 2018/19. Having the main office space co-located with workshop and biosecurity store facilities will increase efficiencies and oversight.

### 6.4.4. Biosecurity

The mainland supply chain must include facilities and personnel to manage biosecurity risk through throughout the project. The risk of introducing unwanted plant, animal or microbial pests exists with every movement of people and goods to islands. The risk is heightened by the extraordinary amount of equipment, supplies and personnel that will need to be transported to and from Auckland Island for this project. Good biosecurity systems exist for DOC operations on the Subantarctic islands for current operations. DOC has mainland biosecurity facilities used for Subantarctic work in Invercargill. However, the Southern Islands Quarantine Store is functional but too small to meet all the requirements of this project. The current facilities have 224 $m^2$ of space for processing dirty gear and 135 $m^2$ for storing clean gear, and a small office area for pre-departure briefings. Space and staffing capacity were stretched during the summer 2018/19 trials, which emulates the scale expected for regular staff changeover voyages. Current capacity is not suitable to manage the large volume of cargo for 6+ cargo voyages, particularly large items for infrastructure.

There is limited space for gear storage – Maukahuka project gear is currently kept at three locations in Invercargill: at the Quarantine Store, in three shipping containers on the other side of town, and in the District office. The quarantine facility is also used for all other southern island work including Whenua Hou and is extremely busy during kākāpō breeding seasons.

Additional standalone quarantine and bio-secure storage facilities will be required to differing levels throughout the operation to handle and store supplies and equipment. Yard storage and the ability to load shipping containers inside would be an advantage as these can be used to fumigate items or directly load to port. This facility would need to be leased for the duration of operations until demobilisation is complete. It would complement the current Quarantine Store where personal gear and small goods quarantine would remain focused. Temporary large-scale, bio-secure warehousing will be needed to hold mice bait during production and prior to deployment at the port of departure. Around 1290 $m^3$ is required and 1088 $m^2$ to 272$m^2$ of floor space depending on stacking of pods (Figure 22).

*Figure 22. Bait storage pods prior to Antipodes Island mice eradication at warehousing in Timaru*

*Key risk:*

- *A dedicated mainland biosecurity facility in excess of current DOC capacity is essential to support operations. Invest early in biosecurity planning and infrastructure to ensure readiness for initiation of the infrastructure programme.*

## 6.5. Logistics

All island operations rely on the ability to safely transport personnel and general supplies to the site in a timely and organised fashion. Requirements vary over the life of the project (Figure 23) and can be supported by both maritime and helicopter options.

### 6.5.1. Passenger transport

Passenger transport has usually been by small vessel with capacity for up to 12 people. The voyage takes up to 48 hours from Bluff and seasickness badly affects some passengers. DOC's procurement team established a small vessel supplier panel (DOC-5515843) for the Subantarctic in 2018. The six-month process identified only one local supplier, already relied on by the project to access the site (25 m MY Evohe). The vessel operator works with other projects and could retire soon so availability looms as a critical planning issue. Two smaller local vessels occasionally go to the Subantarctic and prices differ significantly. The frequency of work the project requires is insufficient to sustain a supplier permanently located in Bluff solely focussed on Maukahuka so potential transport frequency and timing will be impacted by availability.

Helicopters have occasionally been used for passenger transport to Auckland Island. However, this is expected to be constrained by changes to DOC's helicopter standard operating procedure (SOP), which is currently being revised. Pappus Consulting analysed aviation passenger transport options based on a minimum payload of six passengers plus luggage. Two helicopter options emerged with suitable payloads, the Defence Force NH90 (16 pax) and Helicopter New Zealand's AW139 (10 pax or 850 kg). NH90 availability is untested but is unlikely to be able to fully accommodate the required frequency and time-critical programmes. Additional supporting infrastructure would be needed on island. Two AW139s are based in Taranaki supporting the oil industry. Availability would be subject to contract holder support and scheduling ability is unconfirmed. This option could potentially supplement a marine option.

The island is not suitable for establishing a runway to support fixed-wing aircraft. Seaplanes have been investigated. Two models (Grumman Albatross and Grumman Mallard) are suitable but rare. Support costs are over $1.9 million per year, so it is not an affordable option.

Passenger transport logistics and associated costs will likely determine how island teams are managed. A dedicated vessel would allow teams to be rostered on and off the island frequently to keep people motivated and broaden the potential pool available for island work. Pig hunters from summer 2018/19 suggested six-week stints would be ideal. However, this frequency is expensive and logistically challenging. Using an overlapping roster (three teams of six; two teams on the island and one off on break), a third more people would be needed relative to the island team size and half the island team would swap out every three weeks. A complete team changeover with no overlap would require a pool of people double the size of the island team but half the relative number of transport voyages. For a pig team of 12 on the island, it is unlikely that a total team of 24 suitable hunters + backups and support staff could be sourced. Longer stints (minimum 12 weeks) are likely to be necessary to make an alternating roster viable. Rotations of 6 months should be considered, with infrastructure reflecting personnel needs for longer deployments (e.g. recreation space, etc). Precedent projects have successfully attracted capable staff for long deployments (3 to 12 months) in remote places (Raoul Island, Gough Island, Macquarie Island, Antipodes Island, Antarctic programmes).

*Key risk:*

- *Market options to support the irregular and infrequent passenger transport requirements are limited. Certainty of supply is a critical dependency to meet project timelines and plan operations. Engage industry experts to understand options.*

### 6.5.2. Cargo transport

Large volumes of cargo must be transported to and from Auckland Island, particularly to establish and remove infrastructure, transport fuel and mice bait (Figure 23) and will require cargo vessels and helicopter support for offloading of supplies. The project needs transportation solutions that can accommodate project-driven timelines and requirements.

Few (if any) suitably sized helicopter capable cargo vessels are available in New Zealand. There are significant costs for each trip (positioning to Bluff, procurement process, health and safety, load design and vessel biosecurity) that will require months of lead time. Required seasonal timings mean a short shipping delay could delay project operations by a year each time a large vessel is needed.

The Italian Antarctic programme has recently purchased the vessel that serviced the South Georgia eradication (formerly the R.V Ernest Shackleton and now called the R.V Laura Bassi). This vessel is large, is helicopter capable and can bunker 150 000 L of Jet A-1 fuel on board. It can also take 20+ shipping containers internally and additional containers on deck and has a small barge for shore loading. It will be based in Lyttelton and may be available for charter outside of Antarctic operations in the summer months (November to March). The New Zealand Navy is a market alternative. However, their operating protocols are restrictive (e.g. the inability to carry fuel, Jet A-1 or petrol, for other entities), they have one Subantarctic run annually and the journey is vulnerable to cancellations for national priorities (e.g. disaster relief). There is some interest from potential project partners to support the lease of a dedicated vessel.

*Key risk:*

- *Bespoke and infrequent cargo transport is required throughout the project with a high chance of large delays or even programme failure if a vessel(s) and helicopters cannot be reliably sourced.*

*Next steps for quality project design:*

- *Seek industry advice early during planning and embed industry expertise into the project team to design procurement and manage complex compliance and contract scenarios.*


*Figure 23. Anticipated logistical support for passenger and cargo requirements and primary operational tasks across the life of the Maukahuka ProjectStandards and support for operational delivery*

## 6.6. Planning

### 6.6.1. Health and safety

#### 6.6.1.1. Plans and Procedures

DOC has good existing systems for health and safety and managing remote island operations. Templates for health and safety planning and emergency response procedures are used. These were developed with Pam McDonald (DOC Health and Safety Advisor) for the mouse eradication project on Antipodes Island and have been modified to suit. The emergency response template is being developed into DOC's standard document for offshore island work as a whole.

The operation will be required to comply with all DOC standard operating practices (SOPs) and systems such as Risk Manager (compliance register DOC-6040470). Overlapping obligations between DOC and suppliers/contractors operating as Persons Conducting a Business or Undertaking (PCBUs) must be addressed in agreements and expressed in integrated safety plans.

DOC's Remote Offshore Island SOP states each expeditioner must go through a medical assessment by the Department's doctor, who then advises the manager if applicants should be deployed. This reduces the risk from known conditions but doesn't eliminate the risk of a severe medical event happening on the island.

New SOPs relating to the use of helicopters are yet to be released and have an unknown impact on the use of helicopters for staff transfers, flying over open water etc.

#### 6.6.1.2. Emergency equipment

Each base will have multiple forms of communication (internet, VHF radio, satellite phone) to allow contact between sites and with the mainland in an emergency. Emergency barrels containing life-preserving equipment and supplies should be present across the island. The network of field huts will provide emergency shelter/accommodation for staff, at a maximum of 7 km apart. Firefighting equipment will be available at huts, fuel stores and helicopter refuelling sites.

All staff will have multiple communication devices whilst in the field (VHF radio, PLB, InReach etc.). Search and rescue (SAR) capability including scoop nets/stretcher to rescue people from water/field will be needed on site. There are currently no VHF repeaters on the island, therefore radio communications are via simplex only. Installation of repeaters will be necessary for the operation. Satellite internet access is good, and surety is likely to get better with new satellites being launched. See section 6.3.4 for more detail on communication devices.

#### 6.6.1.3. Medical capabilities

Current medical requirements are that all team leaders have outdoor pre-hospital emergency care (OPHEC) training and all team members have first aid training. For the operation, more team members could be given OPHEC training to provide greater coverage.

A medical doctor was part of the Antipodes eradication team as well as other island eradications such as Macquarie Island. Medi-vac could be several days away in adverse weather so basic life preservation capability (appropriate medical skills in the team plus equipment) should be available on site. Automated external defibrillator devices should be considered for the three main bases. Inclusion of a 'Field Safety Officer' role as used on Antarctic programmes would help maintain safety training and provide safety oversight for daily operational planning and emergency response capability.

#### 6.6.1.4. Evacuation and rescue capabilities

Staff will be involved in intense operational activity for six to eight years in a remote location. It is likely that a medical evacuation may be required in that time.

DOC is currently working with Rescue Coordination Centre New Zealand (RCCNZ) to clarify the roles and the responsibilities of the organisations in an evacuation scenario. DOC may become responsible for coordinating evacuation of its staff from outlying islands.

The ability to evacuate staff in a medical emergency will be greater during the operation than currently, due to the presence of multiple helicopters and boats at the island. Fishing boats use the area (some seasonal, some year-round) and tourist operators are present in the Subantarctic over the summer months and could provide support both in terms of extracting a team member or allowing access to the ship's doctor.

Auckland Island is close enough to mainland New Zealand to evacuate staff by helicopter (465 km). Twin engine rescue capabilities are available locally through Southern Lakes Helicopters and Otago Helicopters, both of whom have experience in the area. Fuel provisions must be available to enable a helicopter rescue response. A BK117 will take on up to 1000 L of fuel from the island to return to the mainland and two helicopters may fly in tandem. Southern Lakes Helicopters currently maintain a fuel depot of >4000 L at Enderby Island but this has a sloping grass helipad, making it difficult for helicopters to fully refuel. There is a proposal to install a wooden helipad to improve site access for BK117 helicopters to land and refuel. There are difficulties in getting fuel to site, managing the fuel supply and potentially issues with the creation of new fuel depots (see permissions section **Error! Reference source not found.** and fuel storage section 6.3.7 for detail).

The presence of helicopters (all phases) and small vessels (pig and cat ground phases) during the operation will inherently increase the SAR capabilities on-island. Team members will need training in steep slope access/cliff rescue. There will be extensive baiting of the western cliffs, with helicopters operating close to land but over water. The possibility of a helicopter crashing off the western coast must be considered. Pilots will need the ability to recover people from the water, the western coast is generally inaccessible to boats, so any rescue from this area would rely on aerial resources.

*Key risk:*

- *The impact of a serious incident at any stage could have fatal consequences and/or risk the viability of the project. Engage suppliers early to involve them in planning and treat them as part of the team to develop a shared safety culture. Include a dedicated safety role on island.*

#### 6.6.1.5. Veterinary capabilities

There is a high chance of injury to dogs due to falling off a bluff, encounters with pigs, being impaled by vegetation and potentially some risk of suffering primary or secondary poisoning, depending on the toxin used for cats. Section 11 (1) of the Animal Welfare Act 1999 states that "The owner of an animal that is ill or injured, and every person in charge of such an animal, must ensure that the animal receives treatment that alleviates any unreasonable or unnecessary pain or distress being suffered by the animal." The ability to provide some level of veterinary care on-island is therefore necessary. Handlers generally have good experience with basic care but professional support on or off island will be needed.

### 6.6.2. Human resourcing

Planning and implementing the project will be a large undertaking, requiring upscaling from the Feasibility Phase project team of 8.5 full time equivalents (FTE) to participation by ~60 personnel at the peak of the delivery (Figure 24; organisation charts see DOC-6017426). The resourcing presented only covers the operational delivery component of the project, not the wider corporate support roles required (see section 6.6.2.3). The multiple programmes of work will need to operate in parallel, i.e. delivery of infrastructure while planning pigs, and include both on and off island staff and allow for rostering of field-based teams.

Considerations in the proposed team design include:

- Redundancy in case critical people become unavailable at short notice, and succession planning
- Timely recruitment of roles to enable training and planning before delivery of each programme
- Separate Island Manager, Programme Lead and Safety Officer roles on island
- Ongoing recruitment needs and engagement opportunities with Treaty Partner Ngāi Tahu throughout the life of the project
- Sustainable workloads
- Reporting lines and adequate supervision capacity
- Development opportunities throughout the life of the project

It is anticipated that other PF2050 projects will require experienced staff and could provide employment opportunities as this project winds down.

Coordinated incident management system (CIMS) is a scalable framework for the management of activities generally related to response. It is becoming more widely used in DOC. Current uses include fire and emergency, biosecurity incursions and aerial operations to control pest animals. It is worth considering during operational planning as a management tool for the implementation phase for the Maukahuka Project. The CIMS framework can be used to clearly describe the control structure and resource and role allocations during operations. It is particularly helpful when multiple agencies are involved, such as during helicopter or shipping operations and language and expectations are becoming more common in DOC. However, some situations will not warrant stringent application or over-complication so application of CIMS should be assessed on a case-by-case basis and simplified where possible.

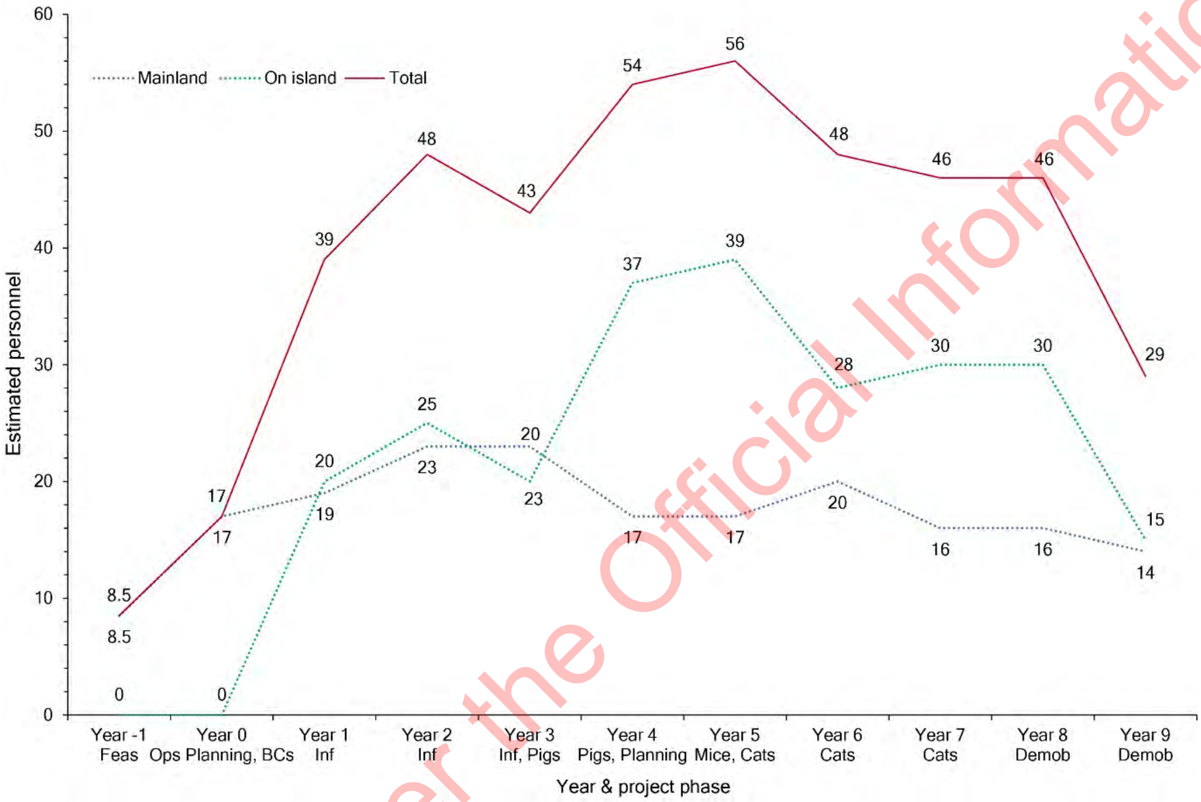



*Figure 24. Predicted on and off island personnel requirements across the life of the project, to eradicate pigs, mice and cats on Auckland Island. Feas. = feasibility; Ops = operational; BC = business case; demob. = demobilisation*

### 6.6.2.1. Field staff by programme

Based on known and estimated effort to service eradication operations, indicative staffing requirements are presented (Table 25). Formal competencies and qualifications required for operational staff are listed in the appendices.

Soft skills required include hunters with an eradication mind-set, backcountry travel and navigation, mental resilience, the ability to live and work in remote locations in confined social conditions etc for long periods of time. Some of these can be taught where required e.g. navigation but recruitment will need to take these into account along-side hard skills and experience. Internal training will be required prior to deployment. Assessment of team fit is a critical consideration for recruitment.

*Table 25. Anticipated on-island and total staffing and hard skills requirements by programme, based on a roster where two thirds of staff are on island at any one time. Note some roles may double up, e.g. boat skippers may also work as support staff; pig feeder maintenance by pig hunters.*

| Programme | Skill | Positions required on island | Positions required total |
|---|---|---|---|
| Infrastructure – set up | Builder | 15 | 23 |
| | Track Cutter | 6 | 9 |
| | Fencer | 8 | 12 |
| | Support Staff | 4 | 6 |
| | Boat skipper | 2 | 3 |
| Pig aerial | Helicopter pilot | 2 | 3 |
| | Helicopter engineer | 1 | 2 |
| | Thermal camera operator | 2 | 3 |
| | Aerial shooter | 2 | 3 |
| | Pig feeder maintenance | 12 | 18 |
| | Support staff | 7 | 11 |
| | Boat skipper | 2 | 3 |
| Pig ground | Helicopter pilot | 2 | 3 |
| | Helicopter engineer | 1 | 2 |
| | Pig hunter | 12 | 18 |
| | Support staff | 7 | 11 |
| | Boat skipper | 2 | 3 |
| Mice | Helicopter pilot | 6 | 8 |
| | Helicopter engineer | 2 | 3 |
| | Bait loading | 12 | 12 |
| | Support staff | 9 | 14 |
| Cat aerial | Helicopter pilot | 2 | 3 |
| | Helicopter engineer | 1 | 2 |
| | Bait loading | 1 | 2 |
| | Support staff | 2 | 3 |
| Cat ground | Helicopter pilot | 1 | 2 |
| | Helicopter engineer | 1 | 2 |
| | Camera service | 10 | 15 |
| | Trapping | 10 | 15 |
| | Support staff | 6 | 9 |
| | Boat skipper | 2 | 3 |

#### 6.6.2.2. Organisational structure

The project is too large and complex for DOC to undertake using business as usual management. Limitations of the status quo include sufficient focus and support from DOC managers (capacity of T2, T3 and T4 managers to devote the time required), appropriate financial delegations for the Project Manager, funding certainty, financial and decision making agility to respond to operational opportunities and needs as they arise. These issues are addressed in more details in a project review undertaken by Keith Broome and Andy Cox in July 2019 (DOC-6011105).

Development of a project plan will articulate needs and capture the design of an optimal operational structure as well as defining roles and responsibilities.

More broadly, initial research has been undertaken to understand operating models that would support successful governance, management, financial control and delivery of the project in collaboration with Ngāi Tahu our Treaty partners, and investment partners (DOC-6322662). Key elements required include:

- A small, highly skilled and committed Governance group with the clear objective of supporting the key objectives of the project i.e. ensure the operations arm is free to deliver
- Defined and well understood roles and relationships
- Dedicated management
- Technical advisory group (TAG) support
- Logistics, planning, operations, communications, procurement etc staff
- A quality project plan and live operational plan with clear objectives, actions, timelines and performance measures
- Quality data collection, storage and analysis
- Effective and agile systems and processes
- Timely and structured decision-making with clarity on who the decision maker(s) is/are
- Ability to receive and manage funds without financial year restrictions
- Culture of trust, transparency, sharing and open progressive thinking
- Effective communication in all elements and between elements
- Legal framework acceptable to all parties, including international funders.
- Reporting and review culture

This operating model will take some time to form and should commence with establishing principles for partnerships agreement in association with iwi. The function of all involved is to support the project team to succeed.

*Key risks:*

- *If Governance is not empowered or properly resourced, it won't be able to support the needs of the project.*
- *DOC's business as usual management may not have the ability to provide and sustain the necessary support to deliver a project of this scale and complexity. The project operating model must include; dedicated high-level management support from within the organisation, delegated financial authority to a level that provides efficient approval processes and good connection with the project team, certainty of funding for the project lifespan, timely approval of budgets and support flexible use of funds between years.*

*Next steps for quality project design:*

- *Complete the following project design tasks as soon as possible and incorporate into project plan: finalise the relationship vision document between Ngāi Tahu and DOC, governance model, team structure, define delegations and decision-making accountabilities, financial management.*

#### 6.6.2.3. Organisational support

Coordinated support from a range of teams within the Department will be required by the project, over and above business as usual (Table 26). Given the scale, complexity and duration it would be advantageous to assign dedicated resources where possible to ensure continuity of support and advice. District and national planning will need to incorporate these requirements over the life of the project. Managers need to champion teamwork, allocate and prioritise resources to help the project team succeed.

The project team needs to be a discrete work unit, operating outside the district's normal shared responsibilities.

*Key Risk:*

- *Insufficient and/or inconsistent shared service support has potential to delay or cause bottlenecks. The required level of internal support services should be planned and assigned, dedicating the same service staff to enable continuity of support and advice (e.g. legal, finance, procurement) and ensuring they have the capacity required.*

*Table 26. Anticipated internal and external support required during lifetime of the Maukahuka project*

| Category | Details | Notes |
|---|---|---|
| Partnerships | • Sourcing and developing relationships and securing funding<br>• Business model design and implementation | |
| Finance | • Costing models for business cases<br>• Financial accounting advice, such as CAPEX/OPEX definition, unusual capital programme, depreciation etc<br>• Business accountant attached to project plus specialist support as required | Business Accountant<br>National Management Accountant |
| Procurement | • Procurement plan and contract process approval<br>• Contribution to business case development<br>• Resource within team during Delivery phase<br>• Planning for a prime contractor for each element, e.g. passenger transfer, cargo, bait, huts.<br>• Aviation and maritime services providers will experience positive impact via increased demand for their services.<br>• Procurement need to be engaged early if we require builds/fencing with support from external contractors. How will we accommodate any external contractors + ~ 30 DOC field staff. | Procurement Advisor<br>Specialist consultant |
| HR | • Recruitment and associated administration for a range of contract structures<br>• ~10 new roles in 2019/20, peaking at ~60 personnel | Bulk of staff recruitment occurs in first two years |
| ISS | • Support new staff with standard DOC Toolset - MS Office, SAP, GIS (ESRI, web apps).<br>• Data capture and governance advice<br>• Data storage<br>• Additional GIS support<br>• Island connectivity | |
| Business Assurance | • Guidance in developing business cases, managing high risk projects and in appropriately delivering and measuring benefits<br>• Conduit to SLT and governance | Risk Advisor<br>Benefits Advisor<br>Portfolio Assurance Advisor and Manager |
| Health and Safety | • A project team of 18 plus short-term support will be exposed to management of safety and wellbeing in remote environment undertaking complex tasks with multiple suppliers including DOC's eight critical safety factors | H&S Advisor |
| Communications | • Media (print and digital), DOC and external, project webpage, design work, alignment with PF2050,<br>• One or more roles will be based in the project team, supported by Communications Advisor(s) attached to the project and assist requests for other support as required | Communications Advisor<br>Media Advisor |
| Biosecurity & Logistics | • Warehousing, biosecurity, quarantine<br>• Requirement is largely linked to preparation and departure of field operations | Ranger Subantarctic |
| Specialist support | • Governance<br>• IEAG and TAGs<br>• Project reviews | Contractors<br>External stakeholder representation |

CAPEX = capital expenditure; OPEX = operational expenditure; BA = business accountant; DOC = Department of Conservation; MS = Microsoft; SAP = systems and application for data processing, current DCO finance software; GIS = geospatial information services; ESRI = Environmental Systems Research Institute, current DOC geographic information system software; PF2050 = Predator Free 2050; HR = human resources; ISS = information support services; H&S = health and safety' IEAG = island eradication advisory group; TAG = technical advisory group; SLT = senior leadership team

### 6.6.3. Procurement and purchasing

DOC is required to follow Government procurement rules as set out in the Procurement and Supplier Management SOP (DOCDM-912450). Items or services exceeding $100 000 in value must be sourced using an open competitive process and advertised on the Government Electronic Tender Services (GETS) website. An exemption from open competition can be authorised in circumstances where a) only one supplier exists, b) no suitable suppliers were found through open competition, or c) an unsolicited unique proposal is made that aligns with Government objectives, where services are not otherwise readily available and represents value for money. In the case of the Maukahuka Project, several of the purchases exceed $100 000 and some exist where a single supplier is available (Table 27). Most are Type C procurements, involving high complexity (multi-stage sourcing, bespoke contract, unusual purchases) and high risk (high public profile, critical effect on DOC if outcomes are not achieved, involve operations in DOC's eight critical safety categories). Type C procurements require a full procurement plan and approvals from DOC's procurement team and the delegated financial authority for the plan, the Request for (RFX) documents and final contract. The final contract also requires legal approval. A team process is used to initiate the procurement for Type C. The various procurement approaches and their function, request for tenders (RFT), proposals (RFP), quotes (RFQ), registration of interest (ROI) are described here procurement approaches.

The process is designed to test suppliers and provide the best outcome for DOC but is not geared well for extraordinary activities with few potential suppliers and high risk (see lessons from Antipodes - After Action Review DOC-2928572 and Great Mercury Island Post Operational Report DOCDM-1477863). The same reviews record the lesson that "suppliers are part of the project team" and a partnerships approach with good communication pays off. Suppliers for such complex operations are a critical part of operational design and planning. These relationships must be nurtured and valued.

Procurement of shipping and helicopter services will be the most complex, with limited supply for specialist services. Helicopter and shipping services will be required for extended periods at several stages of the project. Variable operating requirements may require different suppliers or separate contracts at different times. Significant legal support will be needed for contract development.

The risks and impacts of remote island operation on suppliers' businesses often outweigh the financial incentive for helicopter operators. The exemption from competitive process to source helicopters for the Antipodes mice eradication took 18 months of procurement process to achieve as no one supplier could solve. A three-month process for helicopter services for summer trials on Auckland Island in 2018/19 attracted six suppliers to a briefing but resulted in only one tendered option, wasting time and risking getting an unsuitable operator. As part of the Antipodes After Action review, the DOC Supplier Sourcing Manager recommended that helicopter procurement be the foundation procurement and done as 'Registration of Interest' followed by a 'competitive dialogue' process with short listed potential suppliers, allowing DOC to fully explore options and make informed decisions. Early engagement with industry to build trust and co-design solutions before going to tender is another important lesson. Once tendered on GETS, all communications with potential suppliers are directed through DOC's procurement team so quality and dedicated procurement team support is essential.

*Table 27. Summary of indicative purchases and services requiring approval at Director General level (>$500 000) over life of project. Taken from project cost estimation for business case June 2019 (DOC-6001129).*

| Item/Service | One-off or repeat | Estimated cost |
|---|---|---|
| Field huts | One-off | $1.3 million |
| Main base | One-off | $1.8 million |
| Subsidiary bases | One-off | $1.1 million |
| Boatsheds | One-off | $900 000 |
| Track cutting | One-off | $1.25 million |
| Chartered cargo shipping | Up to 8 times | $6 million (total) |
| Chartered passenger vessel | 60+ voyages | $2.8 million (total) |
| Helicopter fuel | One-off | $800 000 (total) |
| Trail cameras | One-off | $600 000 |
| Helicopter services for each operation | Repeat | Several $million per operation |
| Bait | One-off | $2.1 million |
| Cat traps and remote sensing network | One-off | $600 000 |
| High-resolution thermal cameras - pigs | One-off | $500 000 |

*Key risk:*

- *Government procurement processes deterring suppliers and lengthy process impacting operational timelines. Investigate custom procurement options, reduce risk to attract suppliers and simplify procurement.*

*Next steps for quality project design:*

- *A Procurement Plan approved by the Delegated Financial Authority (DFA) and Supplier and Sourcing Manager is required to outline proposed procurement approach for all type-C procurements (value over $100 000 or high risk or high complexity such as multi-stage process) for a Treasury and/or DOC Detailed Business Case.*
- *Delegate financial authority, supported by Governance, to a level that provides efficient approval processes and good connection with the project team.*

### 6.6.4. Advocacy and engagement

Advocacy and engagement have three roles:

- To build private and political support for the project;
- To report on the value gained from any spending and
- To generate further revenue by engendering further public interest.

This project will likely be funded by a combination of public money, private contributions via partner organisations and individual donations. Advocacy and engagement will therefore need to target a range of audiences to effectively support the project. A communications strategy has been developed for the feasibility stage of the project and will need updating upon project initiation (DOC-5900613).

Advocacy and engagement are currently largely covered by the project team with some internal support. Dedicated resources are required to adequately meet this need (both capacity and skillset) once the project is initiated. The value provided by professionals should not be underestimated, exemplified by the positive engagement with the project promotion film. Contributions by professionals, such as design of project brochures and compelling writing have exponentially greater impact and are warranted for a project of this size. The form that this support takes and who it is provided by will be affected by the operating model of the project, which is currently undecided.

Minimum requirements are 1 FTE focussed on communications with budget to engage professionals, and further staffing resource to focus on relationship building and liaison with partner organisations. Resourcing and specific skills are needed to fulfil the objective of engaging people with the Subantarctic.

### 6.6.5. Data management

The DOC Content Management (DOCCM) system in conjunction with the project 'Home Page' index is the default storage and management solution for corporate documents (Maukahuka homepage: DOC-2999881). These are also backed up onto the Invercargill S: drive to facilitate offline work.

Images and videos from trail cameras require extremely large and reliable storage capacity. Currently these files are stored in DOC's Amazon cloud system (S3 Bucket; Amazon.com Inc, Seattle, USA) which also supports external sharing. These data will accumulate quickly as trials continue and operations commence, so it's vital a full data management plan is developed as early as possible. This is an extremely valuable dataset (to DOC and external researchers) and warrants appropriate planning effort.

GIS data is managed to corporate standards. These standards include naming conventions, metadata, version control, and a defined data steward. All data and mapping products are stored on the Q: drive; and data management checks happen regularly. Some data is also published to ArcGIS Online to enable interactive web maps, web applications, dashboards and story maps.

Field observations to date have been captured using a combination of the Avenza Maps (Avenza Systems Inc., Toronto, Canada) mobile app and Survey123 (ESRI, Redlands, USA), with DOC mobile phones and Garmin (Garmin Ltd., Olathe, USA) GPS units. This has ensured some degree of uniformity but has limitations. An improved solution for both hardware and software will be required for the delivery phase, which will require liaison with DOC information shared devices and corporate architecture (DOC-6261065). Storage and indexing of photos and videos taken by expeditioners also needs to be planned and addressed from the beginning to ensure most value is obtained. Currently these files are stored in DOC's Amazon cloud system (S3 Bucket).

### 6.6.6. Monitoring plan

The key motivation for invasive species eradications is to protect threatened species, ecosystems or economies. Several factors (principally tight budgets) have meant that outcome monitoring of many island eradications have been inadequately measured or reported, despite the importance of these data to inform positive ecological, social and economic outcomes, as well as communicating benefits realisation to the public and stakeholders[70,71]. Too often the assumption that positive outcomes in new locales will repeat, are based on limited evidence from previous eradications with differing natural and cultural community structures[71].

A monitoring plan is required to assess whether project benefits have been realised and to account for potential disbenefits of the project. The expected benefits of the project have been mapped with reference to the outcomes of the project and fall into five main categories: biodiversity, capability, iwi, partnerships and social (DOC-6035780). It is expected the project will improve DOC's processes, operations and relationships in these categories. To effectively measure and report on these benefits, a monitoring plan with specific answerable questions and timeframes, that forms part of the operational plan, is required. The monitoring plan would measure short and medium-term project outcomes with the intention of assisting DOC's Murihiku district in the development of future priorities and resource allocations for monitoring, research and management activities in the region.

The monitoring plan will be written and initially implemented during the detailed operational planning phase and will run through the life of the project. Years 0 – 3, prior to the eradication of pests, provides an ideal opportunity to implement a baseline monitoring programme that will allow robust before-after-control-impact sample design. Regular servicing of the island provides opportunities to support monitoring activities through the life of the project.

*Next steps for quality project design:*

- *Species monitoring should be initiated and undertaken immediately as opportunities arise to provide robust baseline data that will allow impacts and benefits to be understood. Findings will support key project planning documents such as the AEE and would benefit other DOC work such as the Subantarctic Science Strategy.*

*Plate 7. The pest-free islands within the Auckland Islands archipelago provide a glimpse into the post-eradication future of Auckland Island; the promise of recovery and proliferation of native species through all levels of the ecosystems. Nearby Enderby Island, cleared of rabbits (*Oryctolagus cuniculus*), mice (*Mus musculus*) and cattle (*Bos taurus*) in the 1980 – 1990s showcases how quickly the mauri is restored once pests are removed. Photo credits: Jacob Osborne and Jack Mace/DOC*

# 7. Acknowledgements

The need to complete the Maukahuka Project has long been understood in the conservation community and work to understand how it could be achieved is a long reoccurring theme in the eradication space. We would like to thank those who came before, providing invaluable context and concepts that contributed to the completion of this study. Particular thanks to the Island Eradication Advisory Group and technical experts who provided vital and tireless critique and feedback through the process that has led to the point of being able to say this project is feasible. Thank you to the skilled and passionate field teams, who braved the seas and scrub to test tools and techniques that prove this project feasible, and worthwhile. Special thanks to Steve Kafka and the crew of the MY Evohe for going above and beyond to provide safe, enjoyable passage to the island and find solutions to transport all of our gear! Thanks to the Quarantine Store team for your support getting us away on time and biosecure. Thank you to DOC whanau, suppliers, stakeholders, project partners, our Treaty Partner Ngāi Tahu, especially Gail Thompson and Ta Tipene O'Regan for your representation. Thank you to the conservation community for engaging wholeheartedly with the vision for a pest free Auckland Island – your support and enthusiasm has driven this study forward and we look forward to delivering this project with you one day soon.

This study is the culmination of decades of pioneering research, development and implementation of eradication capability in New Zealand. We stand on the shoulders of giants.


*Plate 8. Feasibility field trials in 2018 – 2019 saw 57 personnel voyage south to undertake work on Auckland Island, spending 68 days at sea across nine return voyages. Personnel built important knowledge of the site, and included helicopter pilots, pig hunters, an archaeologist, Ngāi Tahu representatives, scientists and photographers amongst others. Staff were present on the island for 140 days, equating to over three and a half people years of boots on the ground. Photo credits: James Ware/DOC and Finlay Cox/DOC.*

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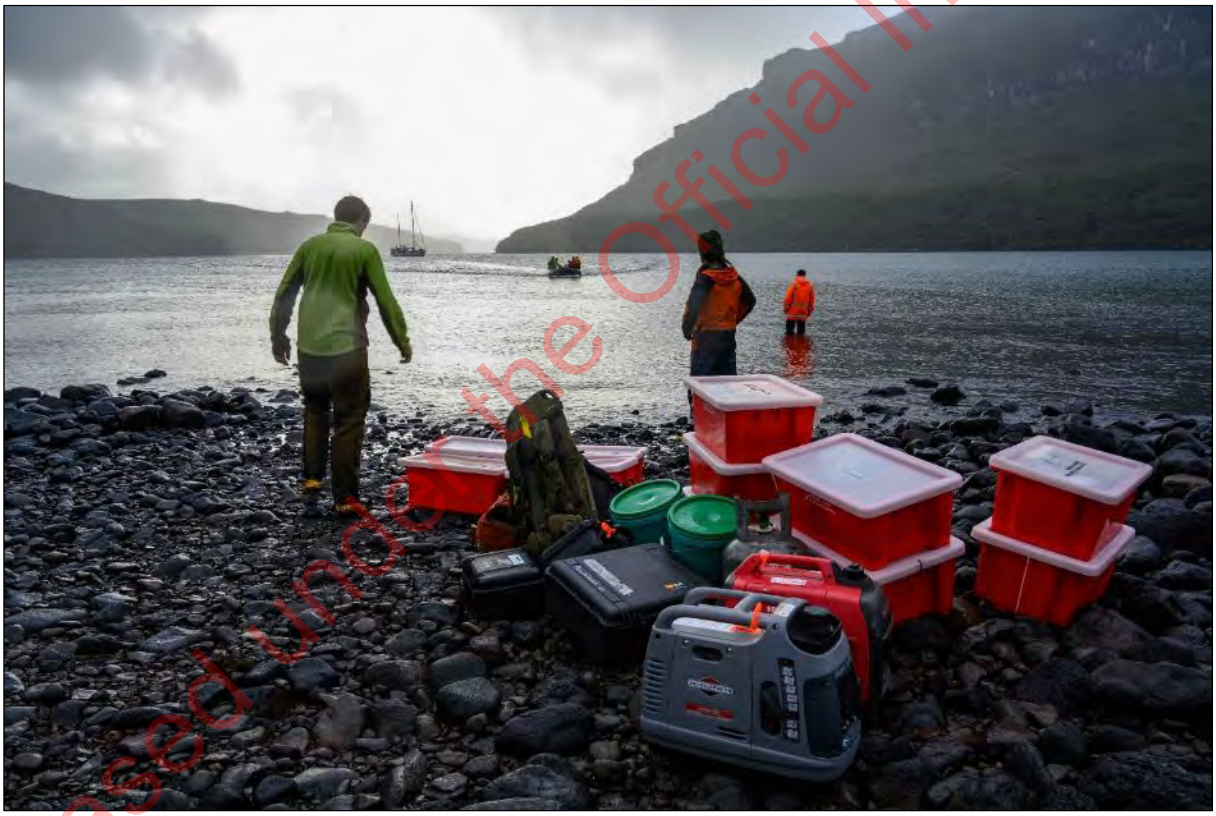


*Plate 9. Travel to Auckland Island during field trials in 2018/2019 relied on MY Evohe. The voyage through the waters of the Roaring Forties and Furious Fifties typically takes 30 – 48 hours, depending on conditions. Upon arrival, personnel and gear must be safely shifted to shore and onwards to base sites. Planning gear requirements, packing efficiently and covering contingencies requires careful thought and experience. During feasibility field trials at Auckland Island in 2018/19, more than 50 t of cargo was transported to the island to facilitate work. Photo credits: Mat Goodman and Stephen Bradley*

# Appendices

## Glossary of terms

| | |
|---|---|
| **Adaptive management** | Monitoring and data are used to inform situational decision making about the changing application of eradication tools and techniques. Often changes to arise from specific knowledge of the site or target species behaviours. |
| **AWS** | Automatic weather station |
| **Bait application rate** | The target for the 'on the ground' amount of bait to be applied to the treatment area. Delivered bait application densities are estimated from pre-calibrated bait bucket swath and operational data such as helicopter speed, bait usage and the area covered. These estimates are analysed and compared against the target application rate. |
| **Baiting prescription** | A combination of factors that define how the total volume of bait will be applied such as bait application rate, timing, specific area or block variation, number of treatments, swath overlap etc. |
| **BAU** | Business as usual |
| **CI** | Confidence interval (e.g. 95% CI) |
| **CMS** | Conservation Management Strategy – 10 year regional strategies that provide an overview of issues and give direction for the management of public conservation land, waters and species for which DOC is responsible. |
| **Detection line hunting** | A hunting technique that is designed to put all target animals at risk in a specified area. Hunters with close-range bailing dogs maintain a line (move at the same rate to ensure there is one front). Hunters are reading the terrain, sign and dog behaviour. Dogs contribute to the coverage by searching an area around the hunter. Regular communication is critical to ensure a unified sweep is maintained. Spacing between hunters and hunting direction is dictated by relief and environment to ensure dogs can scent animals and there are no gaps large enough for an animal to remain undetected (maintain high detection probability). Coverage is ascertained through analysis of tracks (hunter and dog if applicable) and site-specific considerations to inform confidence. Also known as team hunting. |
| **Detection probability** | The probability of a monitoring tool detecting a target animal if the animal is present. Detection rates are influenced by target species abundance. |
| **DOC** | Department of Conservation / Te Papa Atawhai; sometimes referred to as 'the Department' |
| **DOOCM** | Department of Conservation Content Management (document management database) |
| **Eradication phases** | Phases including knockdown, mop-up and validation used to describe eradication strategy. These phrases are theoretical constructs that describe the overarching strategic approach to an eradication. In practice these phases regularly overlap (but are sometimes distinct) so the eradication strategy is a continuum of techniques. |
| **GETS** | Government Electronic Tender Services |
| **Hard skills** | Teachable and measurable abilities that are required to succeed in a role. |
| **IEAG** | Island Eradication Advisory Group |
| **IUCN** | International Union for the Conservation of Nature |

| | |
|---|---|
| **IVL** | International Visitor Levy – a $35 fee applied on arrival in New Zealand to support conservation and tourism functions. |
| **Judas pig** | A pest control technique that capitalises on the social nature of pigs by releasing radio-collared pigs back into an area that has been hunted and using them to seek out surviving pigs. |
| **Knockdown** | Phase of an eradication where the target species interacts with an eradication tool leading to rapid population decline. Typically, this is the first phase of an eradication attempt and the most passive tools are used. |
| **MOC** | Minister of Conservation |
| **Mop-up** | Phase of an eradication where tools and efforts are concentrated in response to known survivors of the target species, or areas where they are suspected to persist based on evidence or prior knowledge. Typically, the second phase of an eradication, though may run concurrently with knockdown depending on the target species. Often multiple techniques are used. This phase is often informed by site or species-specific knowledge that is gathered during delivery (adaptive management). |
| **NZSIA** | New Zealand Subantarctic Islands area |
| **RFX** | Common acronyms in the procurement landscape; a catch-all term that captures all references to Request for Information (RFI), Request for Proposal (RFP), Request for Quote (RFQ), and Request for Bid (RFB) |
| **Risk** | The combination of likelihood and consequence of an issue arising in the future that could impede the goals of the project. Risks are avoided or managed by pre-planned actions to reduce their likelihood or impact. All eradications have risks that cannot be mitigated and an assessment of the project risks versus benefits before proceeding is warranted. |
| **Rolling front** | Systematic approach for deploying an eradication technique over a large area where the scale does not allow complete coverage at once. The 'front' of the techniques 'rolls' over the area leaving only treated area behind. |
| **SAR** | Search and rescue |
| **SLT** | Senior Leadership Team, Department of Conservation / Te Papa Atawhai |
| **Soft skills** | A combination of traits such as social skills, communication skills, attitudes, career attributes, social and emotional intelligence and personality traits that enable a person to navigate their environment and work well with others. |
| **SOP** | Standard operating procedure |
| **Summer trials 2018/19** | Field trials undertaken on Auckland Island during summer (Nov – Mar) 2018/19 to reduce uncertainties that arose from an initial feasibility assessment. |
| **TAG** | Technical advisory group |
| **Treatment area** | The extent of area to be treated by an eradication technique and/or strategy. In Auckland Island context, it includes all islands in the archipelago unless there is confidence the target species is absent. |
| **UNESCO** | United Nations Educational Scientific Cultural Organisation |
| **Validation** | The final phase of an eradication attempt where tools and efforts are targeted at detecting any individuals that may persist. Target species population information, an understanding of eradication technique specific detection probabilities and how techniques were implemented (e.g. validation period and tools, risk of device avoidance, etc) will inform the eradication result (success or failure). |

| | |
|---|---|
| **Voucher specimen/sample** | A preserved specimen/sample that serves as a verifiable and permanent record of wildlife at a place and point in time. |
| **VTA** | Vertebrate toxic agent |
| **Winter trials 2019** | Field trials on Auckland Island during winter (July – Sept) 2019 undertaken to reduce outstanding or new uncertainties that arose from an initial assessment of project feasibility, and/or required follow up after the summer trials 2018/19 |
| **ZIP** | Zero Invasive Predators Ltd |

## Key documents

| | |
|---|---|
| Summary feasibility report | DOC-6085426 |
| Business cases | DOC-6119140<br>DOC-6119801 |
| Research and Development Plan* | DOC-6214883<br>DOC-5999483 |
| Organisational charts* | DOC-6017426 |
| Benefits maps and inventory* | DOC-6035780<br>DOC-6035663 |
| Summer 2018/19 operational report | DOC-5911275 |
| Winter 2019 operational report | DOC-6099361 |
| Project review July 2019 | DOC-6011105 |
| Treaty Partners Relationship Vision* | DOC-6262719 |

*Living documents and/or in draft stages

## Eradication tools that have been discounted for Auckland Island

### Pigs

#### Disease

There are no effective diseases that are likely to cause widespread fatality in New Zealand currently. Diseases such as ‘African swine fever’ could be effective but importation of a disease would not be supported because of risk to domestic pigs (Newmann 2018, pers. comm.).

#### Pesticides

Pesticides were considered as a knockdown technique but were discounted because other currently available tools are considered as or more effective and do not require registration (Table 28).

*Table 28. Toxin options considered for the eradication of pigs on Auckland Island, New Zealand*

| Toxin | Currently registered for use? | Other issues |
|---|---|---|
| Warfarin | No | • Inhumane |

| | | |
|---|---|---|
| 1080 | No | • Bait shyness develops<br>• High concentration required – poisoning of non-targets.<br>• Risk to hunting/detection dogs |
| Sodium nitrite | Yes | • Bait stations only<br>• Low efficacy |
| Brodifacoum | No | • Quantity needed<br>• Impact on mice eradication |

## Mice

### Gene drive

This tool is still in the early stages of development, is unlikely to be available for many years and would require significant testing outside of New Zealand (D Tompkins 2018, pers. comm.). Current legislation in New Zealand doesn't allow for such tools.

## Cats

### Shooting and spotlighting

The dense nature of the habitat and the low density of cats on Auckland Island means hunting with a spotlight is not a viable primary mop-up tool. Shooting with a spotlight could be used in combination with other techniques (e.g. bait dumps) to target specific animals.

### Fences

Using cat proof fencing to divide the island into three blocks was discounted due to the impracticality of constructing cat-proof terminuses at either end of the fence, the cost of the materials and the necessary maintenance requirements.

### Disease

The viral disease feline enteritis, or feline parvovirus, is present in New Zealand. The disease is highly contagious through direct cat-cat contact, or indirectly through vomit or faeces and can persist in the environment for a long time. It can be seeded in the population by inoculating and releasing cats or possibly by distributing infected meat. However, the disease is not registered as a biocide and achieving this would be as complex, costly and time-consuming as a new pesticide. The future use of this tool in New Zealand beyond Auckland Island is considered unlikely. Moreover, there is concern that transmission would be ineffective due to the low density of cats on Auckland Island. Given that pesticides are likely to be more effective, this potential tool is not considered further.

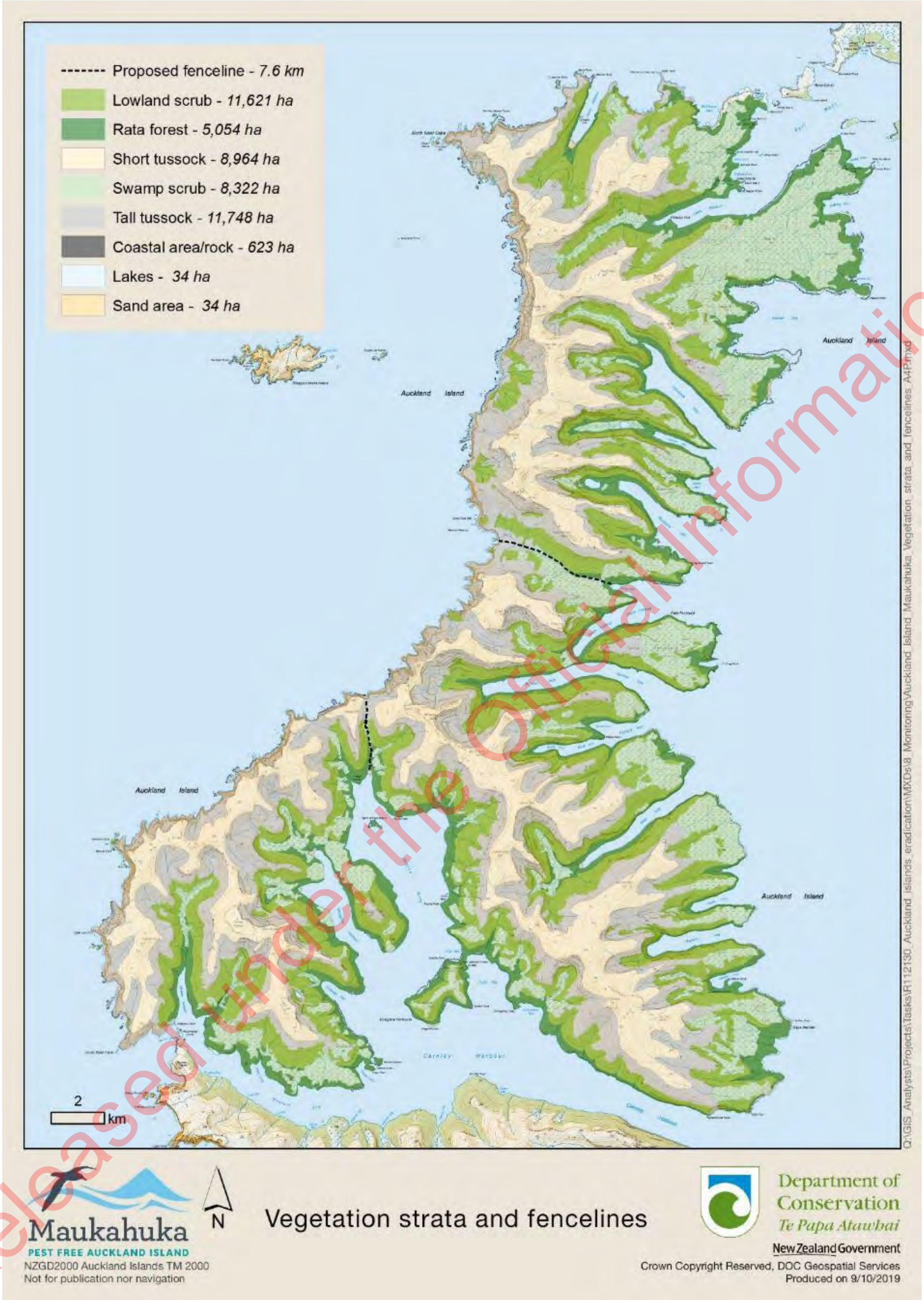



*Figure 25. Broad vegetation classification and proposed fence lines on Auckland Island*

*Table 29. Estimated bait volumes for proposed mice baiting prescription for Auckland Island*

| | | 1st Treatment | | | 2nd Treatment | | | TOTALS | |
|---|---|---|---|---|---|---|---|---|---|
| **Treatment Site** | Area (ha) | Bucket flow rate (kg/ha) | Nominal rate (kg/ha) | Bait volume (kg) | Bucket flow rate (kg/ha) | Nominal rate (kg/ha) | Bait volume (kg) | Total bait (kg) | Flight time estimate (hr) |
| Across Island Swaths (50% overlap) | 45905 | 2 | 4 | 183 620 | 2 | 4 | 183 620 | 367 240 | 459.1[2] |
| Coastal Strip (deflector bucket) | 1470 | 2 | 4 | 5880 | 2 | 4 | 5880 | 11 760 | 23.5[3] |
| Coastal Strip (standard bucket) | 3135 | 4 | 4 | 12 540 | 4 | 4 | 12 540 | 25 080 | 31.4[2] |
| Steep Slopes 50° to 70° (standard bucket) outside coastal strip | 1051 | 2 | 2 | 2102 | 2 | 2 | 2102 | 4204 | 5.3[2] |
| Cliffs > 70° (deflector bucket) | 4042 | 2 | 4 | 16 168 | 2 | 4 | 16 168 | 320336 | 64.7[2] |
| Cliffs > 70° (broadcast bucket) | 1078 | 4 | 4 | 4312 | 4 | 4 | 4312 | 8624 | 10.8[3] |
| Named offshore islands/stacks (8) | 38 | 2 | 4 | 151 | 2 | 4 | 151 | 302 | 2 |
| Larger rock stacks ≥ 0.5ha (19) | 22 | 2 | 4 | 88 | 2 | 4 | 88 | 176 | 2 |
| Small rock stacks ≤ 0.5ha (156) | 19 | n/a | 4 | 76 kg in 200 g bags | n/a | 4 | 76 kg in 200 g bags | 152 | 2 |
| Infrastructure | n/a | n/a | 50 kg | 50 | n/a | 50 kg | 50 | 100 | n/a |
| Subtotal | 56 760 | | | 224 987 | | | 224 987 | **449 974** | **600.1 hr** |
| Contingency (12%) | | | | 22 499 | | | 22 499 | 53 997 kg | 67.5[1] hr |
| | **Total (two treatments) rounded to nearest 500 kg = 504 tonnes over 668 hours flying** | | | | | | | **503 971 kg** | **668.1 hr** |

[2] Based on productivity of 0.8 tonnes/hr inclusive of 15 min/hr for refueling and GPS downloads
[3] Based on productivity of 0.5 tonnes/hr inclusive of 15 min/hr for refueling and GPS downloads

## Permissions

*Table 30. Permissions required and standards that must be met that may have an impact on the Maukahuka Project planning and operations*

| Name | Category | Type | Issuing authority | Legislation | Programme | Covers | Comments |
|---|---|---|---|---|---|---|---|
| Regional Coastal Plan | Infrastructure | Coastal Permit | DOC | Resource Management Act 1977 | Infrastructure & Logistics | Discharge from the land into the sea/costal marine zone<br>Erection, alteration and demolition of structures in the marine and coastal area<br>Discharge untreated sewage from land into seas is prohibited<br>Carriage or use of heavy fuel oil is prohibited<br>Ship to ship transfers of MGO and MDO prohibited<br>Ship anti-fouling requirements | The Coastal Plan is due for review. No information on when this is likely to happen but project could contribute to new plan. Activities need to take into account the current and proposed plans.<br>River mouth classification altered from RMA to MHWS line across river mouth |
| Permission to apply pesticides | Pest control | Permission | DOC | Section 95a Hazard Substances and New Organisms Act 1996<br>Section 53 and 54 Wildlife Act 1953<br>Section 50(1) Reserves Act 1977 | Cat; Mice | Discharge of brodifacoum, PAPP and 1080 onto DOC land.<br>By kill of native species from pesticide use. | Brodifacoum and 1080 exempt from resource consent under section 360. Discharge of PAPP will require Resource Consent. |
| Conservation Management Strategy | Operations | Permission/ Rule / Standard | Conservation Board, Murihiku | General Conservation Policy 2005 | All | Activities on Public Conservation Land and or those that may affect native species | Amendments or exemptions to rules that disallow activities proposed by Maukahuka operations are required |
| Marine Reserves Act | Infrastructure | Permission | DOC | Marine Reserves Act 1971 | All | Discharge of toxic substance or pollutant into reserve.<br>Take or removal of any sand, shingle, natural material.<br>Discharge of firearm in or into reserve.<br>Erect any structure in or over reserve | Legal advice received during the Antipodes Mice Eradication indicated that Resource Consent is not required under the Marine Reserves Act for aerial discharge of toxin into a Marine Reserve. |

| Name | Category | Type | Issuing authority | Legislation | Programme | Covers | Comments |
|---|---|---|---|---|---|---|---|
| Helicopter SOP | Helicopters | SOP | DOC | | All | All helicopter flights | Not yet released. Unknown impact on use of helicopters for passenger transport to and from the island. |
| Carbon budget | Operations | Rule / Standard | DOC | | All | Regional and national carbon budgets that DOC must operate within. | Not yet released. Unknown impact on project. |
| Civil Aviation Rules - Air transport | Helicopters | Rule / Standard | CAA | Civil Aviation Rules Parts 135 and 137 | All | Flight times and duty rosters for pilots | Will need sufficient pilots to cover mandatory rest periods |
| Conservation Management Strategy - Structures | Infrastructure | Permission | DOC | Conservation Act 1987 | Infrastructure and Logistics | Construction | No new fuel depots are allowed. Currently seeking advice on definition and exemption. |
| Storage of hazardous substances - Location Compliance Certificate and Secondary Containment | Dangerous Goods | Rule / Standard | Work Safe | Health and Safety at Work (Hazardous Substances) Regulations 2017 | Infrastructure and Logistics | Required for diesel, kerosene and petrol if >2000 L and stored for >14 days | EPA and Worksafe are to provide certainty around final storage design.<br>Antarctic NZ and Raoul Island both hold exemptions under the legislation.<br>Options include double skinned bladders, bulk containment tanks or a bunding for fuel drums and containers.<br>RCCNZ and the Defence Force are currently investigating installing fuel depots for emergency responses in the Subantarctic. |
| Registration of new VTA | Pest control | Permission | EPA and MPI | Hazardous Substance and New Organisms Act 1996<br>Agricultural Compounds and Veterinary Medicines Act 1997 | Cat | Registration of a new toxin for general release | Requires data on the pesticides chemistry, manufacturing, animal welfare, residues, efficacy, environmental and human health effects. |
| Resource Consent - Discharge of VTA | Pest control | Consent | DOC | Resource Management Act 1977, Section 15 | Cat | Discharge of a toxin to land | Only required for PAPP, not required for 1080 or brodifacoum. |
| Animal Ethics Committee approval | Pest control | Permission | DOC | Animal Welfare Act 1999<br>Agricultural Chemicals and Veterinary Medicines Act 1997 S. 28 | Cat; Mice; Pig; Monitoring | Manipulating animals for research, testing or teaching. | DOC Vet recommendations are included in the research proposal put to AEC. |

| Name | Category | Type | Issuing authority | Legislation | Programme | Covers | Comments |
|---|---|---|---|---|---|---|---|
| Archaeological authority | Infrastructure | Permission | Heritage New Zealand | Heritage New Zealand Pouhere Taonga Act 2014 | Infrastructure and Logistics | Alteration or work in proximity to archaeological sites | Can empower person to carry out archaeological activity |
| Building Consent | Infrastructure | Consent | SDC | Building Act 2004 | Infrastructure and Logistics | Required for waste management systems and main base buildings. | Exemption currently held for huts and toilets if chartered engineer involved.<br>If building under 10 $m^2$ and doesn't contain sanitary facilities, is exempt.<br>List of exemption reasons currently under review. |
| Resource consent - Discharge to land | Infrastructure | Consent | DOC | Resource Management Act 1977 | Infrastructure and Logistics | Toxic baiting activities.<br><br>Long drops, grey water, sewage | Standing consent exists for brodifacoum spread.<br><br>Discretionary activity. Must be over 50 m from coast, no water in bottom of long drop. Not required for containment toilets. |
| Resource consent – native vegetation clearance | Infrastructure | Permission | DOC | | Infrastructure and Logistics | Track cutting and infrastructure site preparations and maintenance | |
| Licensed boat operator and boat survey | Shipping | SOP | DOC | Marine Transport Act 1994 | Infrastructure and Logistics | Use of boats in offshore areas. | DOC Boat operator ISC or MNZ license and DOC Approval for vessels <6m<br>MNZ issued license and DOC approval for specific vessel >6m<br>Mid-term survey within 3 years of date of first survey |
| Firearms License (Endorsement) | Firearms | Qualification | Police | Arms Act 1983 and Arms (Prohibited Firearms, Magazines and Parts) Amendment Act 2019, Arms Act 1983 Section 4A (1)(f) | Pig; Cat | Storage and use of restricted firearms | Murihiku currently has a licensed operator for restricted E Cat firearms. |
| Firearms - import of banned weapons | Firearms | Rule / standard | Police | Arms Act 1983 and Arms (Prohibited Firearms, Magazines and Parts) Amendment Act 2019, Arms Act 1983 Section 4A (1)(f) | Pig; Cat | Import of banned weapons | Permission required to import semiautomatic rifles for aerial hunting - unclear as to procedure |

1080 = sodium fluoroacetate; AEC = animal ethics committee; CAA = Civil Aviation Authority; DOC = Department of Conservation Te Papa Atawhai; EPA = Environmental Protection Agency; ISC = inshore skippers certificate; MDO = marine-safety duty officer; MGO = marine gas oil; MHWS = mean high water springs; MNZ = Maritime New Zealand; PAPP = 4'-Aminopropiophenone; RCCNZ = Rescue Coordination Centre New Zealand; RMA = Resource Management Act; SDC = Southland District Council; SOP = standard operating procedure; VTA = vertebrate toxic agent

| Name | Category | Type | Issuing authority | Legislation | Programme | Covers | Comments |
|---|---|---|---|---|---|---|---|

## Competencies

*Table 31. Department of Conservation competencies and other qualifications required by work programme for the Maukahuka Project*

| | Infrastructure | Pig aerial | Pig ground | Mice | Cat aerial | Cat ground | Mainland |
|---|---|---|---|---|---|---|---|
| Certified handler - Dangerous good | x | x | x | x | x | x | x |
| Helicopter - general | x | x | x | x | x | x | x |
| Quarantine procedures | x | x | x | x | x | x | x |
| Back country work competency | x | x | x | x | x | x | |
| First Aid | x | x | x | x | x | x | |
| OPHEC (Team leaders) | x | x | x | x | x | x | |
| Firefighting (extinguishers) | x | x | x | x | x | x | |
| DOC Boat operator ISC / MNZ licence | x | | x | | | x | |
| Helicopter - working under/strop loading | x | | | x | x | | x |
| Asset inspector | x | | | | | | |
| Chainsaw - basic and high level | x | | | | | | |
| Scrub bar | x | | | | | | |
| Part 101 Course - Drones | x | | | | | | |
| Certified engineer | x | | | | | | |
| Working at heights | x | | | | | | |
| Firearms license - endorsement for restricted weapons | | x | | | | | |
| Firearms license | | | x | | | x | |
| Controlled drugs - license to deal in | | | x | | | x | |
| Veterinary sign off (DOC) | | | x | | | x | |
| Administration sedative to feral animals | | | x | | | x | |
| Dog handler team certification | | | | | | x | x |
| HT driving license | | | | | | | x |
| Forklift license | | | | | | | x |

DOC = Department of Conservation Te Papa Atawhai; ISC = inshore skipper certificate; MNZ = Maritime New Zealand; OPHEC = outdoor pre-hospital emergency care; HT = heavy vehicle

## Recommendations

*Table 32. Recommendations to address issues, reduce risk and increase the likelihood of success of the project*

| Priority | Recommendation | Rationale | Who | When |
|---|---|---|---|---|
| **Top 10** | | | | |
| 1. | The scope of the project should encompass eradication of all three pest species delivered in sequential operations in short succession. | • Most efficient and likely way to achieve success<br>• Full benefits realisation, avoids disbenefits<br>• Lower cost than separate projects over longer timeframe<br>• Extract most value from the investment to establish project team, infrastructure and complex logistics solutions. | Project Sponsor | Immediate |
| 2. | DOC should lead with a commitment to the project by securing the Crown investment and articulating an investment strategy for the life of the project, this will provide investor confidence enabling the required third-party contributions. | • Confidence required for other partners to invest<br>• Protect against external disruptions<br>• Enables work on critical path tasks such as tools development, vessel procurement. | DG | Immediate |
| 3. | Invest in capability developments for technical feasibility:<br>• thermal camera technology and experienced aerial hunting teams,<br>• improved helicopter bait bucket for reliable low sow rate application,<br>• automated image processing software to label and triage imagery from trail cameras,<br>• an effective toxic bait registered for cats that can be aerially applied,<br>• cat detection dogs and handlers. | • Technical feasibility of eradications dependant on these.<br>• Action early (pre project initiation) to ensure capability is highly reliable, operationalised and available on time.<br>• Investment would also benefit other DOC work, key suppliers, and other agencies.<br>• Increase confidence to stop early and save time/cost | DDG Biodiversit y | Ongoing |
| 4. | Complete the following project design tasks as soon as possible and incorporate into project plan: finalise the relationship vision document between Ngāi Tahu and DOC, | • Ensure co-design and good Treaty partnership.<br>• Facilitate the creation of a workable partnerships agreement ready for initiation.<br>• Reduce lag at project initiation | DDG Biodiversit y | Design |

| | | | | |
|---|---|---|---|---|
| | governance model, team structure, define delegations and decision-making accountabilities, financial management. | • Enable informed discussions with investment partners<br>• Establishing management structure/entity will take time | | |
| 5. | The project operating model must include dedicated high-level management support from within the organisation, so decision-makers are engaged in the project and connected to project management. | • Ensure capacity is available and applied for timely decision making and direction.<br>• Avoid constraints experienced in Feasibility Phase due to limited capacity of DOC T2 and T3 and short-term funding cycle. | DDG Biodiversit y | Design |
| 6. | Overarching site management plans including:<br>• NZSIA Biosecurity Plan,<br>• Subantarctic Research Strategy and a<br>• Subantarctic Strategy<br>should be updated/completed by the relevant district and national teams to guide project design and ensure strategic alignment. | • Ensure coordination and alignment of strategy and programmes; guide prioritisation of opportunities for other work in the Subantarctic with increased access.<br>• Guide future project planning. E.g. management of Olearia, inform a departmental decision on long term infrastructure needs, guide prioritisation of monitoring effort and selection of ancillary activities given the opportunity to do work on site due to the unusually regular access.<br>• A current Biosecurity Plan is needed to protect investment | Murihiku /<br><br>DDG Biodiversit y | Immediate |
| 7. | Share Infrastructure plan to initiate consultation with local teams and authorities and progress interim actions identified. | • Some permissions can be obtained ahead of time (e.g. Archaeological Authority), and steps taken to prepare for others.<br>• Reduces complexity, time pressure and delays once the project is initiated. | Project Manager | Early 2021 |
| 8. | Embed shipping and helicopter industry expertise into the project team to design procurement and manage complex compliance and contract scenarios. Ensure contract management capacity is resourced appropriately. | • To build trust with suppliers and better understand the market<br>• Explore custom procurement solutions | Project Manager | Planning |

| | | | | |
|---|---|---|---|---|
| | | • Explore options to improve chances of certainty of supply long-term shipping and helicopter services | | |
| 9. | Invest in biosecurity planning and infrastructure to manage biosecurity risk appropriately and in readiness for the start of the infrastructure programme e.g. establish additional biosecurity facilities in Invercargill for managing quarantine and storage of large-scale equipment and supplies. | • The vast amounts of gear and supplies will require a dedicated mainland biosecurity facility in excess of current local DOC capacity.<br>• Essential to support operations and should be invested in early to ensure they are functional in time.<br>• Protects existing and project investment<br>• Prevent project delays if quarantine facilities do not meet needs and processing supplies leads to 'bottleneck' | Project Manager | Planning – within first year of project initiation |
| 10. | Continue engagement with potential funding partners and stakeholders to facilitate better understanding of relative costs, wider benefits, stopping points, complexities, and opportunities. | • Understand opportunities and changing context<br>• Readiness to proceed when the time is right<br>• Contribute to project design | | Ongoing |
| **Operational Planning** | | | | |
| | Operational plans for infrastructure, pigs, mice, cats, and native species monitoring should be drafted and peer reviewed now. | • Capture and test current thinking and share knowledge<br>• Assessment of environmental effects (AEE) and Archaeological Authority (AA) can then be produced for the infrastructure programme<br>• Maximise existing investment | Maukahuka | 31/12/2020 |
| | Review and update project cost estimates once operational plans are drafted. | • More accurate project costing<br>• Capture and test current thinking | Maukahuka | 31/12/2020 |
| | Understand how changes to protocols (e.g. Regional Coastal Plan, DOC Helicopter SOP, Conservation Management Strategy) may impact project activities and plan contingencies. | • Potential seasonal shipping restrictions in Port Ross<br>• Restricted helicopter passenger transfer over water<br>• Need for direct flights to island by single-engine helicopters | Project Manager | Ongoing |

| | | | | |
|---|---|---|---|---|
| | | • Fuel storage certification | | |
| | Understand the future implications of carbon budgeting. | • Likely to be mandatory when the project is initiated<br>• Allows operating plans to initiate baseline measures to assess potential carbon sequestration following release from pest impacts against short-term carbon use | Project Manager | Planning |
| | Budget for operational duration with enough contingency to realistically account for potential operating conditions and resource well (e.g. base at least 6 helicopters on Auckland Island for the mice eradication). | • To achieve objectives within the required timeframes<br>• To make rapid progress when weather conditions are suitable; give best chance to finish early<br>• Ensure required funding is available | Project Manager | Planning |
| | Engage industry expertise with compliance expertise to design a supply chain solution for helicopter fuel supply and storage. This should include collaboration with regulatory authorities for site certification and developing protocols for managing of fuel in remote locations without personnel present. | • The current CMS restricts establishment of new fuel depots on Auckland Island.<br>• Approximately 150,000 litres Jet A1 needs to be stored on island for each eradication operation. | Project Manager | Planning |
| | Ensure milestones for key developments are integrated into the project plan to inform stage gate decisions for governance. Design contingencies during operational planning where possible in case key developments are not available. Model potential disruption scenarios and record stopping points. | • Ensure the overall effect of delays is understood, can be anticipated, avoided or minimised and governed. | Project Manager | Planning |
| | Include a dedicated safety officer role on island. | • Assist with planning of day to day operations, reporting and debriefing to capture lessons for safety management.<br>• The impact of a serious incident at any stage could have fatal consequences and/or risk the viability of the project.<br>• Simplifies Operations Lead role | Project Manager | Initiation |

| **Research and development** | | | | |
|---|---|---|---|---|
| | Initiate native species monitoring; undertake opportunities as they arise based on priorities in the monitoring plan | • Provide robust baseline data that will allow changes from the eradication activities to be measured and understood. | Project Manager | Immediate |
| | The design and function of a prototype flat-pack modular field hut should be tested and finalised. | • Proven build method will inform design of larger base facilities.<br>• Allows tendering for construction of several huts as soon as the project is launched, resulting in field huts ready to support initial infrastructure programme. | Maukahuka | 30/06/2021 |
| | Pursue hardware developments for trail cameras that reduce maintenance requirements and/or enable remote data transmission. | • For example, a rechargeable battery pack would avoid the use and cost of vast quantities of AA lithium batteries over a two to three year period; Automated alerts would save the need to physically visit every device to download data, simplifying field logistics and reducing time to respond to a detected animal.<br>• Benefits to other DOC programmes | Project Manager | Planning |
| | Contract helicopter supplier for pig programme early and perhaps separately from other helicopter services so development of thermal camera capability is ready in time. | • Investment in camera technology testing aids hunting team development; time is available to train aerial hunting teams working together for a minimum of 60 hrs<br>• The supplier is an engaged team member. | Project Manager | Planning |
| | Write a research and development plan that outlines user case requirements for eradication tools and phasing to achieve development objectives in time for project implementation. | • Development objectives could be integrated into other DOC activities such as Tools to Market<br>• Investment in improved eradication can start before project initiation and will take time<br>• The work would benefit other conservation objectives | Project Manager | 31/12/2020 |

| Project Design | | | | |
|---|---|---|---|---|
| | Review the Feasibility Phase of the project. | • To capture key lessons and inform future project design | SRO | 30/10/2020 |
| | Ensure governance is empowered, properly structured, resourced and connected to lessons from other projects. | • Optimises design and delivery and reduces risk<br>• Decisions are evidence based<br>• Benefits from investment in other projects are shared | SLT | Planning |
| | Funding mechanisms and structure must provide certainty of funding for the project lifespan, timely approval of budgets and support flexible use of funds between years. | • Avoid delays to key activities such as recruitment.<br>• Optimally support the agile operations work considering uncertainty from weather constraints, permissions. | SRO | Planning |
| | Delegate financial authority, supported by Governance, to a level that provides efficient approval processes and good connection with the project team. | • The project will have many contracts and associated process approvals.<br>• Current approval processes would be too slow to allow desired project timeframe | SLT | Planning |
| | Establish a reporting line with direct access to decision-makers; and empower the team with appropriate mandate, delegation and authority to manage timeframes and risk. | • Agreed processes must allow for efficient decision making and manage scope. | DDG Biodiversity | Planning |
| | Carefully consider partnership commitments and ensure agreements and Governance reflect expectations, mutual benefits and accountabilities including safety. | • A joint venture of this scale over the long timeframe will unlock the project but has potential to complicate it. Support must be well designed, sustained and improve likelihood of success. | SRO | Planning |
| | Explore option to purchase/lease two helicopters to remain on island. | • Potential to save several million dollars in standby fees | Project Manager | Planning |
| | The required level of internal support services should be planned and assigned, dedicating the same service staff to enable continuity of support and advice (e.g. legal, finance, procurement) and ensuring they have the capacity required. | • The project is currently costed as a standalone undertaking, internal support has the potential to significantly reduce budget burden (e.g. Works Officers to manage contracts). | SLT | Planning |

| | | | | |
|---|---|---|---|---|
| | | • Quality and efficient support will be required to ensure good project knowledge. | | |
| | Resource the project team well. Plan for succession and contingency throughout all team levels (field team, team leaders, programme leaders, project and contract management, training and supplier capacity). Ensure comprehensive training plans are in place before staff selection, with adequate lead-in time planned to train staff.<br><br>Use relationship vision document with Ngāi Tahu to contribute to project design for capability development. | • Optimise chances of success<br>• Allow for upskilling and training, succession planning and redundancy in key roles so alternate staff to be able to step up to fill critical roles when required.<br>• Advocacy and engagement skills reflective of the project size and complexity are required to manage risk. | SRO | Planning |
| | Investigate simple, flexible and bespoke procurement options and understand how government procurement rules will be affected if the project is managed/governed externally. | • Risks must be shared to attract suppliers.<br>• Avoid lengthy processes | | Planning |
| **Stakeholders / Relationships** | | | | |
| | Develop long-term relationships with regulatory bodies and other parts of DOC. | • To anticipate and proactively manage the impact of changing protocols, permissions and legislation which have potential to increase complexity and cost which could impact feasibility<br>• Potential exemptions or grandfather clauses may mitigate some of the effects for changes introduced during the project | Project Manager | Ongoing |
| | Engage with Murihiku Subantarctics team to ensure coordination and alignment of strategy and programmes. | • Identify opportunities for baseline monitoring in conjunction with other programmes<br>• Maximise benefit of Operation Endurance taskings<br>• Directives are required regarding retention of any infrastructure for future DOC use post project; and management of the weed Olearia. | Project Manager | Immediate |

| | | | | |
|---|---|---|---|---|
| | Maintain communication with medical research company(s) interested in obtaining Auckland Island pigs and address future needs to avoid risking delays. Engage with key contacts during planning phase. Removal of further pigs should be completed as early as possible. | • Living Cell technologies has previously sourced Auckland Island pigs to use for medical research and manages a self-sustaining quarantined herd for this purpose in New Zealand (due to their disease-free status).<br>• A second New Zealand medical research company, NZeno, has indicated a desire to acquire Auckland Island pigs in the future, this should be timed well in advance of the eradication attempt. | Project Manager | Planning |
| | Consult with other programmes and explore opportunities to co-develop capacity. | • Large teams of field workers are required with specific skills. Other programmes in DOC could provide training opportunities or foster capability development and make good use of skills at the end of each eradication. | Project Manager | Planning |
| | Engage openly with suppliers, treating them as team members and seek industry advice early during planning. Design solutions collaboratively. | • Build trust; understand capacity, options and find solutions<br>• Options inform project design<br>• Improve ability to secure shipping, helicopters, pilots, and engineers<br>• Develop shared safety culture | Project Manager | Planning |
| | Increase advocacy with concessionaires, permitted visitors and the fishing industry | • As the eyes and ears to help protect the integrity of the site as the project develops<br>• Increase biosecurity awareness and surveillance | Project Manager | Initiation |

# Optimised Landscape Investment Plan

## Brent Beaven, Director Predator Free 2050

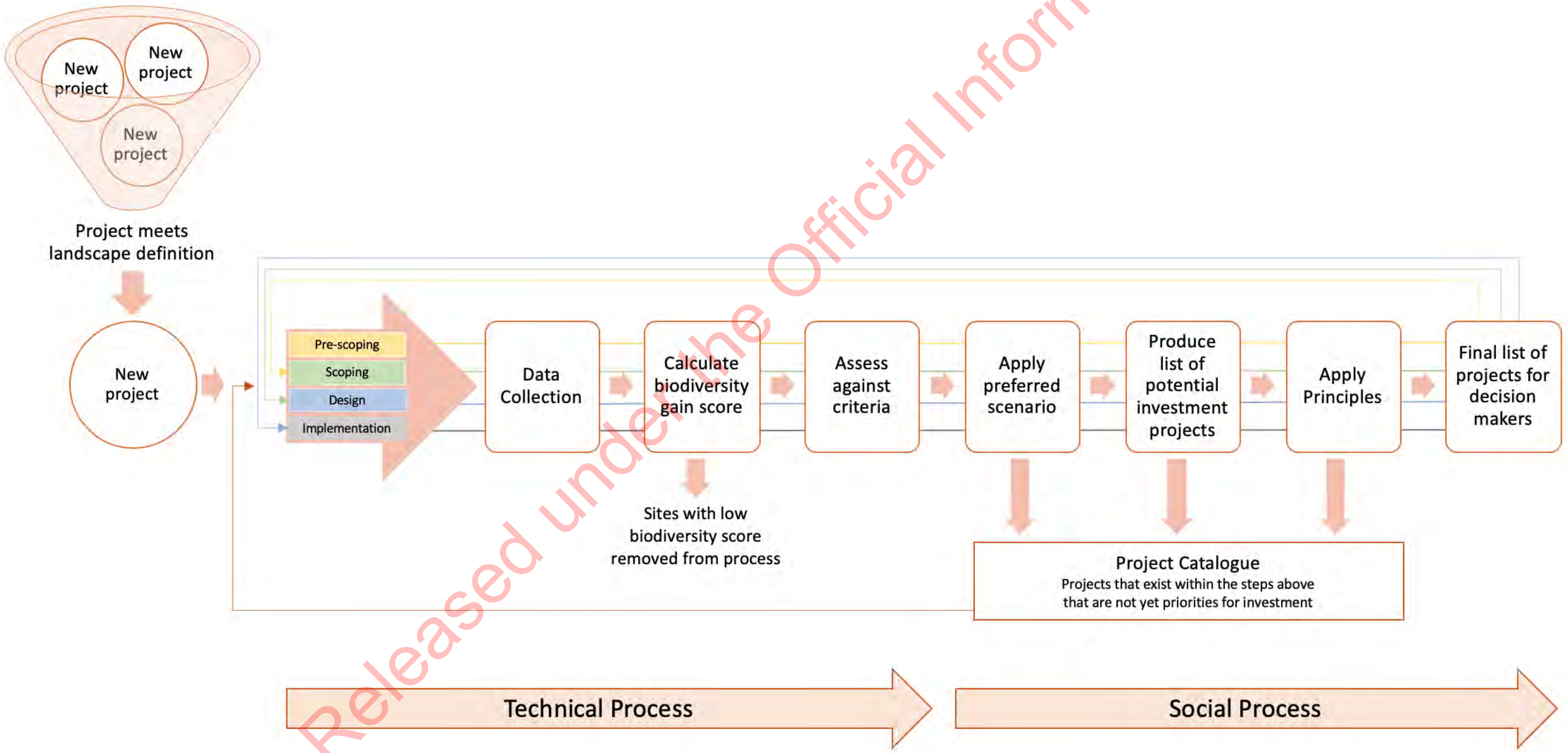
2020

Department of Conservation
*Te Papa Atawhai*

New Zealand Government

*A landscape scale project is a large place-based project where pressure(s) are managed to maximise the mana, mauri, wairua, whakapapa and ecological integrity across the entire whenua/site as part of a national network of managed landscapes.*

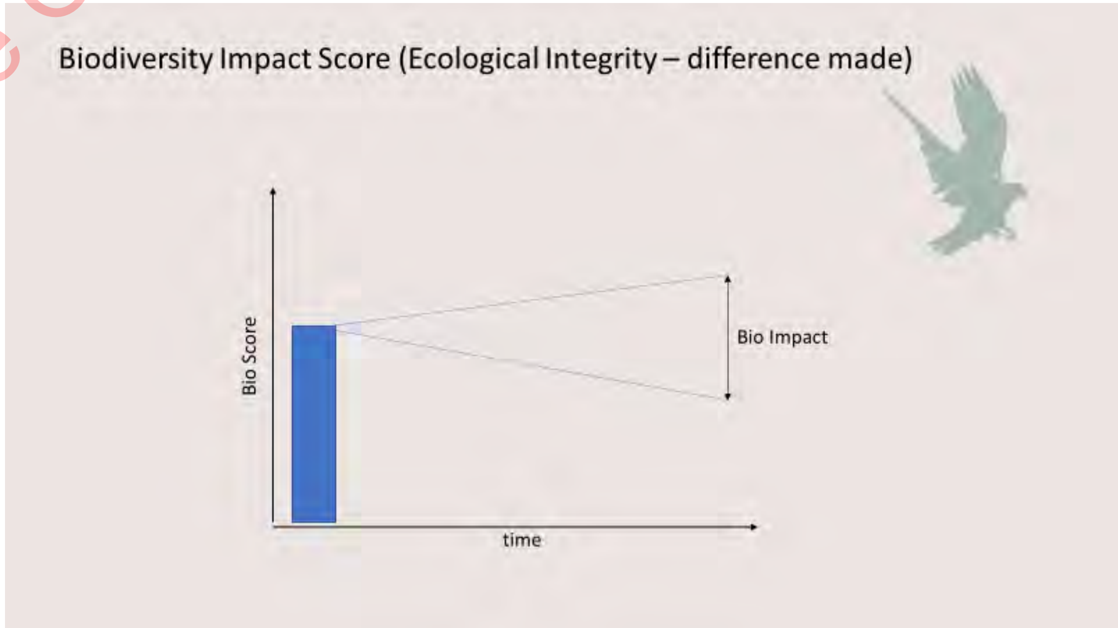
# Optimised Landscape Investment Plan Framework



# Technical Method

## Use of data

- Data gathering of project information from project leads and subject matter experts.
- Defined what a landscape scale project is and applied this definition to reduce the number of projects in consideration.
- Biodiversity scores were developed by technical experts (see report docCM-6255385). These were ecological integrity and catchment ranking scores. Alignment of catchment rank and ecological integrity into a single score was attempted.



# Social Method

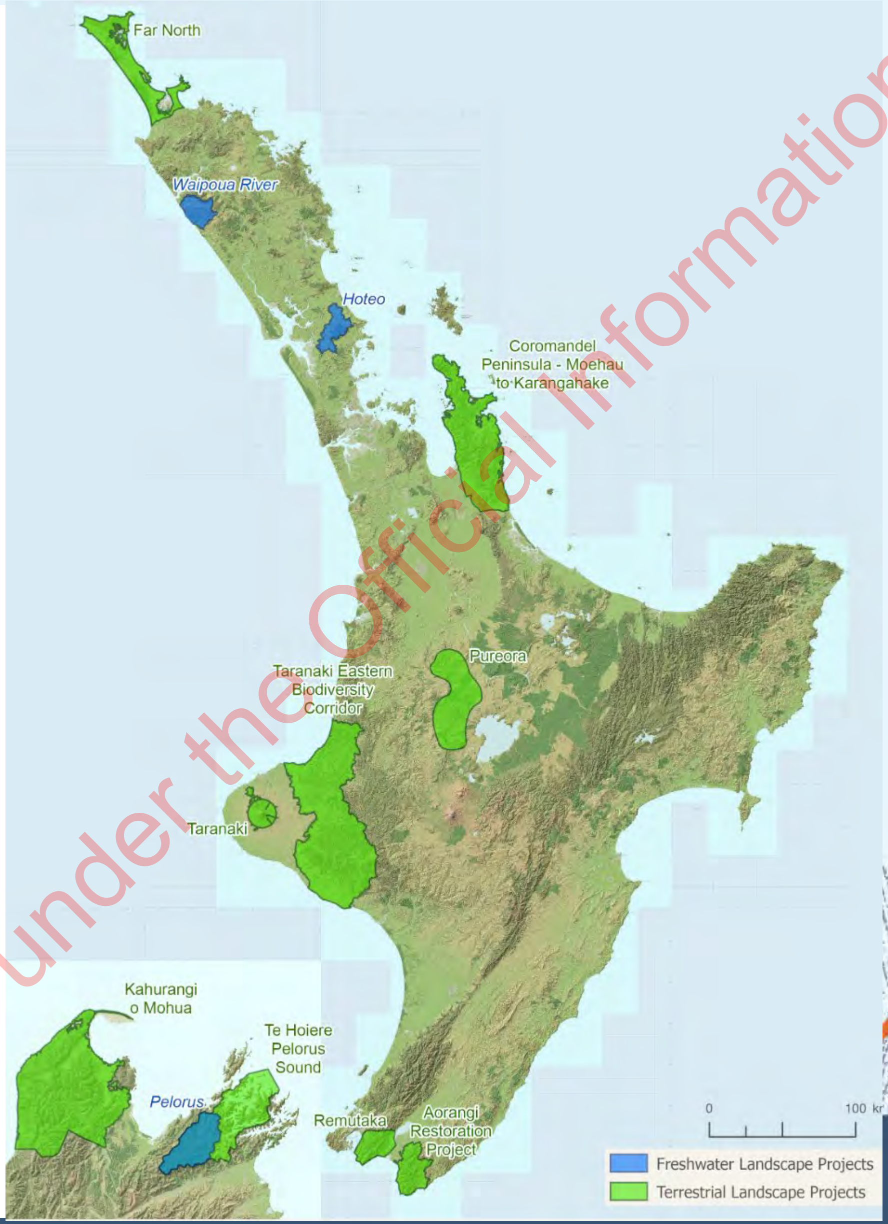
## Use of Judgement

- In an online workshop setting, gained PAG advice on accuracy of scoring and how to apply the criteria using different scenarios to optimise a landscape package of work.
- Informed decision making through data visualisation
- Built lists of projects using these scenarios and presented lists to PAG to gain feedback on scenarios that best apply criteria.
- Optimisation as opposed to Prioritisation
- Discussion by PAG on how to best optimise lists of projects to fit resource constraints, forming a list of principles that could be applied to aid decision making.

# Landscape Work Delivery System – Project Phasing

| Pre-Scope | Scope | Design | Implement | Sustain |
|---|---|---|---|---|
| To identify opportunities that will deliver Step Change Growth | To develop and recommend options to achieve the opportunity | To define the solution ready for implementation | To deliver the approved design so that it can be transitioned | To embed into existing systems so that the outcomes are sustained |
| ❑ Undefined process<br>❑ Requires an understating and creation of desired future state<br>❑ Pre scope may come from outside the group | ❑ As simple as possible<br>❑ Short timeframe<br>❑ Right team<br>❑ Include end user/benefits owner<br>❑ May not proceed to design | ❑ Critical phase<br>❑ Prepare plans for implementation (Operational plan, Resource Plan, Project Governance, Monitoring, Transition plan)<br>❑ Include end user in design | ❑ Partnerships is still SPA<br>❑ Testing project design at scale<br>❑ End user delivers the work<br>❑ All parties agree when standards for handover are met | ❑ SPA moves to end user<br>❑ Work embedded into core systems<br>❑ Reset of task assignments<br>❑ Scheduling of post implementation review |

# North Island

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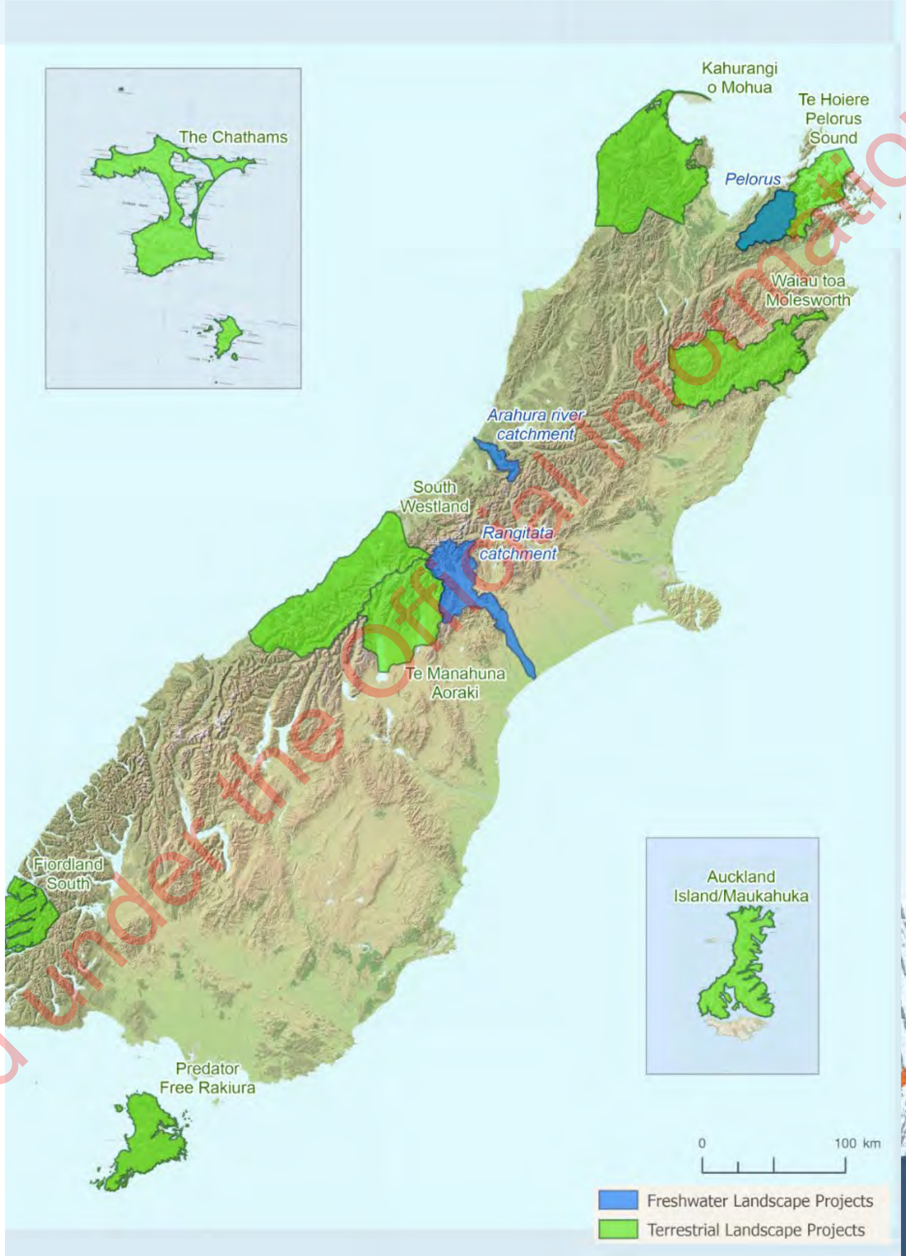
# South Island

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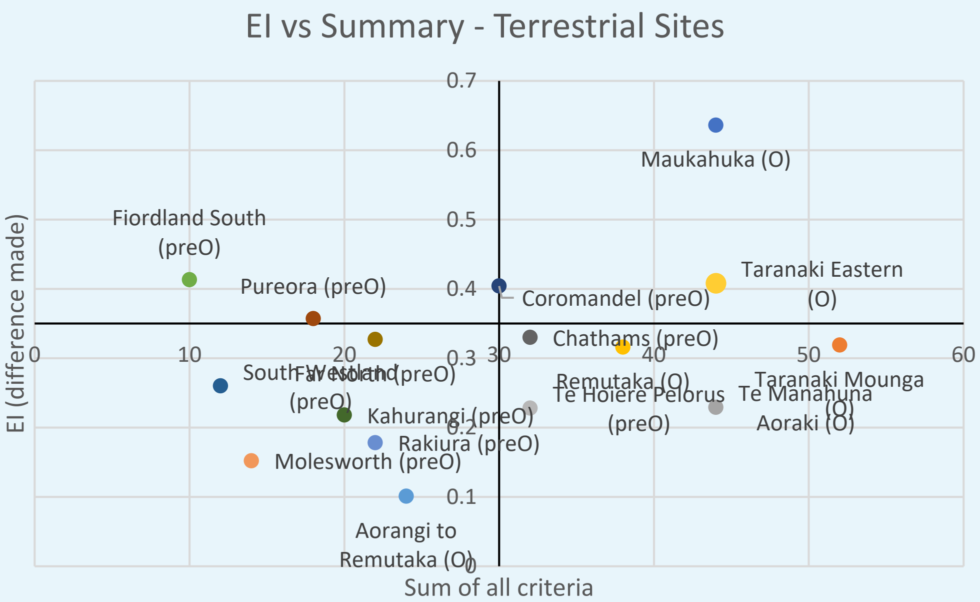
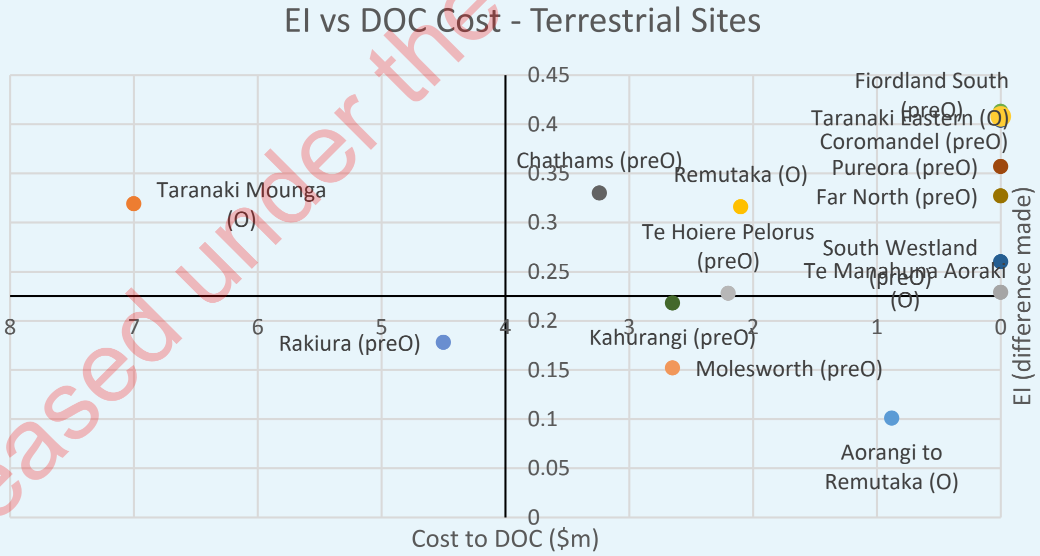
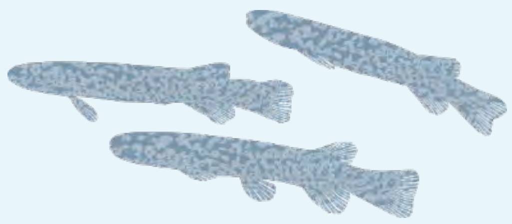
# Criteria

- Ecological Benefit – biodiversity gain and restoration of mana, mauri, wairua and whakapapa scores
- Treaty Partner Benefit
- Community Benefit
- *Employment Benefit*
- Technical Feasbility
- Social Feasibility
- Defendability of gains
- Treaty Partner Readiness
- Social Readiness
- Project Readiness
- Investment

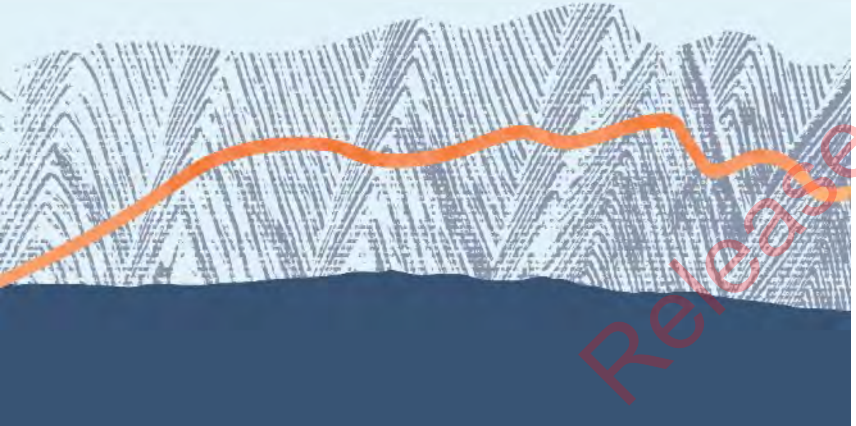

EI vs Summary - Terrestrial Sites
EI (difference made)
Sum of all criteria
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
10
20
30
40
50
60
Maukahuka (O)
Fiordland South (preO)
Pureora (preO)
Coromandel (preO)
Taranaki Eastern (O)
Chathams (preO)
Far North (preO)
South Westland (preO)
Remutaka (O)
Taranaki Mounga (O)
Te Hoiere Pelorus (preO)
Te Manahuna Aoraki (O)
Kahurangi (preO)
Rakiura (preO)
Molesworth (preO)
Aorangi to Remutaka (O)


EI vs DOC Cost - Terrestrial Sites
EI (difference made)
Cost to DOC ($m)
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
8
7
6
5
4
3
2
1
0
Fiordland South (preO)
Taranaki Eastern (O)
Coromandel (preO)
Pureora (preO)
Far North (preO)
Chathams (preO)
Remutaka (O)
Taranaki Mounga (O)
Te Hoiere Pelorus (preO)
South Westland (preO)
Te Manahuna Aoraki (O)
Kahurangi (preO)
Rakiura (preO)
Molesworth (preO)
Aorangi to Remutaka (O)



# Guiding Principles of an Optimised List

## What the final investment list should include



- Difference made to biodiversity (biodiversity gain scores) must be high.
- Geographic spread of projects.
- Both freshwater and terrestrial focused projects
- A combination of projects that deliver the highest biodiversity benefit is included i.e.; resourcing spread across multiple projects rather than a single project.
- Treaty Partner benefit maximised (even if it is also a selection criteria)
- A mix of phases is included i.e. a guide of 30:30:40 split of scope:design:implement shifting to 20:20:60 over time.
- Purchase of a project is for its next phase only, not the entire project.

# The difference between eradication and supression

Eradication

Eradication is not control 'intensified'; it **must remove the last individual** which means taking individual behaviour into account from the very beginning.

Suppression

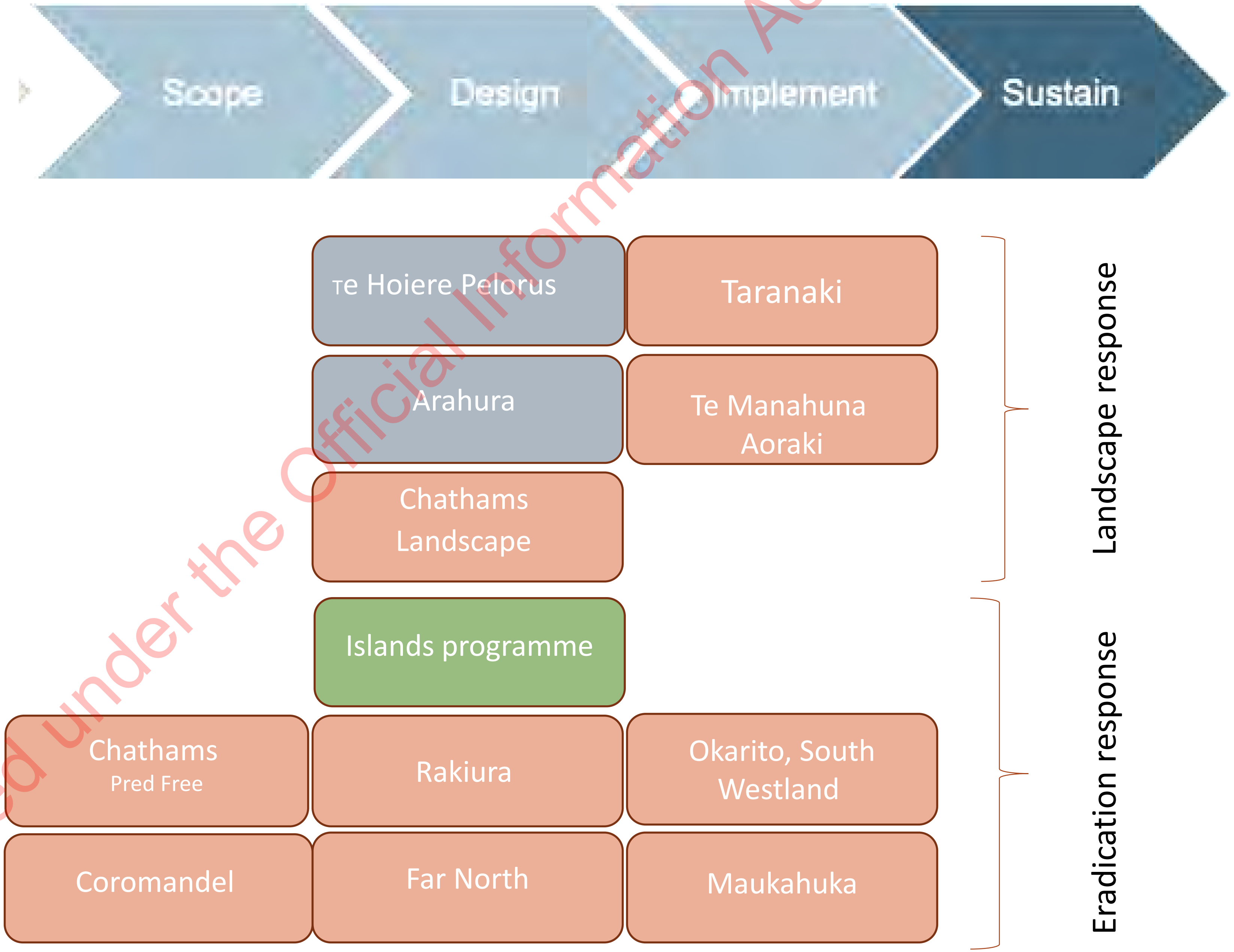
Sustains a harvest of pests to **reduce numbers and therefore impacts** - the level of harvest balances acceptable impacts of remaining pests and efficiency in the costs of harvest

Credit; P McClelland

**<u>Eradication of invasive species populations differs greatly from control of those same species and requires a shift in thinking about the approach</u>**. Robust and meticulous planning is required – with the level of resourcing "whatever it takes" (IEAG).

# Agreed Landscape Scale Projects

Assuming 50 Million over 5 years



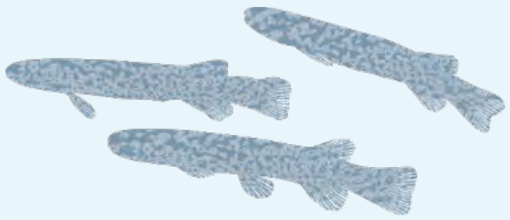
## Securing Funding and Reviewing Governance are required next steps

- When these projects hit Implementation, they range from $40-$65m each over 5 years.
- Scenarios presented here require $50m of DOC investment over 5 years
- DDG-Bio and Brent Beaven have been tasked with identifying the options to secure $10m per annum to support this work.
- Report back to SLT in December for decision on preferred pathway.
- Mervyn English's review showed that Maukahuka governance and operating model wasn't effective
- We are supporting a task identifying the ideal governance and operating model for Landscape Scale programmes, due March 2021.
- Have formed NET

# But we aren’t waiting….

- We are looking to progress this year – Rakiura, Far North, Islands programme, Chathams, Okarito and the completion of Maukahuka Design.
- We have committed $2.5m to start some work, including the Design stage of Rakiura / Stewart Island, Far North and a dedicated islands eradication programme.
- We are exploring how to progress Chatham Island through Jobs for Nature and the Alliance.
- Supporting expansion of the ZIP work in South Westland - tests the PF2050 goal of 20,000 ha eradicated and defended.

# Discussion



# Developing an optimised package of landscape scale projects

## Technical Report

June 2020

Jane McKessar, Jo Ledington, Richard Maloney



Department of Conservation
Te Papa Atawhai

New Zealand Government

# Summary

The intent of this work is twofold: to develop recommendations for the DDG Biodiversity on an optimised package of landscape scale sites for investment and to test a process for future investment. The optimised list was delivered through a mixture of technical and social process, using information collated for projects, and extra criteria developed as part of this work.

We defined landscape scale work as:

*A landscape scale project is a large place-based project where pressure(s) are managed to maximise the mana, mauri, wairua, whakapapa and ecological integrity across the entire whenua/site as part of a national network of managed landscapes.*

The methods used to build an optimised list are as follows:

a. Information from 72 projects was collated and sub-setted to 39 after removal of those that didn't fit the above definition or were without adequate data.
b. We developed a measure of Ecological Integrity (EI) appropriate to landscape scale sites by extrapolating EI (difference made) scores from nearby equivalent ecosystems for terrestrial-based ecosystems.
c. We developed a score for ranking EI values for freshwater ecosystems.
d. We developed a method for combining terrestrial and freshwater EI ranks together to give a combined ecological value (biodiversity gain) score for each site.
e. We worked with Kahui Kaupapa Atawhai / Director of Cultural Awareness and Capability to draft a definition of a cultural measure of ecological benefit and a method of measuring this.
f. We developed ten additional criteria based on feasibility, project readiness, project benefits and investment.
g. We used a Project Advisory Group (PAG) made up of Science Advisors and Directors from across the Department to determine the current importance of each criteria in the overall score.
h. We then provided scenarios for resource allocation by: ranking projects based on their criteria scores, then summing the total combined cumulative budgets against a series of principles developed by the PAG to match allocations of approximately $20, 30 and 50 million. This final process prioritised projects for investment.

We make a series of recommendations for future improvements and to complete work not able to be undertaken in this first iteration.

# Context

The Biodiversity Group was tasked by the Director-General to improve biodiversity outcomes from landscape scale work. The aim was to develop a strategic optimised investment plan for landscape scale work with the emphasis on biodiversity, to guide where the Department should invest.

The initial intention was that the plan would guide the Department's investment in landscape scale projects including via the International Visitor Levy (IVL), considering projects that were already visible and ready to be invested in over the next five years.

Covid-19, and the collapse of our international tourism market meant that IVL was not available for this purpose. The strategic plan is still needed to guide investment using resources from any future sources, including DOC baseline funding.

The new Covid-19 environment provided some additional incentives to use this strategic approach to guide landscape-scale investment in nature-based employment opportunities. To make these types of projects transparent, we have included a criterion on expected FTEs created from each project so that employment opportunities can be part of the decision framework.

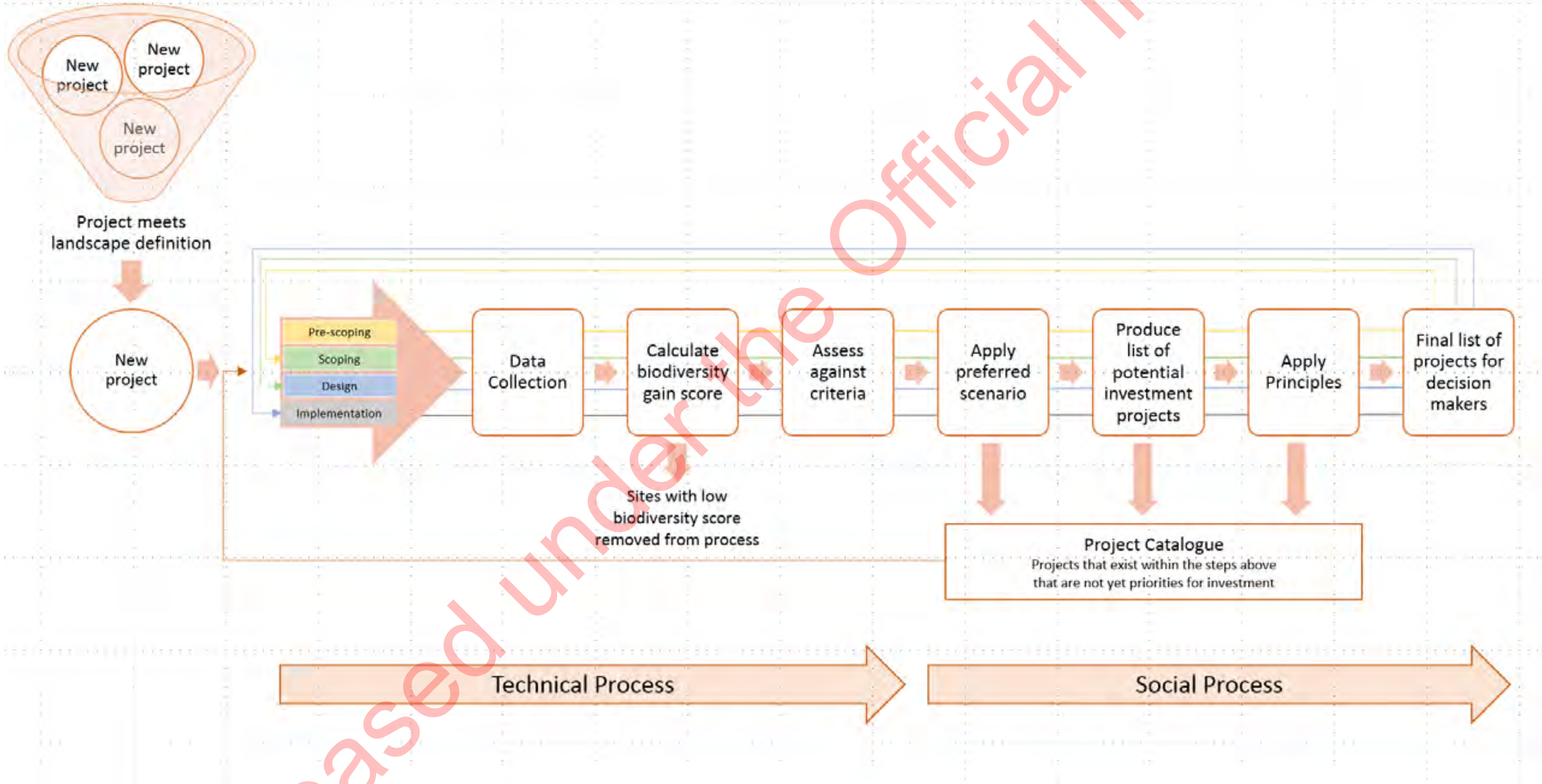
# Purpose

To provide a replicable strategic approach to achieving a biodiversity centric package of projects for landscape scale investment and to deliver an initial list of high value landscape-scale projects to decision makers.

# Suggested Landscape Investment Framework

We developed a strategic framework described in the flowchart below. Further details are described in the method section. The process steps started by looking at how new and existing projects could be considered for investment. Projects that meet the landscape definition enter the framework and so long as they have a suitable biodiversity gain score, stay in the framework until funded. This framework assists decision makers in determining which of these landscape projects get funded first. As projects move through the work delivery system phases outlined in the methods in step 1 below, they must be reassessed within the framework to ensure full and current understanding of project risks, costs, opportunities and relative priorities.

Figure 1: Optimised Landscape Investment Plan Framework



In summary, projects were assessed against the landscape-scale definition, then scored on the basis of a range of criteria. A social process was then run, to determine which of the criteria were more important drivers in the ranking of projects at this time.

We tested this process and used it to produce the initial recommended lists of projects under three difference budget scenarios. This process is repeatable and enables standard criteria to be applied differently as context changes. For example, "benefit" criteria such as employment could be given more or less weighting in future processes. We consider that the process could also be applied more broadly, to assess biodiversity projects that are working to other objectives for example management of iconic species or pest-led work.

Further description of the process we followed and our definitions and assumptions are given in the detailed methods section below.

# Key Results

1. A definition for landscape scale projects was developed to filter projects. The recommended definition is:
   *"A landscape scale project is a large place-based project where pressure(s) are managed to maximise the mana, mauri, wairua, whakapapa and ecological integrity across the entire whenua/site as part of a national network of managed landscapes."*
2. Terrestrial and freshwater projects that met this definition were scored for Ecological Integrity (difference management makes) and catchment rank (table 1). Decision makers can be confident that any project in this list would provide significant biodiversity gain if invested in.
3. A standardised series of criteria were developed to measure projects against (Appendix 3). These scores were used to build a smaller list of projects based on the Project Advisory Group's (PAG) decision that an investment list is optimised by selecting for projects that have very high or high biodiversity gain, high or very high Treaty Partner benefit, high or very high Treaty Partner readiness and medium, high or very high technical feasibility (table 2 below; Appendix 4)
4. A series of principles were developed by the PAG to further reduce the list to fit resource availability.
5. A final list of projects recommended for investment was compiled (table 3 below).

Table 1: Terrestrial focused landscape scale projects with ecological integrity (difference made) and catchment rank scores suitable for investment. Table is ranked in order of high biodiversity gain to lower biodiversity gain.

| ProjectName | EI (Diff Made) | Catchment rank # | *Hectares* |
|---|---|---|---|
| **Auckland Island/Maukahuka** | **0.636** | * | 46,022 |
| **Fiordland South** | **0.413** | 0.07 | 152,440 |
| **Taranaki Eastern Biodiversity Corridor** | **0.408** | 0.53 | 450,142 |
| **Coromandel Peninsula - Moehau to Karangahake** | **0.404** | 0.52 | 256,388 |
| **Pureora** | **0.357** | 0.43 | 147,676 |
| **The Chathams** | **0.33** | * | 81,561 |
| **Northland Kaitaia** | **0.327** | 0.21 | 122,625 |
| **Taranaki Mounga** | **0.319** | 0.57 | 34,078 |

| | | | |
|---|---|---|---|
| **Remutaka collaborative restoration** | **0.316** | 0.39 | 44,087 |
| **South Westland** | **0.26** | 0.14 | 440,118 |
| **Te Manahuna Aoraki** | **0.229** | 0.16 | 305,795 |
| **Te Hoiere Pelorus Landscape Restoration** | **0.228** | 0.26 | 175,867 |
| **Kahurangi o Mohua** | **0.218** | 0.39 | 471,206 |
| **Predator Free Rakiura** | **0.178** | 0.08 | 173,400 |
| **Waiau toa Molesworth** | **0.152** | 0.43 | 357,212 |
| **Aorangi Restoration Project** | **0.101** | 0.55 | 30,297 |

Freshwater catchment focused landscape-scale projects with readiness and national priority score suitable for investment. Table is in order of high biodiversity gain to low biodiversity gain.

| **Landscape site (Priority river catchments)** | **Landscape site extent (ha)** | **Readiness (DOC +Iwi Partner + Other Stakeholders) Highest score = 9** | **National priority (Zonation)[B]** (low = higher priority) |
|---|---|---|---|
| Arahura | 28,654 | 8 | 0.33 |
| Rangitata | 182,372 | 7 | 0.36 |
| Hoteo (within Kaipara) | 35,782 | 5.5 | 0.38 |
| Waipoua | 34,064 | 8.5 | 0.39 |

Table 2: Recommended Sites for Investment

Scenario One – Selects for projects that have very high or high biodiversity gain, medium, high or very high feasibility.
Scenario Two – Adds high or very high Treaty Partner benefit, high or very high Treaty Partner readiness.

| Site | Meets Scenario One | Meets Scenario Two | What is being bought | Cost ($) | Comments (risks, technical issues, benefits etc) |
|---|---|---|---|---|---|
| Taranaki Eastern 450,695ha (ready) | Y | Y | 5 years of implementation | 8,486,000 | High combined biodiversity score. Very high level of Treaty Partner readiness and benefit and high social licence/feasibility. Project has training, employment, education and tourism opportunities. Technical feasibility is moderate because we don't yet know how effective projects will be at implementing and maintaining predator control of possums, mustelids and rats at landscape scale. There is low defendability of the site due to few large geographical features on boundaries. There seems to be a disjunct between ETCT and local DOC office – local office may not have capacity to support. Led by Eastern Taranaki Conservation Trust with representatives from Ngati Maru, New Plymouth District Council, community and business. |
| Taranaki Mounga 34,078ha (ready) | Y | Y | 5 years of implementation | 7,000,000 | High combined biodiversity score and very high social feasibility, Treaty Partner benefit and readiness. The project has moderate technical feasibility because we don't yet know how effective projects will be at implementing and maintaining predator control of possums, mustelids and rats at landscape scale. Defendability is moderate due to a long eastern boundary with no geographical features, requiring extensive buffering beyond project boundary.<br>Regional delivery partners (e.g. Taranaki Regional Council, other conversation/ biodiversity trusts etc) are all engaged and actively collaborating to deliver the outcomes of the project. |
| Te Hoiere Pelorus 233,532ha (design) | Y | Y | 5 years of design | 2,198,600 | High combined biodiversity score and social feasibility. Treaty Partner benefit and readiness are very high. Technical feasibility is moderate because we don't yet know how effective projects will be at implementing and maintaining predator control of possums, mustelids and rats at landscape scale. Defendability is moderate as the project has mostly adequate water boundaries and long land boundaries.<br>This project is strongly supported externally after 3 years of building relationships and governance arrangements with Ngati Kuia, MfE, MPI, Marlborough District Council.<br>Funding requested here is to build a project team to identify project opportunities, priority work areas and design mitigations for landscape issues. Agreement with partners that funding required for mitigation/work projects would be co-funded/externally funded. |
| Te Manahuna Aoraki 310,000ha (ready) | Y | Y | 5 years of implementation | 9,333,333 | High combined biodiversity score. Moderate technical feasibility because we don't yet know how effective projects will be at implementing and maintaining predator control of possums, mustelids and rats at landscape scale. High defendability due to mostly high mountain and lake boundaries. The southern boundary while proportionally short has canal that needs defending. High social feasibility, treaty partner benefit and very high treaty partner readiness. NEXT are key partners, with DOC contributing 1/3 of the costs. |

| | | | | | |
|---|---|---|---|---|---|
| Waipoua 34,064ha (ready) | Y | Y | 5 years of implementation | 21,000,000 | High combined biodiversity score. Moderate technical feasibility because we don't yet know how effective projects will be at implementing and maintaining predator control of possums, mustelids and rats at landscape scale. Low defendability as few barriers on land margins, high edge to area ratio. High social feasibility and treaty partner readiness and very high treaty partner benefits as the project is led by Te Roa with DOC support and aims to support mana whenua aspirations within the broader Waipoua landscape to develop and implement a restoration/health/management plan by tackling a number of pressures. Project has tourism and employment opportunities. |
| Coromandel 256,388ha (design) | Y | Y | Design phase | TBD | This Biocultural Restoration Project has a very high combined biodiversity score. Moderate technical feasibility because we don't yet know how effective projects will be at implementing and maintaining predator control of possums, mustelids and rats at landscape scale. Site has high defendability due to the long coastline and short boundary at base end of peninsula. Because the project is led by Pare Hauraki iwi with support from councils, other government agencies and DOC it has very high treaty partner benefit, readiness and social feasibility (therefore the project and outcomes are very strongly supported, despite methods not yet being confirmed). |
| Chathams (includes Predator Free Chathams and Chathams Securing, Sharing and Growing Species and Ecosystems) 81,574ha (design/ ready) | Y | Y | 4 years of design for Pred. Free Chathams and 5 years of implementation for Chathams Securing, Sharing and Growing Species and Ecosystems) | 3,855,000<br>14,604,810 | Very high combined biodiversity score. High technical feasibility because we have evidence of effective implementation and maintenance of predator control programmes on islands. As it is an island site it has very high defendability. Social feasibility is very high and Treaty Partner Benefit and readiness are high because Pred Free Chathams is community led and chaired by Ngai Mutunga with Moriori support and employment and tourism opportunities are expected for the community. While the Chathams Securing, Sharing and Growing Species and Ecosystems project is DOC led it has a strong relationship with iwi/imi who are keen to progress now that settlement has occurred/soon to occur. |
| Arahura 28,654ha (design) | Y | Y | 1 year of final design<br>4 years of implementation | 330,000<br>3,350,000 | High combined biodiversity score. Moderate technical feasibility score because we don't yet know how effective projects will be at implementing and maintaining predator control of possums, mustelids and rats at landscape scale. Medium defendability as project is in upper catchment with some mountain barriers. Treaty Partner benefit and readiness is high as this project builds on the current catchment project with mana whenua who hold ownership of the river and they lead the project in partnership with DOC. Social feasibility is moderate and likely to be highly supported by end of design period – just need to work through details with Partner. |
| Far North 122,734ha | Y | Y | 1 year of pre-scoping | 300,000 | Very high combined biodiversity score. Moderate technical feasibility because we don't yet know how effective projects will be at implementing and maintaining predator control of possums, mustelids and rats at landscape |

| | | | | | |
|---|---|---|---|---|---|
| (pre-scope) | | | 1 year of scoping | 500,000 | scale. High defendability as site has a long coast with a short boundary at base end of peninsula. Treaty Partner benefit and readiness is high as iwi have recently asked DOC to restart conversations on this project and large iwi employment opportunities are expected. Social feasibility is moderate as technical methods for effectiveness have not yet been scoped. Costs are estimates based on similar project costs. |
| Kahurangi 471,206ha (scoping) | Y | N | 1 year scoping<br>3 years design (cost estimated)<br>1 year implementation (cost estimated) | 2,650,000 | High combined biodiversity score. Moderate technical feasibility score because we don't yet know how effective projects will be at implementing and maintaining predator control of possums, mustelids and rats at landscape scale. Medium defendability as some coastline and river margins, but significant lengths of boundary with few barriers and difficult access. Treaty Partner readiness is very high and social feasibility is high as partners are actively engaged and expected methods of management are already common in the area. Treaty Partner benefit is moderate. |
| Maukahuka 46,022ha (ready) | Y | N | 5 years implementation | 21,054,399 | High combined biodiversity score. High technical feasibility because we have evidence of effective implementation and maintenance of predator control programmes on islands. Very high defendability as it is a remote island location. Social feasibility and Treaty Partner readiness are very high as design is complete and has had strong engagement. Treaty Partner benefit is moderate as location is remote. |
| Rangitata 182,372ha (ready) | Y | N | 5 years implementation | 19,000,000 | Very high combined biodiversity score. Moderate technical feasibility as we don't yet know how effective projects will be at implementing and maintaining predator control of possums, mustelids and rats at landscape scale. Moderate defendability as upper catchment has some mountain barriers with long linear borders in lower river with mixed farming types. Social feasibility and Treaty Partner readiness are moderate as engagement is still in early stages and Treaty Partner benefit is high as has mana whenua support as a partner, project recognises their cultural narrative, & provides for strengthening & growing their ongoing involvement. |
| South Westland 440,118ha (pre-scope) | Y | N | 1 year pre-scope | 500,000 | High combined biodiversity score. Moderate technical feasibility as we don't yet know how effective projects will be at implementing and maintaining predator control of possums, mustelids and rats at landscape scale. High defendability as good mountain and coastal barriers, some areas with lower barriers and difficult access. Social feasibility is high as Ospri is already actively engaging with DOC and ZIP on how to deliver. Treaty Partner readiness is very high as Makaawhio are actively engaged. Treaty Partner benefit is moderate as project not yet scoped but expected to provide training and employment benefit to iwi. |
| Remutaka 44,087ha (design) | Y | N | 1 year of final project design<br>4 years of implementation | 120,000<br>1,990,000 | High combined biodiversity score. Moderate technical feasibility as we don't yet know how effective projects will be at implementing and maintaining predator control of possums, mustelids and rats at landscape scale. Low defendability as few large geographical features on boundaries. Social feasibility and Treaty Partner readiness very high as most of the design work is complete with full partner engagement. Treaty Partner benefit moderate as DOC led, no significant employment or economic benefit expected. |
| Pureora 147,676ha (design) | Y | N | Design phase | TBD | High combined biodiversity score. Moderate technical feasibility as we don't yet know how effective projects will be at implementing and maintaining predator control of possums, mustelids and rats at landscape scale. Low defendability as few barriers, high edge to area ratio. Social feasibility is high as strong council and partner support. Treaty Partner benefit is moderate as project DOC led with iwi partner and no significant employment or economic benefit expected. Treaty Partner readiness is very high. |
| **Total** | | | | **$116,272,142 + Coromandel + Pureora costs TBD** | |

Table 3: List of projects recommended for investment at different resource levels

The principles have been applied at different resource levels to derive optimised lists (see below). Waipoua is another valid addition to these lists but was removed from contention, due to cost, to enable a wider number of projects to proceed with greater geographic spread. It should be considered for investment next should further funding be available. Selection of Taranaki Eastern over Taranaki Mounga enables more work to proceed in that region and therefore achieves better outcomes for biodiversity overall (the investment in Taranaki Mounga accelerates existing work).

| **Landscape project name** | **What is being bought** | **Cost ($)** | **$50m budget over 5 years** | **$30m budget over 5 years** | **$20m budget over 5 years** |
|---|---|---|---|---|---|
| Taranaki Eastern (ready) 450,695ha | 5 years of implementation | 7,000,000 | Yes | Yes | No |
| Te Hoiere Pelorus (scoping) 233,532ha | 5 years of design | 2,198,600 | Yes | Yes | Yes |
| Te Manahuna Aoraki (ready) 310,000ha | 5 years of implementation | 9,333,333 | Yes | Yes | Yes |
| Coromandel (design) 256,388ha | Design phase | TBD | Yes | Yes | Yes |
| Chathams (includes Predator Free Chathams and Landscape Scale restoration (design/ready) 81,574ha | 4 years of design for Pred. Free Chathams<br>and<br>5 years of implementation for Chathams Securing, Sharing and Growing Species and Ecosystems) | 3,855,000<br><br>14,604,810 | Yes | No | No |
| Far North (pre-scope) 122,734ha | 1 year of pre-scoping<br>1 year of scoping | 300,000<br>500,000 | Yes | Yes | Yes |
| Arahura (design/ready) 28,654ha | 1 year of final design<br>4 years of implementation | 330,000<br>3,350,000 | Yes | Yes | Yes |
| | | **Total** | $41,471,743<br>+ Coromandel costs TBD | $23,011,933<br>+ Coromandel costs TBD | $16,011,933<br>+ Coromandel costs TBD |

We were not asked by the PAG to apply the defendability criteria to the preferred scenario. However, defendability scores are also relevant here. High defendability means there is more chance of securing the gains made and therefore lower whole of life costs, and much reduced risk of failure. The list where a defendability test (H/VH defendability) is also applied to the preferred scenario is as follows:

Table 4: Sites that meet scenario 2 and are highly defendable

| Site | What is being bought | Cost ($) |
|---|---|---|
| Te Manahuna Aoraki 310,000ha (ready) | 5 years of implementation | 9,333,333 |
| Coromandel 256,388ha (design) | Design phase | TBD |
| Chathams (includes Predator Free Chathams and Chathams Securing, Sharing and Growing Species and Ecosystems) 81,574ha (design/ready) | 4 years of design for Pred. Free Chathams and<br>5 years of implementation for Chathams Securing, Sharing and Growing Species and Ecosystems) | 3,855,000<br>14,604,810 |
| Far North 122,734ha (pre-scope) | 1 year of pre-scoping<br>1 year of scoping | 300,000<br>500,000 |
| **Total** | | **$28,593,143 (+ Coromandel TBD)** |

# Detailed Methods

This section describes the strategic approach outlined in the investment plan framework above including the technical and social methods, our data collation process, definitions, development of criteria and scoring, and the use of scenarios to provide recommended packages of projects.

## Technical Method

1. Data gathering of project information from project leads and subject matter experts.
2. Defined what a landscape scale project is and applied this definition to reduce the number of projects in consideration.
3. Biodiversity scores were developed by technical experts (see report docCM-6255385). These were ecological integrity and catchment ranking scores. Alignment of catchment rank and ecological integrity into a single score was attempted.
4. Built criteria to score projects and did preliminary scoring based on information from project leads and technical experts. Graphed these for visual representation of how projects sat against criteria.

## Social Method

5. In an online workshop setting, gained PAG advice on accuracy of scoring and how to apply the criteria using different scenarios to optimise a landscape package of work.
6. Built lists of projects using these scenarios and presented lists to PAG to gain feedback on scenarios that best apply criteria.
7. Discussion by PAG on how to best optimise lists of projects to fit resource constraints, forming a list of principles that could be applied to aid decision making.

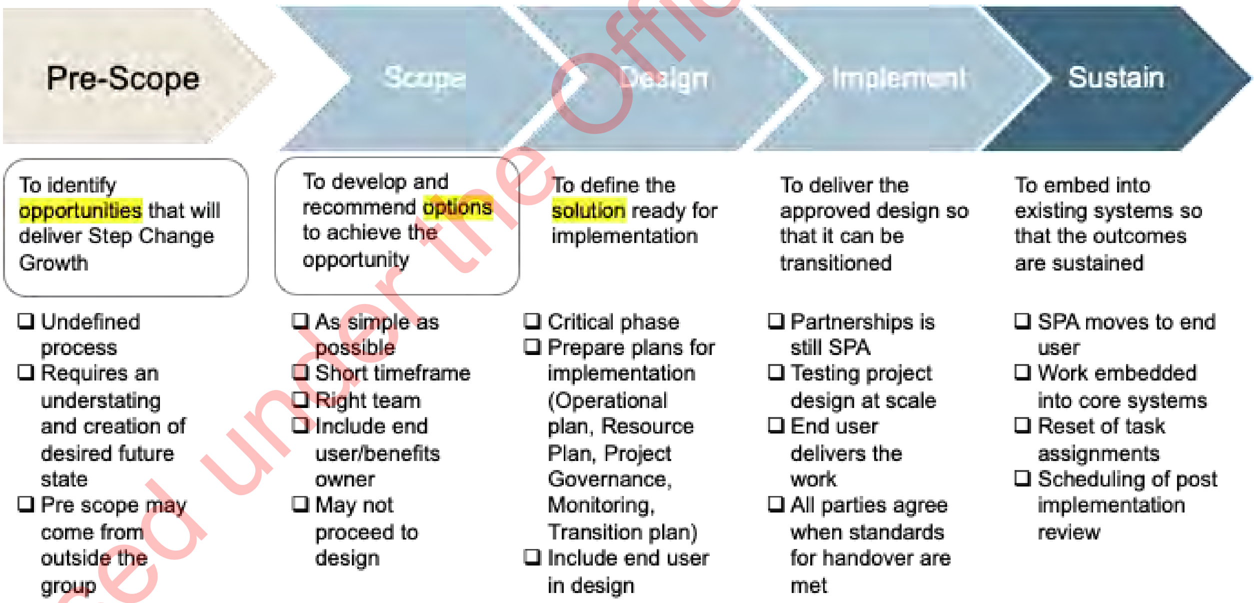
1. Data collection

To obtain a starting pool of potential projects, Directors were asked to have their teams complete a spreadsheet with any projects that they considered to be ready for landscape-scale investment. This process produced a list of 72 potential projects with five year costings and workplans. This was comprised of a mix of projects, including Ecological Resilience Sites, Operations EMU sites, community, Treaty Partner and Predator Free projects. It is this list of projects that was analysed against the definition of landscape scale work and for which the technical team calculated biodiversity scores.

Once the criteria had been determined, information was gained by talking to project leads and subject matter experts about the projects, alongside analysing project documentation.

The specificity of the data collected depended on the phase that the project was in. The data collected on projects that were in pre-scope or scope was often estimated based on intended work to allow some comparison to be made between projects. Projects that were in design or implementation phases have had 2-3 years of scoping and design work completed and have a very thorough understanding of their methods, costs and risks. Because we gathered information from project leads there may be discrepancies between how this information was collected and recorded between projects.

In this process we used the following definitions for project phases as used in the Partnerships work delivery system, excluding the sustain phase (docCM-5942737).




Projects are constantly evolving and we saw this to an even greater degree during the Covid-19 response. For example, one project where DOC has spent years building relationships with externals, suddenly had collaborators keen to progress in light of the proposed Government economic response package. The data used in this exercise was a snapshot in time from April 2020 and remeasures of all project data needs to be undertaken periodically and as projects move through the different phases, to keep data current and provide high quality advice to decision makers.

2. Defining landscape-scale work

The technical team determined a definition of landscape-scale work for use in the Optimised Landscape Investment Project. For full details of options assessed and background thinking refer to docCM-6255385 'Ranking landscape scale sites based on their biodiversity benefits'.

*A landscape scale project is a large place-based project where pressure(s) are managed to maximise the mana, mauri, wairua, whakapapa and ecological integrity across the entire whenua/site as part of a national network of managed landscapes.*

The objective is to restore the mana, mauri, wairua and whakapapa, and ecological integrity of the landscape to a healthy state.

The following definitions of terms apply:

a. Landscapes are considered to contain multiple ecosystems
b. Large = several kms in diameter, larger than an ecosystem and smaller than a biome or ecoregion. 'Large', in general, means more than 30,000 ha because this is the upper limit cut off for an EMU, and because it allows for the concepts of core-corridor-buffers, is at a scale where life cycle processes are sustained, will have permeability and porosity, and has a series of interconnected and functioning ecosystems. Drivers such as climate change and for managing genetic drift are provided for.
c. A place is a defined area or site of large scale, within which management actions will occur over some or all of the place. While landscapes will not have unambiguous boundaries, for planning purposes a hard and contiguous boundary should be described for each place. These boundaries should also directly consider the terrestrial and aquatic processes that underpin their ecological integrity (e.g., encapsulate catchment boundaries).
d. Mana, mauri, wairua and whakapapa (the relationships between elements (species, taxa, ecosystems) within the landscape) are the cultural elements management of the site will restore.
e. Ecological integrity = the degree to which the full potential of indigenous biotic and abiotic features and natural processes, functioning in sustainable communities, habitats, and landscapes is met. Structure, function and composition are key components.
f. Ecosystem services provided by landscapes are assumed to be maximised when ecological integrity is maximised.
g. Landscapes are across any, and all, of the marine, freshwater and terrestrial domains.

Many of the initial sites identified did not meet this definition and were excluded from further assessment.

## 3. Biodiversity scores

A total of 72 terrestrial-focused landscape projects were collated. Of these, 34 projects were defined as too small and/or were without available GIS spatial boundaries, or without data on Ecological Integrity in or near the site, or were largely intensive farmland or urban, in which case they were excluded. The remaining 39 terrestrial-focused projects were considered for assessment and ranked based on Ecological Integrity (biodiversity value), alongside a pool of 14 highly ranked landscape-scale freshwater catchment-based projects. The technical team recommended 22 landscape-scale projects suitable for consideration for resource allocation: 16 are landscape-scale terrestrial-focused sites, 6 are landscape-scale freshwater catchments-focused sites (Appendix 1). One landscape-scale freshwater catchment-based project (Pelorus) was subsequently removed from the list and incorporated in the existing Pelorus landscape project. The Chathams project that had been excluded by the technical team was merged with the other project occurring in the same location. This left a pool of 20 projects, 16 are landscape-scale terrestrial-focused, 4 are landscape-scale freshwater catchments-focused.

The technical team calculated Ecological Integrity (EI) scores for each of the landscape-scale sites. To calculate total EI they started with existing EMU data sources and generated values for EI (difference made), EI (with management), EI (without management). They then identified the land types over the whole landscape-scale site and extrapolated the EMU EI scores to the scale of the landscape site, weighted by area. The method used assumed that a similar level of management would be applied across the wider landscape-scale site. Some land use types were excluded from the landscape-scale sites, including urban areas, high-intensity land use and exotic forest, because they are not habitats where ecological values will be improved. In addition, some river types (but not wetlands, lakes, and braided rivers which have EI scores at EMU level) were excluded from this calculation because no EI(difference made) scores were available. The limitation of excluding river and streams ecosystems was addressed by evaluating 'catchment ranks' for each site and adding this metric for consideration in the final ranking.

Sites were then ranked in order from high difference made in EI to low difference made in EI. Where sites with high EI(diff) scores will provide for the greatest biodiversity gain when management is applied across listed pressures – i.e., ecological integrity is maximised.

The technical group then considered the ranked projects and their EI scores. From a biodiversity (difference made) perspective they consider all these projects have merit. There was no obvious cut-off in EI gain below which this set of projects should be dropped from consideration. However, decisions should not include other candidate projects further down the priority lists – focusing on these will result in wasted resources that could achieve more outcomes within the priority pool. For further details of how biodiversity scores were generated refer to the technical report docCM- 6255385.

Sites have not yet been assessed through a cultural lens i.e. the degree to which the mana, mauri, wairua, whakapapa of the landscape will be restored to a healthy state by the proposed management.

One of the challenges of the biodiversity scoring system used was that terrestrial and freshwater landscape-scale projects were scored differently. Historically, these are scored using different systems with different data inputs e.g. freshwater sites include readiness and feasibility scoring within their biodiversity score. In our process, because not all sites could be given both EI and catchment rank scores an attempt was made to rationalise these values to increase comparability of sites. This was done in two ways:

1. by giving all EI scores and freshwater scores for a site a Low to Very High score. These two scores were then added together and divided by 2 to give a mean EI rank across terrestrial and freshwater values. The final biodiversity score was therefore ranked on a scale of 1 = Low to 4 = Very High for each site
2. by graphing freshwater rank against terrestrial sites EI(difference made) to illustrate projects that scored highly on both scales.

## 4. Criteria

In addition to the initial ecological filter to find projects, a further nine criteria were selected to measure the projects against. The additional criteria captured operational considerations such as feasibility and project benefits - to Treaty Partners, communities, and employment. The aim of these additional criteria was to make decisions about selection of projects more transparent, assuming that there will not be enough resources to fund all desirable landscape scale projects with high ecological integrity. The additional criteria were determined by the project and technical teams and included work to align the criteria with other related projects, then refined following feedback from the PAG.

| Criteria | Measures |
|---|---|
| **Project Benefits** | |

| | |
|---|---|
| 1. Ecological | - Biodiversity gain score derived from combined terrestrial ecological integrity and freshwater biodiversity scores (potential difference with management).<br>- Restoration of mana, mauri, wairua and whakapapa score (potential difference with management) |
| 2. Treaty Partner | a) Demonstrates added value to whānau and/or hapū<br>b) Project is Treaty Partner led or partnered<br>c) Treaty Partner is actively involved in project<br>d) Project is Treaty Partner supported |
| 3. Community | - Project focused in vulnerable regions or vulnerable sectors of society with the greatest need for growth<br>- Provides well documented value to the community<br>- Community led<br>- Provides for future additional opportunities aligned with biodiversity and community growth |
| 4. Employment | - Number of FTEs created by project |
| **Feasibility** | |
| 5. Technical feasibility | a) Does the method/technology already exist?<br>b) Will it work?<br>c) Can we demonstrate it will make the intended difference? |
| 6. Social feasibility | - Project is supported by Treaty Partner?<br>- Are the project actions socially acceptable to stakeholders e.g. landowners and community? |
| 7. Defendability | The nine principles in Table 3, DOCCM-3092020 (and below) should be followed.<br><br>Projects need to meet relevant criteria in Defendability Principles table. The % of the boundary length that is defendable against reinvasion determines its score. |
| **Readiness** | |
| 8. Treaty Partner readiness | a) Treaty Partner is ready now<br>b) Treaty Partner almost ready<br>c) Treaty Partner not ready yet<br>d) Treaty Partner disengaged |
| 9. Social readiness | - Are relationships, roles and mutual interests among contributors agreed?<br>- Are other contributors ready/have capacity? |
| 10. Project readiness | Design and Implementation project<br>- Has a feasibility assessment been done?<br>- Have Treaty settlement obligations been met?<br>- Is a phased project plan documented, costed by phase and completed?<br>- Does DOC have capacity to fulfil their role as outlined in project plan?<br>- Is external funding procured (if required)?<br><br>Scoping project measures<br>- Scope and area defined<br>- Project requirements clear<br>- Project lead identified<br>- Does DOC have capacity? |
| **Investment** | |
| 11. Investment | - Cost to DOC per year over 5 years |

| | |
|---|---|
| | - Total cost to DOC for 5 years<br>- Total cost of project (including external funding) over 5 years |

See Appendix 3 for further detail including scoring of the measures

Using the data collected from the organization in the data collection step (step 1 above), all projects were scored on each of the criteria and these scores were used to visualise where projects stood in relation to each other by graphing each criteria against the ecological integrity and freshwater scores. An example of the Treaty Partner benefit criteria is below (figure 2). This also provided an opportunity for the PAG to raise any concerns with the scoring system as many in the group have deep knowledge of the individual projects and could highlight sites that appeared to be scored inappropriately. While the scoring was useful and generated discussion, we considered it important to include narration on the scoring for full disclosure and understanding.

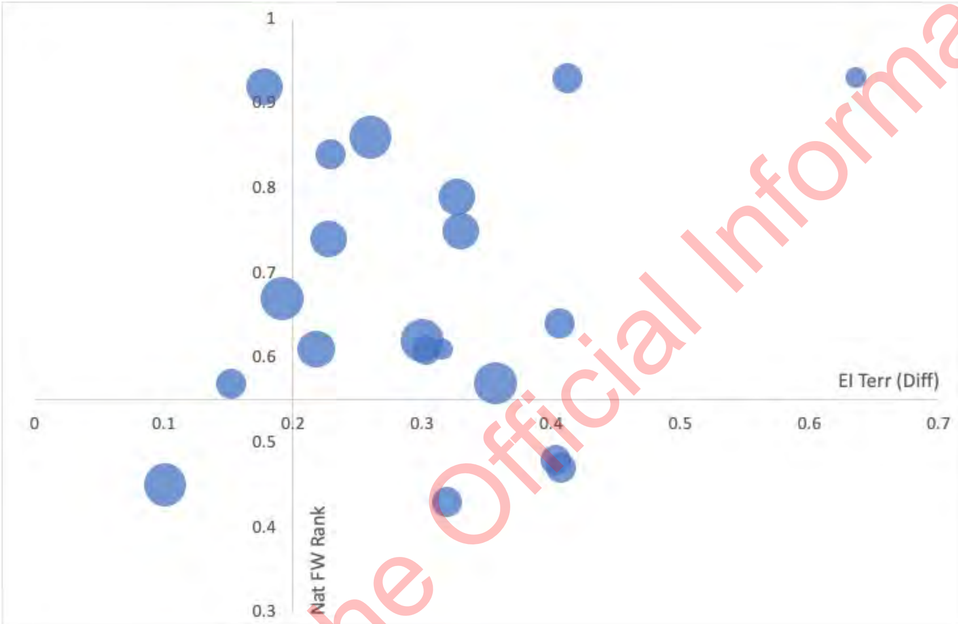



Figure 2: National freshwater rank vs terrestrial ecological integrity (difference made) scores with bubbles showing the Treaty Partner benefit of each project (larger the bubble, greater the benefit).

5. Scenarios

The major focus of the first workshop with the PAG was that not all of the 10 criteria were equally valued as part of the decision-making process. We received clear feedback from the group that the following criteria were priorities: Treaty Partner readiness, feasibility and Treaty Partner benefit. These were critical for projects to measure highly against prior to investment being considered.

The project team used this advice to develop scenarios to assess projects against. Five scenarios were developed by the project team to demonstrate how choice of sites would vary.

Scenarios:

1. Treaty Partner readiness, feasibility and Treaty Partner benefit are all high or very high
2. All criteria rank highly or very highly
3. Treaty Partner benefit is high or very high
4. Employment benefit is high or very high
5. Community benefit is high or very high

Using the five scenarios above, lists of projects that met the required criteria were built and presented to the PAG at workshop 2 (Appendix 3).

After discussion with the group, it was decided to alter the feasibility criteria to include moderately feasible projects as many mainland sites fall in that category. This resulted in the PAG's preferred scenario being:

Treaty Partner readiness is high or very high. Feasibility is medium, high or very high and Treaty Partner benefit is high or very high.

Subsequent to the 2nd workshop another scenario was developed to further emphasis high EI.  After discussion with the PAG two final scenarios have been proposed.

Scenario One – EI(difference made) high or very high, Feasibility is medium, high or very high.
Scenario Two – EI(difference made) high or very high, Treaty Partner readiness is high or very high. Feasibility is medium, high or very high and Treaty Partner benefit is high or very high.

For the full list of projects that meet the tests for one or both of these scenarios see Table 2 - Recommended Sites for Investment.

The PAG noted that while they were comfortable with selecting projects based on moderate or higher feasibility, there are nuances of technical feasibility with certain projects that may need further assessment. This will ensure the risks associated with those projects are well understood and decision makers have explicit information on these. These nuances are likely to include aspects such as:

- defendability of a site
- specific risks with each project
- if a project has scored moderately feasible is it because of unknown factors or because of a known issue that can or cannot be mitigated?
- if feasibility has changed due to gaining knowledge.

## 6. Guiding principles - developing an optimised list

Any optimisation process is bound by resource availability. While the context around funding changed during this project's process and there is currently no fixed dollar amount available to fund landscape-scale projects, this framework allows for a data driven selection of candidate projects, with biodiversity gain at its centre. The final selection of the pool of projects, given the constraints used a social process to determine the subset of scores (Low to Very High) that would be included in the selection of the final pool of projects.

The PAG gave clear guidance on principles that should be applied to achieve this. A final package of landscape investment is to include:

- Difference made to biodiversity (biodiversity gain scores)
- A geographic spread of projects
- Both freshwater and terrestrial focused projects (until true landscape projects are developed)
- A combination of projects that deliver the highest biodiversity benefit i.e., resourcing should be spread across multiple projects rather than a single project. This reduces risk and maximises overall biodiversity gain.
- Treaty Partner benefit should be maximised within the investment package (even if it is also a selection criteria)
- A mix of phases i.e. a guide of 30:30:40 split of scope: design: implement shifting to 20:20:60 over time. These splits are to be based on the proportion of projects in the agreed package, not the project costs.

- Purchase of a project is for its next phase only, not the entire project. This is to ensure that only robust projects that continue to meet the chosen criteria are implemented.

When these principles were applied to the preferred scenarios, in conjunction with the graph from step 3, the following selection of projects was decided on by the PAG at different funding levels (table 5).

Table 5: List of projects recommended for investment at different resource levels.

| **Landscape project name** | **What is being bought** | **Cost ($)** | **$50m budget over 5 years** | **$30m budget over 5 years** | **$20m budget over 5 years** |
|---|---|---|---|---|---|
| Taranaki Eastern (ready) 450,695ha | 5 years of implementation | 7,000,000 | Yes | Yes | No |
| Te Hoiere Pelorus (scoping) 233,532ha | 5 years of design | 2,198,600 | Yes | Yes | Yes |
| Te Manahuna Aoraki (ready) 310,000ha | 5 years of implementation | 9,333,333 | Yes | Yes | Yes |
| Coromandel (design) 256,388ha | Design phase | TBD | Yes | Yes | Yes |
| Chathams (includes Predator Free Chathams and Landscape Scale restoration (design/ready) 81,574ha | 4 years of design for Pred. Free Chathams AND 5 years of implementation for Chathams Securing, Sharing and Growing Species and Ecosystems) | 3,855,000<br>14,604,810 | Yes | No | No |
| Waipoua (ready) | 5 years implementation | 21,000,000 | No | No | No |
| Far North (pre-scope) 122,734ha | 1 year of pre-scoping<br>1 year of scoping | 300,000<br>500,000 | Yes | Yes | Yes |
| Arahura (design/ready) 28,654ha | 1 year of final design<br>4 years of implementation | 3,680,000 | Yes | Yes | Yes |
| | | **Total** | $41,471,743 + Coromandel costs TBD | $23,011,933 + Coromandel costs TBD | $16,011,933 + Coromandel costs TBD |

# Discussion

## Optimised Biodiversity Management

This approach to develop an optimised landscape scale investment plan could be extended to consider other large-scale project work including work on ecological management units and pest-led work at a landscape scale. These would be funded out of other Intermediate Outcomes. How the criteria are applied can be adapted depending on changing context and values, for example employment potential could be given a greater weight. This tool is not, as yet, a robust way to support decisions on how to distribute limited resources between species, ecosystem, landscape projects and threat-led work.

Some of the methods for doing this have been used in DOC's Long-term Investment Plan where tradeoffs among competing objectives, values and outcomes are made explicit and decision makers can make rapid choices and immediately see the impact of those decisions on the wider business. The landscape decision support tool is an important piece of that wider puzzle because it provides the ability to allow trading (increases or reductions in numbers of funded projects) of landscape-scale projects given any future budget choices, and this can then be seen in the context of other allocation choices for this resource.

## Intermediate Outcome Objective Framework

### Where does landscape-scale work fit within the Intermediate Outcome Objective framework?

Landscape-scale work is an increasing focus of the Department. Current definitions within IOO1.1 and IOO1.6, where most large-scale and ecosystem-based work is categorised, do not adequately cover landscape-scale work. We recommend that work to understand the fit of landscapes within the IOO1.3 "landscapes" objective and including ecological and cultural values at landscape scale across all land tenures, not on iconic sites, is initiated.

## Integration

### Integration of cultural and ecological values

The definition implies an intention to maximise mana, mauri, wairua, whakapapa and ecological integrity, enabling biodiversity gains made by management to be viewed through both a cultural and ecological lens.

Draft measures for assessing the difference management makes from a cultural perspective have been developed. Mana, mauri, wairua and whakapapa are effectively describing the same thing as ecological integrity but through a cultural lens. Unlike the criteria for ecological integrity, these are yet to be applied to the selected projects. These two different ways of measuring the difference made to biodiversity should both be applied as part of a biodiversity assessment in the future.

This is separate from an assessment of Treaty Partner benefit and readiness. How to best integrate these with high biodiversity projects is a conversation for leaders.

### Integration of freshwater and terrestrial values

The definition doesn't distinguish between freshwater, terrestrial and marine values within a landscape. It implies an approach to management based on addressing the range of pressures at a site. Due to historical differences in assessing biodiversity value within these different domains, it was at first difficult to consider freshwater catchments and terrestrial sites together. Integration of marine values is yet to occur.

At the request of the PAG, a "combination method" to identifying difference made to biodiversity (EI) was applied following the workshops and EI scores adjusted accordingly. The combination method that has been used has not been explored or peer reviewed. There are other ways to split EI values across the range into categories. These have not been tried nor have the different outcomes that come from these methods been explored. More work is required on refining a single biodiversity gain measure in the future (see recommendations).

The key shift is away from management of terrestrial and freshwater sites towards landscape scale management where all significant pressures are addressed regardless of domain.

## Data Collation

Particularly during the Covid-19 response, project leads were inundated with requests for project information, for a variety of related purposes. Collation of landscape project information in one place would ensure data is centralised, can be readily updated and would assist quality control. It would also reduce duplication of effort by project leads.

Explicit data quality measures are required when collecting data to ensure fair comparison between projects. There are inconsistencies in the Department on how projects are planned and costed and therefore in the quality of data we had access to. If project leads are required to make assumptions, especially in early project phases, guidelines around this should be provided to ensure consistency. Because this was an evolving project, the initial collection of data wasn't necessarily fit for purpose e.g. annual costs were collected over a five year period and through the process we became more interested in phasing costs which were difficult to pull out as not all projects use a Project Management Framework. We suggest that explicit clarity is given on what costs are included and excluded from projects, a level of certainty is given around these costs, and inclusion (or exclusion) of contingencies is clear. To mitigate data error it is important that projects are reevaluated as they move through the work delivery system phases.

Criteria scoring was done by the project team with assistance from the technical team, project leads and subject matter experts. A more rigorous peer review of criteria scoring should be undertaken in future iterations of this process to ensure expected costs and benefits are 'true' to build confidence in the recommendations for investment.

## Limitations of EI scores

Some projects were removed from the process because they did not have nearby EMU sites available to generate biodiversity gain scores. In our process this mostly impacted projects situated far from existing EMUs containing ecosystems of a similar type. Some of these are led by our Treaty Partner including a site proposed for investment by Ngā Whenua Rahui "State Highway 35 Predator Control and Coastal Headlands Predator Eradication." The cultural measures to determine biodiversity gain may be useful here, and this needs further testing and application at the project scale. Other projects were removed due to not having GIS spatial boundaries available.

## Phasing

The implications of the principle *"purchase of a project is for its next phase only, not the entire project"* need consideration.

The intent of this principle is to enable decision makers to make calls at the end of each phase as new information comes to light e.g. refined costings, feasibility etc. It implies projects would need to be able to apply for further funding at the end of each phase or risk "sitting on the shelf" for the remainder of the 5-year period. There is also tension between this approach and the need to provide a level of certainty for staff, Treaty Partners, stakeholders etc.

In the list of recommended investment provided here, we have included projects with multiple phases as most projects that have requested funding over multiple phases are early in their pre-scoping or late in their design. These phases are expected to only take 1-2 years so by including multiple phases in funding considerations it would give projects some certainty of funding. We would however expect the partnership work delivery system gates to be used between phases and explicitly ensure that only projects that met the requirements would progress to the next phase.

### Whole of Life Costs

Many high biodiversity gain landscape projects that appear to have a high initial cost (e.g. offshore island eradication work) actually have low whole of life costs. This is due to a reduced need for ongoing management compared to mainland sites where constant pressure of threats exist. Having whole of life costs included in the investment criteria would make optimised rankings possible for these data.

We were not asked by the PAG to apply the defendability criteria in the preferred scenario. However, defendability scores are also relevant here as high defendability means more chance of securing the gains made and therefore lower whole of life costs, and much reduced risk of failure.

The list where a defendability test (H/VH defendability) is then applied to the preferred scenario is as follows:

Sites that meet scenario 2 and are highly defendable

| **Site** | **What is being bought** | **Cost ($)** |
|---|---|---|
| Te Manahuna Aoraki 310,000ha (ready) | 5 years of implementation | 9,333,333 |
| Coromandel 256,388ha (design) | Design phase | TBD |
| Chathams (includes Predator Free Chathams and Chathams Securing, Sharing and Growing Species and Ecosystems) 81,574ha (design/ready) | 4 years of design for Pred. Free Chathams and<br>5 years of implementation for Chathams Securing, Sharing and Growing Species and Ecosystems) | 3,855,000<br>14,604,810 |
| Far North 122,734ha (pre-scope) | 1 year of pre-scoping<br>1 year of scoping | 300,000<br>500,000 |
| **Total** | | **28,593,143 (+ Coromandel TBD)** |

## Assumptions

In building this framework and a final list of optimised landscape investment recommendations we have assumed that the data collected from project leads and subject matter experts was correct at time of collection. We have moderate confidence of this currently.

The EMU level EI values were extrapolated to the landscape-scale to calculate a single area weighted mean EI value for each landscape-scale site. The method used assumed that a similar level of management would be applied across the wider landscape-scale site.

When generating biodiversity scores, it was assumed that the right pressures had been recorded and the right actions prescribed for all landscape-scale work. We currently have moderate confidence that this is the case.

## Recommendations for future work

- This approach to develop an optimised landscape scale investment plan could be extended to consider other large-scale project work including work on ecological management units and pest-led work at a landscape scale.
- We support the suggested modification of IOO1.3 "landscapes" proposed to focus on ecological and cultural values at landscape scale across all land tenures.
- The draft cultural measures developed during this process need to be tested and finalised. These are outlined in the criteria table on pages 15-16 and Appendix 3. We recommend the cultural measures are refined through application to the final list of projects selected by the PAG.
- We recommend that cultural measures are used to assess all projects. A priority is sites on Māori land that were excluded due to lack of EMU data for inclusion on the list, including "State Highway 35 Predator Control and Coastal Headlands Predator Eradication."
- Further consideration is given to how to progress sites for which biodiversity gain scores were not possible due to absence of EMUs or spatial boundaries.
- Further rationalisation of biodiversity scores is required for landscape sites
    - A task assignment to the Planning and Support Unit is required to look at how to merge freshwater and terrestrial EMU and landscape scale EI scores properly – this has implications for how we use zonation to do this work, and what our underlying assumptions have been.
    - A second task assignment to the technical team to refine the methods for extrapolating EI scores from EMUs to landscape scale.
- To ensure projects are true landscape projects and that the right pressures have been recorded and the right actions prescribed we suggest:
    - Peer review application of the new definition of landscape-scale projects to exclude single species pest-led work. These invariably rank lower in EI terms than multi-pressure management at landscape-scale sites.
    - Apply the conceptual model framework to projects to give a clear view of values and pressures to help identify a full suite of elements to be worked on in the future.
    - Inclusion of marine landscape-scale work which will require more technical discussion and potentially more data. This should be included in future approaches for long-term work.
    - Seek to merge marine, terrestrial and freshwater prioritisation systems in assessing landscape-scale projects.
- A centralised data system for landscape project information is collated.
- Explicit data quality measures are required when collecting data to ensure fair comparison between projects.
- Peer review of criteria scoring is undertaken to ensure expected costs and benefits are 'true' to build confidence in the recommendations for investment.
- Review inclusion of the 'Sustain' phase of the work delivery system in the framework.
- The advice of the PAG was that funding should be per phase only. We recommend that thought be given to an annual funding round that eligible projects can apply for to support their next phase of work and in the meantime, budgets allow for priority projects to move quickly between phases if they continue to meet work delivery system gates.
- A valuable addition to the technical process within the framework would be a stronger understanding of the urgency of responding to pressures. For example, if investment in a landscape site was delayed for five years, how it would impact on the project?
- We recommend whole of life cost of projects are included in the investment criteria to ensure visibility of ongoing project costs. Optimised rankings could be generated by dividing landscape site EI by the sum of the 50-year cost of management at each site. This would indicate the pool

of the most cost-effective landscape-sites, where resources spent maximise EI gains towards the landscape objective.

# Appendices

Appendix 1: Table of terrestrial focused landscape scale projects with ecological integrity (difference made) and catchment rank scores (sourced from docCM-6255385 'Ranking landscape scale sites based on their biodiversity benefits').

| ProjectName | EI (Diff Made) | Catchment rank # | *Hectares* |
|---|---|---|---|
| **Auckland Island/Maukahuka** | **0.636** | * | 46,022 |
| **Fiordland South** | **0.413** | 0.07 | 152,440 |
| **Taranaki Eastern Biodiversity Corridor** | **0.408** | 0.53 | 450,142 |
| **Coromandel Peninsula - Moehau to Karangahake** | **0.404** | 0.52 | 256,388 |
| **Pureora** | **0.357** | 0.43 | 147,676 |
| **The Chathams** | **0.33** | * | 81,561 |
| **Northland Kaitaia** | **0.327** | 0.21 | 122,625 |
| **Taranaki Mounga** | **0.319** | 0.57 | 34,078 |
| **Remutaka collaborative restoration** | **0.316** | 0.39 | 44,087 |
| **South Westland** | **0.26** | 0.14 | 440,118 |
| **Te Manahuna Aoraki** | **0.229** | 0.16 | 305,795 |
| **Te Hoiere Pelorus Landscape Restoration** | **0.228** | 0.26 | 175,867 |
| **Kahurangi o Mohua** | **0.218** | 0.39 | 471,206 |
| **Predator Free Rakiura** | **0.178** | 0.08 | 173,400 |
| **Waiau toa Molesworth** | **0.152** | 0.43 | 357,212 |
| **Aorangi Restoration Project** | **0.101** | 0.55 | 30,297 |

Table of six freshwater catchment focused landscape-scale projects with readiness and national priority score (sourced from docCM-6255385 'Ranking landscape scale sites based on their biodiversity benefits').

| **Landscape site (Priority river catchments)** | **Landscape site extent (ha)** | **Readiness (DOC +Iwi Partner + Other Stakeholders) Highest score = 9** | **National priority (Zonation)**[B] (low = higher priority) |
|---|---|---|---|
| Arahura | 28654 | 8 | 0.33 |
| Rangitata | 182372 | 7 | 0.36 |
| Hoteo (within Kaipara) | 35782 | 5.5 | 0.38 |
| Waipoua | 11163 | 8.5 | 0.39 |
| Pelorus (Te Hoiere) | 89058 | 9 | 0.40 |
| Waikanae | 15328 | 7.5 | 0.49 |

Appendix 2: Team who worked on the Optimised Landscape Investment Plan

Appendix 3: Optimised Landscape Investment Criteria (docCM- 6319611)

The framework below will be applied to projects multiple times as they proceed through the investment pipeline i.e. at pre-scoping, scoping, design and once project design is completed, prior to investment. While the same criteria will be used for all phases, projects in pre-scope and scope may be measured on intent or best knowledge rather than actual information or values that would be expected for projects that have completed design phase.

| **Criteria** | **Measures** | **Outcome** |
|---|---|---|
| | | |
| **Project Benefits** | | |
| 1. Ecological | - Biodiversity gain score derived from combined terrestrial ecological integrity and freshwater biodiversity scores.<br><br>- Restoration of mana, mauri, wairua and whakapapa score (potential difference with management)<br><br>Leads to mana of that species, environment or forest being restored. | Terrestrial score<br>Very High (4) = 0.4-0.724<br>High (3) = 0.297-0.399<br>Medium (2) = 0.187-0.296<br>Low (1) = 0.001-0.186<br><br>Freshwater score<br>Very High (4) = 0.615-0.9<br>High (3) = 0.366-0.614<br>Medium (2) = 0.071-0.365<br>Low (1) = >0.9 OR <0.071<br><br>The cumulative score is gained by adding both scores for each site and dividing by 2, rounding up where required.<br><br>VH/H/M/L scoring to be developed. Identification likely by practitioners (e.g. weavers, rongoa) and/or hapū |
| 2. Treaty Partner | a) Demonstrates added value to whānau and/or hapū<br>b) Project is Treaty Partner led or partnered<br>c) Treaty Partner is actively involved in project<br>d) Project is Treaty Partner supported | Very high (4) = all criteria are strongly supported<br>High (3) = all criteria are supported<br>Medium (2) = one of criteria a-c is supported<br>Low (1) = criteria d is met |
| 3. Community | - Project focused in vulnerable regions or vulnerable sectors of society with the greatest need for growth<br>- Provides well documented value to the community<br>- Community led<br>- Provides for future additional | Very high (4) = 4 measures strongly supported<br>High (3) = 3 measures strongly supported<br>Medium (2) = 2 measures strongly supported<br>Low (1) = <2 measures supported |

| | | |
|---|---|---|
| | opportunities aligned with biodiversity and community growth | |
| 4. Employment | - Number of FTEs created by project | Very high (4) = >100<br>High (3) = 50-100<br>Medium (2) = 10-49<br>Low (1) = <10 |
| **Feasibility** | | |
| 5. Technical feasibility | a) Does the method/technology already exist?<br>b) Will it work?<br>c) Can we demonstrate it will make the intended difference? | Very high (4) = >90% confident all are met<br>High (3) = >70% confident all are met<br>Medium (2) = >50% confident all are met<br>Low (1) = <50% confident all are met |
| 6. Social feasibility | - Project is supported by Treaty Partner?<br>- Are the project actions socially acceptable to stakeholders e.g. landowners and community? | Very high (4) = all measures strongly supported<br>High (3) = all measures supported<br>Medium (2) = 1 measure strongly supported<br>Low (1) = 1 measure supported |
| 7. Defendability | The nine principles in Table 3, DOCCM-3092020 (and below) should be followed.<br><br>Projects need to meet relevant criteria in Defendability Principles table. The % of the boundary length that is defendable against reinvasion determines its score. | Very high (4) = All or almost all of site has a defendable boundary<br>High (3) = more than 70% (much) of boundary has features aiding defendability<br>Medium (2) = 30-70% (some) of boundary defendable<br>Low (1) = almost none of boundary defendable |
| **Readiness** | NB: Pre-scope projects score 4 for all readiness measures as possibilities have not yet been scoped. | |
| 8. Treaty Partner readiness | a) Treaty Partner is ready now<br>b) Treaty Partner almost ready<br>c) Treaty Partner not ready yet<br>d) Treaty Partner disengaged | Very High (4) = criteria a is met<br>High (3) = criteria b is met<br>Medium (2) = criteria c is met<br>Low (1) = criteria d is met |
| 9. Social readiness | - Are relationships, roles and mutual interests among contributors agreed?<br>- Are other contributors ready/have capacity? | Very high (4) = all measures strongly supported<br>High (3) = all measures supported<br>Medium (2) = 1 measure strongly supported<br>Low (1) = 1 measure supported |
| 10. Project readiness | Design and Implementation project | Design and Implementation projects<br>Very high (4) = all measures met |

| | | |
|---|---|---|
| | - Has a feasibility assessment been done?<br>- Have Treaty settlement obligations been met?<br>- Is a phased project plan documented, costed by phase and completed?<br>- Does DOC have capacity to fulfil their role as outlined in project plan?<br>- Is external funding procured (if required)?<br><br>Scoping project measures<br>- Scope and area defined<br>- Project requirements clear<br>- Project lead identified<br>- Does DOC have capacity? | High (3) = 4 measures met<br>Medium (2) = 3 measures met<br>Low (1) = <3 measures met<br><br>Scoping projects<br>Very high (4) = all measures met<br>High (3) = 3 measures met<br>Medium (2) = 2 measures met<br>Low (1) = 1 measure met |
| **Investment** | | |
| 11. Investment | - Cost to DOC per year over 5 years<br>- Total cost to DOC for 5 years<br>- Total cost of project (including external funding) over 5 years | Dollar amounts |

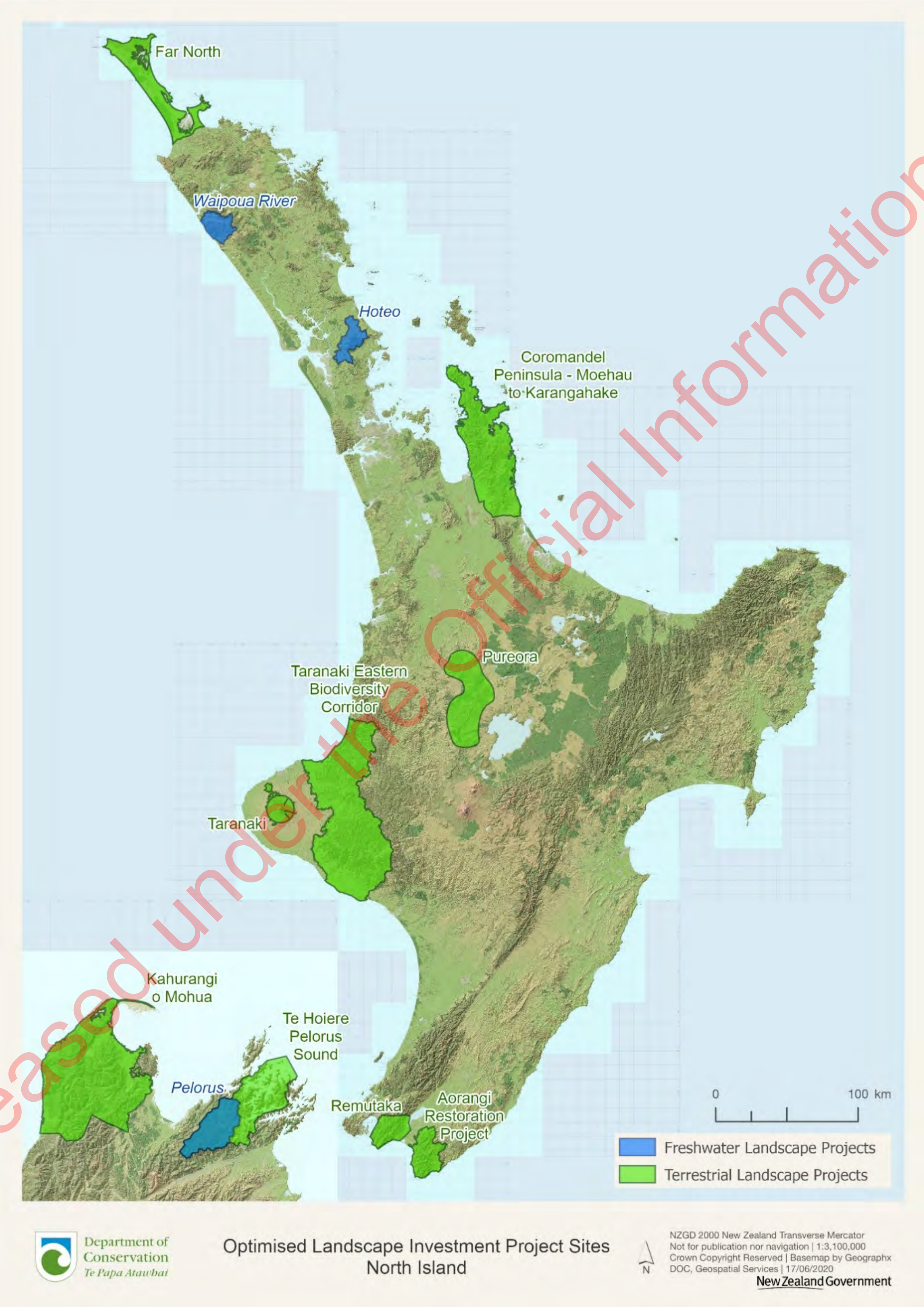
All measures will be reviewed in future iterations of this framework.

Appendix 4: Table of all sites with their combined biodiversity score, technical and social feasibility scores, Treaty Partner benefit and readiness scores.

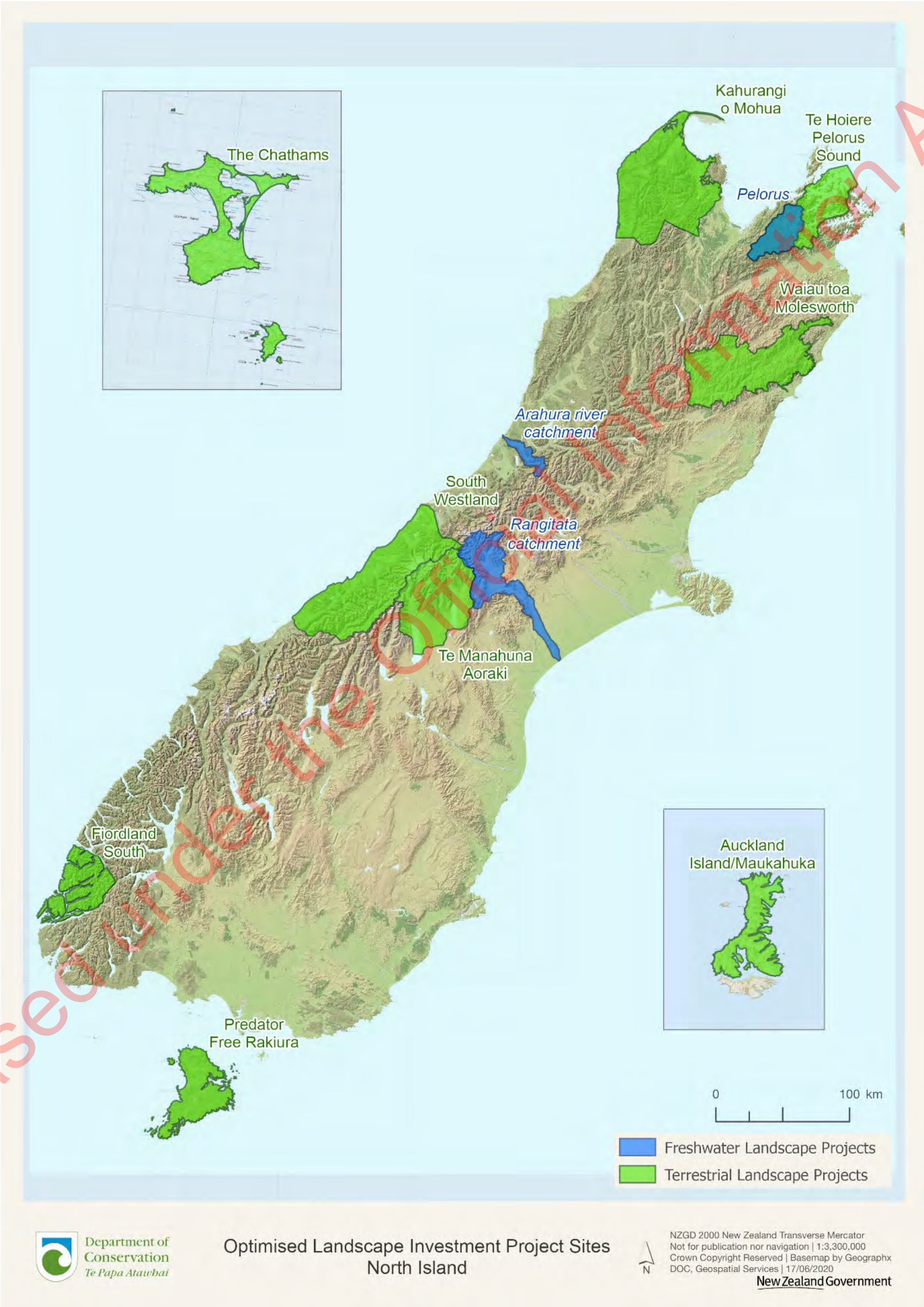
Coloured columns show projects that meet the conditions for each criteria within the preferred scenario. Coloured rows show projects that meet all the required scenario conditions.

| Site | Combined biodiversity score | Technical Feasibility | Social Feasibility | Treaty Partner Benefit | Treaty Partner readiness |
|---|---|---|---|---|---|
| Chathams (includes Predator Free Chathams and Chathams Securing, Sharing and Growing Species and Ecosystems) (design/ready) | 4 | 3 | 4 | 3 | 3 |
| Coromandel (design) | 4 | 2 | 4 | 4 | 4 |
| Taranaki Eastern (ready) | 4 | 2 | 3 | 4 | 4 |
| Far North (pre-scope) | 4 | 2 | 3 | 4 | 4 |
| Rangitata (ready) | 4 | 2 | 2 | 3 | 2 |
| Hoteo (scoping) | 4 | 2 | 1 | 1 | 2 |
| Maukahuka (ready) | 3 | 3 | 4 | 2 | 4 |
| Taranaki Mounga (ready) | 3 | 2 | 4 | 4 | 4 |
| Remutaka (design) | 3 | 2 | 4 | 2 | 4 |
| Te Hoiere Pelorus (scoping) | 3 | 2 | 3 | 4 | 4 |
| Waipoua (ready) | 3 | 2 | 3 | 4 | 3 |
| Te Manahuna Aoraki (ready) | 3 | 2 | 3 | 3 | 4 |
| Kahurangi (scoping) | 3 | 2 | 3 | 2 | 4 |
| Pureora (design) | 3 | 2 | 3 | 2 | 4 |
| South Westland (pre-scope) | 3 | 2 | 3 | 2 | 4 |
| Arahura (design/ready) | 3 | 2 | 2 | 3 | 3 |
| Fiordland South (pre-scope) | 3 | 1 | 3 | 1 | 4 |
| Aorangi to Remutaka (design) | 2 | 3 | 2 | 2 | 4 |
| Molesworth (scoping) | 2 | 2 | 2 | 2 | 2 |
| Rakiura (scoping) | 1 | 3 | 2 | 3 | 4 |

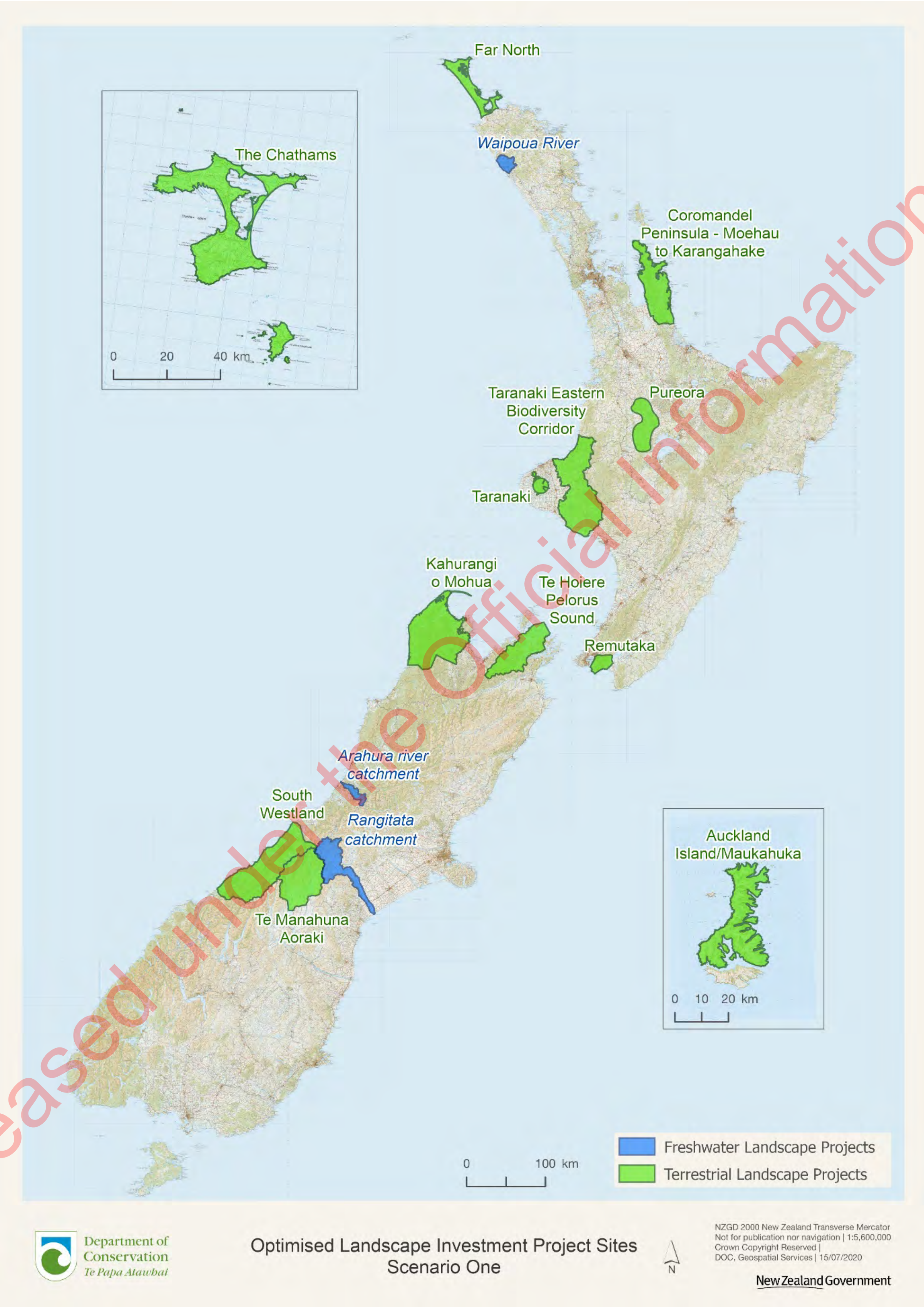
Appendix 5: Map of North Island landscape scale projects considered in the Optimised Landscape Investment Plan



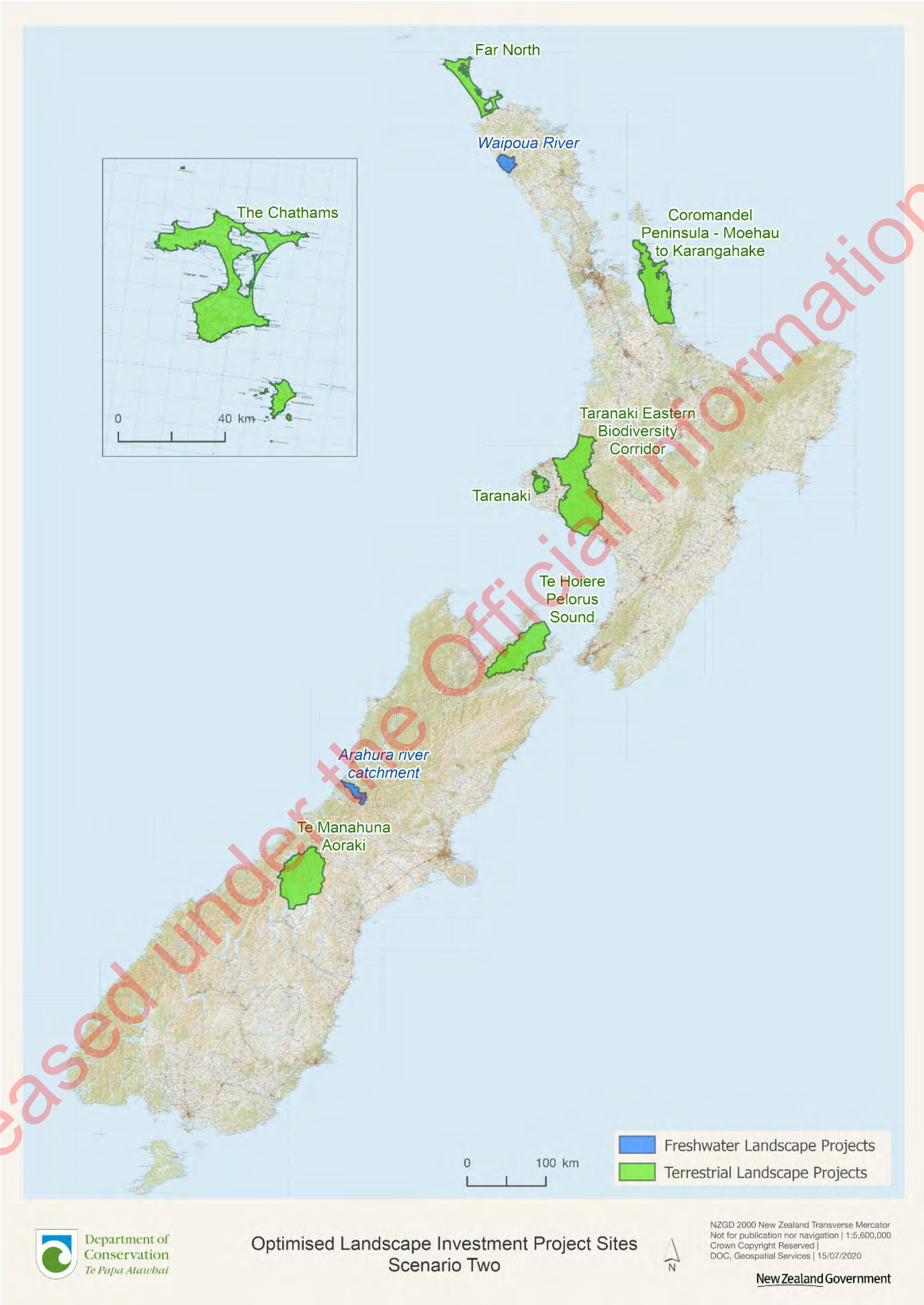
Appendix 6: Map of South Island landscape scale projects considered in the Optimised Landscape Investment Plan



Appendix 7: Map of landscape scale projects that meet Scenario One



Appendix 8: Map of landscape scale projects that meet Scenario Two



Appendix 9: Document list

| **Document Name** | **Comments** | **docCM** |
|---|---|---|
| *Working documents* | | |
| Landscape Projects 5 year pathway | Spreadsheet of project info and data | DOC-6192869 |
| OLIP Criteria for Landscape Projects | Criteria table and scoring | DOC-6319611 |
| OLIP landscape project criteria graphs | Criteria graphed against biodiversity score | DOC-6319617 |
| OLIP landscape project scenario tables | Pivot table to build scenario lists | DOC-6319620 |
| OLIP investment framework flowchart raw | Powerpoint document of suggested framework flowchart | DOC-6318591 |
| *Technical Documents* | | |
| Ranking landscape scale sites based on their biodiversity benefits | Technical report on biodiversity scores | DOC-6255385 |
| Report on review of design of NEXT predator sites | Defendability criteria principles | DOC-3092020 |
| *Workshop #1 documents* | | |
| Treaty and Community Excel Resource | | DOC-6312926 |
| Social & Project Readiness Excel Resource | | DOC-6312953 |
| Social & Technical Feasibility Excel Resource | | DOC-6312987 |
| *Workshop #2 documents* | | |
| OLIP Workshop 2 Agenda | | DOC-6313096 |
| OLIP Workshop 2 Package | | DOC-6313086 |
| OLIP Breakout Group 1 Material | | DOC-6313057 |
| OLIP Breakout Group 2 Material | | DOC-6313069 |
| OLIP Breakout Group 3 Material | | DOC-6313075 |

# Ranking landscape scale sites based on their biodiversity benefits

Task assignment for Brent Beavan: DOCCM-6194682. April 2020.

## Summary


1. This report describes how to determine the biodiversity benefit for terrestrial and freshwater catchment-based landscape-scale projects (marine is out of scope), and it sets this in the context of other types of project work (EMU's, Pest-led) happening on a large-scale.
2. **We recommend 22 landscape-scale projects suitable for consideration for resource allocation: 16 are Landscape-scale terrestrial-focussed, 6 are Landscape-scale freshwater catchments-focussed (Tables A1, A2).**
3. These form a candidate pool of high-ranking Landscape-scale sites, where biodiversity values are maximised. Any selection from this pool of 21 will be a priority. Further consideration needs to include scoping and feasibility assessment, working with our Partner, and consultation about the delivery order of the pool of priority projects with operations.


4. Where possible, we use existing data on the difference management makes to Ecological Integrity (the structure, function and composition of ecosystems) to compare among landscape-scale projects
5. Landscape-scale management has a specific definition, and to achieve high levels of gain in ecological integrity, it generally equates to management of most of the pressures within a large contiguous functional multi-ecosystem site. This means that projects that undertake lesser management of a few pressures (pests) at large-scales do not qualify as landscape-scale management.
6. A total of 72 terrestrial-focussed landscape projects at around 59 sites were assessed, of which 33 projects were defined as too small and/or were without available GIS spatial boundaries, or without data on Ecological Integrity in or near the site, or were largely intensive farmland or urban - these were excluded.

7. The remaining 39 terrestrial-focussed projects were considered for assessment and ranked based on Ecological Integrity (biodiversity value), alongside a pool of 14 highly ranked landscape-scale (freshwater catchment-based).
8. To clarify the difference between landscape-scale and large-scale, we also describe 33 large-scale ecosystem or pest-led projects: 15 large-scale EMUs, and 18 large-scale pest-led projects. Working on these projects will achieve biodiversity gains for other Intermediate Outcome Objectives but should not be considered Landscape-scale projects.

## Context

The Biodiversity Group has been tasked by the DG with developing a landscape-scale strategic investment plan. The aim is to have an optimised investment plan for landscape scale work, guiding where the Department should invest. An initial version will be completed by the end of April 2020, followed by a refined model by October 2020. The plan will guide the Department's investment in landscape scale projects.

A key element in developing an investment plan for landscape-scale sites is to understand how biodiversity is impacted by the selection of sites for management – i.e., what biodiversity benefit could be gained from managing each landscape-scale site?

This document describes the method to calculate relative biodiversity value across landscape-scale sites, and the application of that method to all proposed New Zealand terrestrial and freshwater landscape-scale sites.

## Purpose

To describe the relative biodiversity benefit gained through proposed DOC investment in management at landscape-scale sites.

## Key result

Landscape-scale management is defined. There are 22 recommended Landscape-scale sites: 16 are terrestrial-focussed and 6 are freshwater catchment-based.

The 16 terrestrial focussed Landscape-Scale projects

| ProjectName | EI (Diff Made) | Catchment rank # | *Hectares* |
|---|---|---|---|
| Auckland Island/Maukahuka | **0.636** | * | 46,022 |
| Fiordland South | **0.413** | 0.07 | 152,440 |
| Taranaki Eastern Biodiversity Corridor | **0.408** | 0.53 | 450,142 |
| Coromandel Peninsula - Moehau to Karangahake | **0.404** | 0.52 | 256,388 |
| Pureora | **0.357** | 0.43 | 147,676 |
| The Chathams | **0.33** | * | 81,561 |
| Northland Kaitaia | **0.327** | 0.21 | 122,625 |
| Taranaki Mounga | **0.319** | 0.57 | 34,078 |
| Remutaka collaborative restoration | **0.316** | 0.39 | 44,087 |
| South Westland | **0.26** | 0.14 | 440,118 |
| Te Manahuna Aoraki | **0.229** | 0.16 | 305,795 |
| Te Hoiere Pelorus Landscape Restoration | **0.228** | 0.26 | 175,867 |
| Kahurangi o Mohua | **0.218** | 0.39 | 471,206 |
| Predator Free Rakiura | **0.178** | 0.08 | 173,400 |
| Waiau toa Molesworth | **0.152** | 0.43 | 357,212 |
| Aorangi Restoration Project | **0.101** | 0.55 | 30,297 |

The 6 freshwater-catchment-focussed Landscape-scale projects

| Landscape site (Priority river catchments) | Landscape site extent (ha) | Readiness (DOC +Iwi Partner + Other Stakeholders) Highest score = 9 | National priority (Zonation)[B] (low = higher priority) |
|---|---|---|---|
| Arahura | 28654 | 8 | 0.33 |
| Rangitata | 182372 | 7 | 0.36 |
| Hoteo (within Kaipara) | 35782 | 5.5 | 0.38 |
| Waipoua | 11163 | 8.5 | 0.39 |
| Pelorus (Te Hoiere) | 89058 | 9 | 0.40 |
| Waikanae | 15328 | 7.5 | 0.49 |

All of these sites are listed in Appendix 1. Biodiversity benefits will be maximised if resource allocation and project selection is restricted to this pool in the first instance. Further consideration needs to include scoping ad feasibility assessment, working with our Partner, and consultation about the delivery order of the pool of priority projects with operations.

For clarity, we also assessed submitted projects that were defined as large-scale management opportunities. These types of projects will provide high biodiversity returns under different Intermediate Outcome Objectives. There were 15 large-scale

EMUs, and 18 large-scale pest-led projects that were assessed to have high value as large-scale management opportunities, where biodiversity gains were high.

Scope

In scope:

1. Development of a metric to describe the impact of management on the biodiversity values at landscape-scale sites
2. All terrestrial and freshwater ecosystems within large landscape scale sites, where there were available in-common data. For the current work, this drew primarily on data collected for the integrated ranking of EMUs and SMUs. Catchment prioritisation (based on ecological integrity) was also applied to evaluate catchment benefits of potential landscape sites (terrestrial-focused sites & catchment-based sites). Marine ecosystems were not in scope).
3. Management of single or multiple pressures at landscape-scale sites

Out of scope:

1. Marine landscape-scale sites, and marine ecosystems, although the existing and potential marine protected area network and some areas managed for habitat restoration or for marine species are likely candidates – *because these are mostly managed as policy-based work, their prioritisation will be run separately in the short-term.*
4. Non-site-based work (e.g., policy-based management) – *these do not fit the definition of being site or place-based.*
2. Terrestrial and freshwater ecosystems where EI data or its equivalent has not yet been collated – *these can be added in the longer-term as EI information is generated.*
3. Landscape-scale sites where spatial extent has not yet been clearly defined - *these can be added in the longer-term as spatial information is generated.*
4. A landscape "site" which actually consists of multi-sites or spatially disjunct (except offshore island groups) – *these don't fit the definition of "landscape-scale site".*
5. Any other site that does not meet the definition of a landscape-scale site.
6. Any other measures of impact or value at landscape -scale sites (for e.g., ecosystem services, urgency, representativeness, geographic spread, contribution to threatened species security, socially-derived criteria*) – these can be considered as a weighting on EI as part of longer-term investment plan strategic thinking*

Defining Landscape-scale work and the fit with other objectives

### A. Objective for landscape-scale site work

There are many different definitions of, or objectives for, Landscape, and Landscape-scale management (e.g., summarised in Selman 2006). Because the focus of this work is about protection of biodiversity values rather than social, cultural or abiotic (e.g., landform) values, we use a definition that is based on maximising the impact of management on the ecology of a landscape-scale site.

Within that objective there are a range of elements (i.e., weightings) which can be applied. A key one is to consider the spatial relationship between sites, and provide a network-approach, where favoured projects would aim to represent a range of different landscapes. Including this weighting, the recommended objective is:

**Recommended objective for landscape-scale management.**

***A landscape scale project is a large place-based project where pressure(s) are managed to maximise ecological integrity across the entire site as part of a national network of managed landscapes.***

An alternate objective would not consider spatial relationships.

***A landscape scale project is a large project where pressure(s) are managed to maximise ecological integrity across the entire place.***

For either of these options, the following definitions of terms apply:

a. Landscapes are considered to contain multiple ecosystems

b. Large = several kms in diameter, larger than an ecosystem and smaller than a biome or ecoregion. Our recommendation is that 'large', in general, means more than 30,000 ha because this is the upper limit cut off for an EMU, and because it allows for the concepts of core-corridor-buffers, is at a scale where life cycle processes are sustained, will have permeability and porosity, and has a series of interconnected and functioning ecosystems. As part of sustaining life cycles, drivers such as climate change and for managing genetic drift are provided for.

c. A place is a defined area or site of large scale, within which management actions will occur over some or all of the place. While landscapes will not have unambiguous boundaries, we accept that for planning purposes a hard and contiguous boundary should be described for each place. These boundaries should also directly consider the terrestrial and aquatic processes that underpin their ecological integrity (e.g., encapsulate catchment boundaries).

d. Ecological integrity = describes the level to which the full potential of indigenous biotic and abiotic features and natural processes, functioning in sustainable communities, habitats, and landscapes is met.

e. Ecosystem services provided by landscapes are assumed to be maximised when ecological integrity is maximised

f. Landscapes are across any, and all, of the marine, freshwater and terrestrial domains

If biodiversity values were to be considered equally alongside cultural values in our outcome-based objectives, then an objective statement could be:

*A landscape scale project is a large place-based project where pressure(s) are managed to maximise the integrity of cultural narrative* and *ecological integrity across the entire whenua/site as part of a national network of managed landscapes.*

It is not technically possible to maximise different values in one objective unless they are always completely aligned – i.e., the outcome sought is the same. In the above attempt at an objective statement, those values are integrity of cultural narrative and integrity of biodiversity, but the same is true for combinations of any values. In this case, we would recommend either a staged approach (first identify high priority biodiversity opportunities, then prioritise the work within that high biodiversity set based on values such as cultural narrative), and/or an approach where cultural narrative values related to whenua are an objective in their own right.

**B. Other large-scale work and its fit alongside landscape-scale work**

Managing landscape-scale sites is not the same as managing pressures at large scales. There is some confusion about these different types of management at scale – they have different objectives and should be treated separately. For the potential candidate sites provided for this work via another round of wide consultation, it was clear that these potential management projects were based on both landscape-scale and large-scale work working to multiple objectives.

It's not that this is "wrong" work. These different objectives fit well within our existing Outcomes Framework, and selection of a pool of potential landscape-scale projects can be considered as a stretch goal. Two other DOC Intermediate Outcome Objectives cover other types of management at large scale, and these are legitimate but different objectives. Specifically, the types of large-scale work that is being offered alongside ecologically based landscape-scape work are:

a. Pest-led work. Pest-led work can occur at large and small scales. Managing single or small suites of pests generally does not qualify as landscape-scale work because it mostly does not impact on the functionality of inter-connected ecosystems. Where it does qualify (i.e., in large, contiguous blocks of a monotypic Ecosystem Class), it generally fails to change Ecological Integrity by a large degree, because other pressures at these places are not concurrently managed.
b. Landscape-scale work in urban or agricultural (human-centred) landscapes including restorative work in those places. While these sites meet the definition of landscape-scale sites, the human modified elements provide little or no improvement in ecological integrity, and act mostly as buffer areas for a smaller network of EMUs, SMUs or habitat patches. Likewise, restorative management actions such as translocations and native vegetation planting provide only small elements of the structure, function and composition of sites.

Landscape-scale work fits within the Intermediate Outcome Objective framework, but current definitions within IOO1.1 and IOO1.6. where most large-scale and ecosystem-based word is categorised, do not adequately cover landscape-scale work.

Modification of IOO1.3 "landscapes" is proposed to focus on ecological and cultural values at landscape scale across all land tenures. Cultural values are those that reflect the mauri, wairua, te maunga and whakapapa of the place. Iconic landscapes and features are proposed to merge with iconic species in IOO1.4.

<u>IOO 1.1: Ecosystems</u> - Aimed at ecosystem management, where ecosystems are managed in units at typically moderate scales

<u>IOO 1.2: Threatened species</u> - Aimed at the long-term persistence of threatened species

IOO 1.3: Landscapes - Aimed at landscape-scale management of ecological and cultural values. Ecology-based landscape-scale management is at sites larger than ecosystems, smaller than biomes.

IOO 1.4: Iconic species and landscape features- Aimed at management of iconic species and iconic socially valued landscape features (landforms, "painted" landscapes)

IOO 1.5: Local and regional treasures - Aimed at socially (human) driven values, usually based around a local environment or region. Mostly occurs off PCL.

IOO 1.6: Management on PCL – Aimed at land manager obligations (e.g. boundary fencing), and pest-led work. Mainly occurs on PCL

A key future consideration is to evaluate how investment in a revised Landscape-scale work under IOO1.3 sites alongside outcomes delivered under all other IOOs, and includes clarification, peer review and agreement of definitions, and confirmation of business rules for determining project assignment to the IOO framework.

## Outputs from this report

In this report we provide four separate lists of high priority projects for:

1. Ecological landscape-scale work (terrestrial-focused) outcomes under IOO 1.3 (16 sites in Appendix Table A1)
2. Ecological landscape-scale work (freshwater catchment-based) that supports outcomes under IOO 1.3 (6 priority catchment sites with high readiness scores in Appendix Table A2 from a pool of 14 sites)
3. Large-scale ecosystem management (EMUs) under IOO 1.1 (A pool of 15 sites, Appendix Table A3)
4. Large-scale pest-led priority opportunities under IOO 1.6 (A list of 18 projects, Appendix Table A4)

## Methods for measuring biodiversity value at landscape-scale sites

There are a range of ways to measure biodiversity value at a site, including using measures of biodiversity persistence, the services biodiversity provides to humans, or the condition of biodiversity (i.e., its Ecological Integrity). In conservation management, these are compared to some concept of future natural state, so that the impact of management actions can be calculated.

We use Ecological Integrity (EI) as the metric to calculate the difference made to biodiversity value when management actions are applied at a site. We use EI because this is the metric used for calculating the potential management gains to be made in Ecosystem Management Units, and therefore it provides a consistent measure of change in state of biodiversity from ecosystem level through to landscape level. In addition, as a metric, it is available now, and is scalable to landscape level (i.e., see methods and assumptions below).

Three components of Ecological Integrity were described by Lee et al., (2005):

1. **species occupancy** (the extent to which species inhabit their natural ranges),
2. **environmental representation** (the extent to which native ecosystems remain across all environments), and
3. **native dominance** (the extent to which species composition, biomass and ecosystem processes are dominated by native species).

The process applied here for calculating EI rests on the assumptions that overall EI is degraded by unmanaged pressures; and management to reduce those pressures allows EI to recover. It does not draw on field-based assessment (e.g., surveying which species occupy each site).

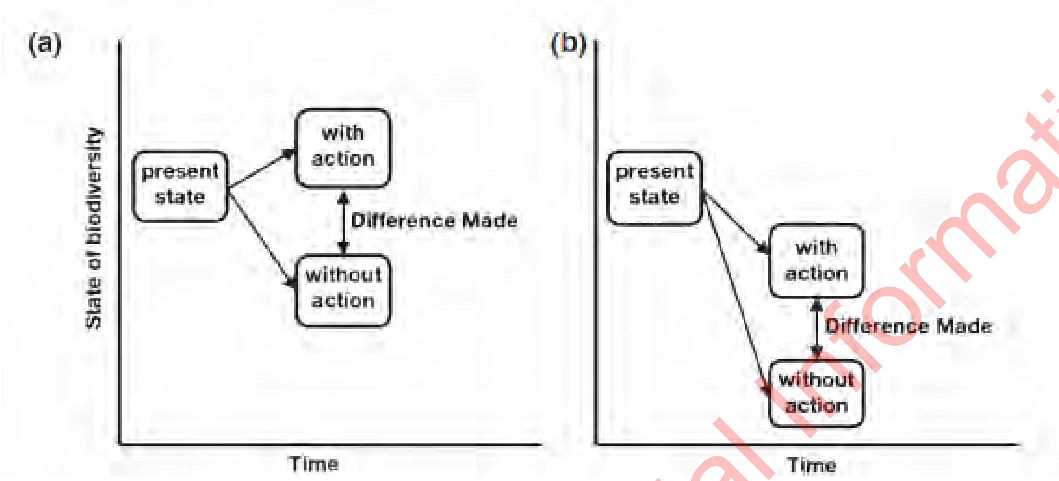
To calculate a single EI score for the difference management can make at a site into the future, we use the following equation:

*EI(diff) = EI with management actions added – EI without any management actions.*

*where the EI (with and without management) at the site level is the mean (weighted area) of EI across each ecosystem type within the site boundaries.*

This is about measuring the degree to which adding management actions at a site changes the future biodiversity outcomes at that site. That change may be positive (i.e., adding management actions increases future Ecological Integrity compared to what it would be without any management), or it may slow down the rate of loss (i.e., adding management actions holds the Ecological Integrity at a site at current levels, or even results in slow decline; whereas, without management, declines in Ecological Integrity would be much worse). This is shown graphically in Figure 1.

Figure 1: The state of biodiversity (~Ecological Integrity (EI) and change in EI (i.e., the difference made) for situations where (a) biodiversity is improved and (b) where decline rates are slowed. Source: copied from Overton et al. (2016).




EI(difference made) data have been calculated for 976 EMU's as part of the contribution towards determining EMU priority rankings under Intermediate Outcome Objectives 1.1 and 1.2. It has been re-calculated each year as part of a technical factsheet to support DOC's annual report, here we used data from 2018/2019.

Detailed methodology is available (Hawcroft et.al., in press) and is not repeated here. Importantly, ecosystems have been classified (Singers and Rogers 2014) into 12 Zonal and Azonal Classes (with additional lake Classes), with nested ecosystem Types (142, with 48 additional Types). With some adjustment, these are available spatially at the Class level across New Zealand, and at the Type level within some Classes, and within all EMUs. That is, we used our judgement of the spatial relationship between sites, Land Cover Database (LCDB) layers and known Ecosystem Classes to determine that, for example, LCDB "Indigenous Forest" in a site such as Waipoua should be considered "WF" = Warm Forest, and not one of the other forest classes.

In comparison, landscape-scale site EI values have not been constructed to date, and Ecosystem Unit level spatial data describing ecosystem types are not generally available outside EMUs. Nor do we have a similarly detailed assessment of the pressures that may affect each ecosystem (as are recorded in planned Prescriptions of work for EMUs). With these limitations in mind, and given both the scope of this work, and the assumptions declared below, the methods described here are the first attempt to derive benefit data at a landscape scale to meet the short-term investment plan objectives above. Additional steps will be needed to fully compare scenarios that use and weight this metric in different ways to ensure the most optimal solution. This should be incorporated into longer-term strategic thinking for the landscape-scale site investment plan.

## Methods for Landscape-scale (terrestrial focus) project identification and applying EI calculations

We used landscape-scale sites identified as part of the broader landscape-scale investment plan work. This included (a) using the existing "Ecological Resilience" sites identified under the Tomorrow Accord between DOC and the NEXT foundation, and (b) asking for contributions from Operations, Biodiversity and Partnership Groups.

A total of 72 potential terrestrial-focussed sites (DOCCM-6192869) were identified that may qualify as landscape sites, of which 39 had appropriate spatial layers to allow analyses and met the criteria of being large sites.

### C. Calculating Landscape scale EI

To calculate total EI within each landscape-scale site we started with existing EMU data sources. We did the following:

1. Located EMUs within the landscape-scale site spatial extent
2. Within each EMU, used the Ecosystem Type and Unit level categorisation data (area of type and unit; pressures present; pressure scores for relative impact, Type and Unit values for EI(difference made), EI (with management), EI (without management)) to calculate the EI (difference; with; without) scores for each ecosystem.
3. Calculated the area-weighted mean value of each ecosystem EI value summed across whichever EMUs were embedded within the landscape site polygon.

At the landscape-scale sites we then excluded some land use types:

4. We excluded rivers from the EMU analysis (but not wetlands, lakes, and braided rivers which have EI scores at EMU level) The limitation of excluding river and streams ecosystems was addressed by evaluating 'catchment ranks' for each site and adding this metric to Table A1 for consideration in the final ranking.
5. We also excluded urban areas, high-intensity land use, and exotic forest because these types of land use are assumed to have zero EI before and after management.

Then we did extrapolated EMU level EI values to the landscape-scale.

6. For all ecosystems, we took the mean of the ecosystem unit level EI values weighted by pressure scores across all units within a type and across all EMUs in the landscape extent, and we averaged these to give a single EI value for each aggregated ecosystem type (warm forest, cool forest etc).

   We then found the spatial extent of the Ecosystem type across the wider landscape-scale site extent using a combination of LCDB5 and climatic layers (described in Singers and Rogers 2014).

   We applied the mean ecosystem type EI scores to the landscape level for each type.

   Note that for rare ecosystems, which have full spatial extents, we applied the mean EI values, weighted by pressure scores for each rare ecosystem type within the EMUs, to the same type across the rest of the landscape-scale site.

7. Finally, we then calculated the areas of the wider ecosystem extents and worked out the single mean EI scores weighted by area based on the mean of each ecosystem type within the landscape extent.

This provided a single area weighted mean EI value for each landscape-scale site (Appendix 1A). This method assumes that a similar level of management would be applied to the wider landscape-scale site as is described in the Prescriptions for EMUs within it, which are written to deliver a healthy and functioning ecosystem (that is, sites of high EI).

Steps 8-11 are what we consider next steps to look at how a subset of the pressures contribute to total EI gain at landscape-scale sites. We have not developed this method and tested it, but we have recorded it here as future guidance. We would:

8. List the pressures recorded as needing management at the landscape-scale site
9. Find each of those pressures within ecosystem types and units within the embedded EMUs and extracted their pressure score and effect. These values are described in Hawcroft (in press) and are described in the Table below.

Table 2.6: Pressure scores and effects

| Score | Effect | Description of typical impacts |
|---|---|---|
| 0.00 | 1.00 | Does not occur |
| 1.00 | 0.97 | Some loss of minor structural components or shift in plant community composition; minor impact on some animal species; minimal change in ecosystem function |
| 2.00 | 0.90 | Some reduction of structurally dominant plants and/or loss of understorey species; decline and loss of some animal species; minor functional change; exotic species are common |
| 3.00 | 0.75 | Significant loss of one or more structurally dominant plants or most larger (k-selected) animals; declines in other species; increases in unpalatable plants; exotic species are locally dominant |
| 4.00 | 0.60 | Major change in community composition; decline and loss of many fauna species, serious loss of structure or function of the ecosystem over a substantial area |

10. Average the pressure scores for each pressure across all the embedded EMUs that had that pressure, at the ecosystem class level. We then would extrapolate and average the pressure scores for each class as per steps 1-3 above.
11. Use the pressure scores to recalculate EI for each broad ecosystem class under – first - the pressure management proposed by the project and – second - the baseline of no management. Then compare these to show potential gain in EI (difference made) across all of the landscape-scale sites given the management regime described in each project.

Sites are then ranked in order from high EI to low EI. Basically, sites with high EI scores will provide for the greatest biodiversity gain when management is applied across listed pressures – i.e., ecological integrity is maximised.

As a technical group, we considered the ranked projects and their EI scores. At this time, we do not think that there is a suitable cut-off in EI gain below which projects do not have merit. Instead, we consider that projects collectively add to our combined Intermediate Outcome Objectives, and decisions to select from within the candidate pools we describe should be based on a narrow range of other factors (e.g., resource availability, capability, feasibility, local capacity, social acceptance, partner engagement and readiness). However, these decisions should not include other candidate projects which are further down the priority lists – focussing on these will result in wasted resources that could achieve more outcomes within the priority pool.

**D. Recommendations, and future improvements to these methods**

1. The definition of landscape-scale projects can be tightened to exclude single species pest-led work. These invariably rank lower in EI terms than multi-pressure management at landscape-scale sites.
2. The definition of landscape-scale projects should from the outset seek to optimise marine, terrestrial and freshwater prioritisation systems.
3. Complete steps 8-11 to demonstrate relative EI contributions of different pressure combinations.
4. Optimised rankings are possible for these data, by dividing Landscape site EI by the sum of the 50-year cost of management at each site. This would indicate the pool of the most cost-effective landscape-sites, where resources spent maximise EI gains towards the landscape objective.
5. Further comparisons of this approach (EI focus), against other approaches that weight EI by urgency, ecosystem services or use complementarity to obtain more representation across ecosystems are required.
6. Inclusion of marine landscape-scale work requires more technical discussion and potentially more data. This should be included in future approaches for long-term work.

## Methods for landscape-scale (catchment-based) site identification

Freshwater catchment-based priorities have been previously ranked by West et.al. (2019). Based on this prioritisation and regional operations input in 2018 and 2019 the Department identified 14 priority river catchments for management[1].

The set of 14 landscape-scale catchment priority sites is identified in Table A2, including 6 sites which are suggested for progressing further.

These catchment sites present landscape-scale conservation opportunities due to their catchment focus (mountains to sea) that includes both river and terrestrial ecosystems. All sites are suited to working in partnership with iwi and councils.

Evaluation of the 14 landscape-scale catchments involved 5-specific steps.

1. Identified catchments (third-order sub-catchments) and terrestrial BMUs within the catchment site spatial extent.

[1] Note: Landscape-scale catchment opportunities with externals exist for the Mataura (Southland) and Ruamahanga (Wairarapa). Assessment of the biodiversity benefit at these sites will occur as part of future work.

2. Catchment rank - Calculation of the average national catchment rank for each landscape-scale (catchment) site. Rank considers, freshwater EI (condition), proximity to intensively managed DOC Biodiversity Management Units (BMUs), sites that support the full range of river, lake and wetland ecosystems, and important sites for species management. It provides an assessment of importance of each catchment of conservation.
3. Landscape connectivity - For each landscape-scale catchment, the number and extent (% of catchment area) of BMUs and QE II convents within each catchment was also calculated. This highlights freshwater-terrestrial linkages
4. Readiness – short-term horizon metric ranks each landscape within the for 3 aspects: a) DOC readiness; b) Iwi Partner (mana whenua) readiness; c) Other Stakeholder readiness with greater value placed on formal structures/agreements in place to implement plans.
5. Opportunity – assessment of strategic opportunity to align with other initiatives.

## Methods for determining priority large-scale EMU and pest-led sites

Large-scale EMU candidate sites were found by sub-sampling from the existing highly 850 ranked EMUs. We used the EMU rank table, with the most recent reporting years (2018-2019) EI metrics joined (see list of projects in Appendix Table A3). Data are reported in DOCCM-6268797 (and see the "readme" tab for further explanation). Two extra fields were added:

1. The column "candidate" gives an indication as to whether the EMU might be regarded as a suitable site simply based on whether it ranks in the top850 or it was ranked in the top500 and has already seen good gains in EI (assessed in 2018 when rankings were prepared, using the "field estimate of difference made" value from prescriptions).

2. The column "reg_ord" provides an indication as to which sites would have the highest delta EI in each region. This is a crude means of achieving a geographic balance. If only the highest delta EI are considered, the top 10 sites would include 6 from southern South Island and none north of Lake Taupo. It is essential to consider regional spread this because these data indicate a strong likelihood that a regional 'flavour'/bias may be introduced from how comprehensive and/or optimistic ops teams have been writing their prescriptions about pressures that are tricky to manage (whether socially e.g., red deer or technically e.g., mice).

Pest-led management projects at large-scales were identified by consulting experts (see list of projects in Appendix Table A4). Many of the recommended candidate projects have been proposed in multiple forums, so there have been many discussions about the merit of the work. The pool of projects aims to achieve a range of pests and scales. All candidate projects will need feasibility studies to confirm the approach towards control, and this may include small field trials to test methods.

Importantly, the pool of projects selected here are those that best align with some key principles for setting priorities for pest-led management. Any large-scale pest-led projects should require an assessment against these principles.

The principles to guide prioritisation of pest-led work are:

**1. Impact avoidance:** The inverse of the extent to which the pest occupies its potential range. *Or* **Benefit area**: the area that will benefit from suppression.

**2. Suppression legacy**: the extent to which suppression/ eradication will endure. Strong preference for slow recovery, and lower ongoing costs.

**3. Assured access**: The extent to which the pest can be targeted on all land on which it is likely to occur.

**4. Impact severity:** The extent to which the pest is implicated in decline of indigenous species.

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# *Appendix 1: Landscape-scale, EMU and Pest-led opportunities*

Table A1: Recommended priority Landscape-scale (terrestrial) sites. Mean weighted area EI values. Sites are listed in rank order with highest ranked difference made by management in EI scores listed first.

| ProjectName | EI (NoMgmt) | EI (With Mgmt) | EI (Diff Made) | Catchment rank # | *Hectares* |
|---|---|---|---|---|---|
| Auckland Island/Maukahuka | 0.364 | 1 | **0.636** | * | 46,022 |
| Fiordland South | 0.36 | 0.773 | **0.413** | 0.07 | 152,440 |
| Taranaki Eastern Biodiversity Corridor | 0.324 | 0.731 | **0.408** | 0.53 | 450,142 |
| Coromandel Peninsula - Moehau to Karangahake | 0.251 | 0.656 | **0.404** | 0.52 | 256,388 |
| Pureora | 0.324 | 0.681 | **0.357** | 0.43 | 147,676 |
| The Chathams | 0.298 | 0.628 | **0.33** | * | 81,561 |
| Northland Kaitaia | 0.259 | 0.584 | **0.327** | 0.21 | 122,625 |
| Taranaki Mounga | 0.322 | 0.641 | **0.319** | 0.57 | 34,078 |
| Remutaka collaborative restoration | 0.444 | 0.760 | **0.316** | 0.39 | 44,087 |
| South Westland | 0.438 | 0.697 | **0.26** | 0.14 | 440,118 |
| Te Manahuna Aoraki | 0.416 | 0.645 | **0.229** | 0.16 | 305,795 |
| Te Hoiere Pelorus Landscape Restoration | 0.316 | 0.543 | **0.228** | 0.26 | 175,867 |
| Kahurangi o Mohua | 0.337 | 0.555 | **0.218** | 0.39 | 471,206 |
| Predator Free Rakiura | 0.372 | 0.551 | **0.178** | 0.08 | 173,400 |
| Waiau toa Molesworth | 0.323 | 0.475 | **0.152** | 0.43 | 357,212 |
| Aorangi Restoration Project | 0.330 | 0.431 | **0.101** | 0.55 | 30,297 |

# National catchment rank is a geospatial assessment of the importance of the landscape site at a catchment scale for biodiversity conservation. Values range from 0 to 1 and are the mean of all sub-catchment ranks within each site. Low scores identify sites that are higher priority for freshwater conservation, Note: sites below 0.1 have high EI and low threat* Sub-catchment ranking only available for NZ main islands.

Table A2: Recommended priority Landscape-scale (catchment) sites. The six sites with high readiness rankings are given in first part of the table.

| Landscape site (Priority river catchments) | Landscape site extent (ha) | Landscape connectivity (no. DOC BMUs) [% area] | QEII (no. covenants) | Readiness (DOC+Iwi Partner + Other Stakeholders) Highest score = 9 [A] | National priority (Zonation)[B] (low = higher priority) | Opportunities | Recommended for Landscape investment |
|---|---|---|---|---|---|---|---|
| READINESS RANKING > 5, then ranked from highest to lowest National Priority Zonation | | | | | | | |
| Arahura | 28654 | 4 (31) | 0 | 8 | 0.33 | Mana whenua strongly engaged. Headwaters Cultural Reserve; mana whenua nursery & replanting has commenced; fencing priority. | Yes |
| Rangitata | 182372 | 40 (59) | 2 | 7 | 0.36 | River Recovery Project, Ō Tū Wharekai, BRAID, BRAG, BRIDGE initiatives, signif. needs to improve DOC mgmt. of PCL re fencing & planting and align w Ngā Awa's positioning. Te Araroa in headwaters. Strong alignment with mana whenua and the Ngai Tahu settlement legislation | Yes |
| Hoteo (within Kaipara) | 35782 | 8 (7) | 24 | 5.5 | 0.38 | Sediment is the salient issue. Major trib in the Kaipara MfE Exemplar Catchment, AC priority site – needs terrestrial investment for traction on sediment issues. Living Water site influences the NE of the Kaipara. Dome Valley Waste Management Site R. Consent application affects headwaters w opportunities re mitigation, community interest. | Yes |
| Waipoua | 11163 | 4 (69) | 4 | 8.5 | 0.39 | Mana whenua leading. Reconnecting Northland (He Ripo Kau), Waipoua Forest Trust. Highly | Yes |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | | significant old growth forest remnants. Significant needs for terrestrial plant weed control in the lower catchment in regenerating forest - combine with cultural site preservation; upper catchment needs fencing PCL & dairy farming land, plus some land acquisition. | |
| Pelorus (Te Hoiere) | 89058 | 37 (35) | 0 | 9 | 0.40 | Kotahitanga mō Te Taiao Alliance (KTTA), MfE Exemplar Catchment. Protection and restoration of rare alluvial forest remnants -linking with riparian revegetation, pest control. KTTA encompasses the north of the Sth Is. (incl. 5 iwi, 6 councils) but initial focus is in the east @ Pelorus. Highly ranked terrest biodiv. Multiple Mana Whenua gps mobilised. | Yes |
| Waikanae | 15328 | 11 (26) | 18 | 7.5 | 0.49 | Strong community and volunteer input; signif. needs re Climate Change resilience. Strong Mountains to Sea opport. w Tararua Forest Park (headwaters), Waikanae Estuary Scientific Reserve, Kapiti Marine Reserve. Te Araroa trail. Upper catchment landowners promoting terrest. restoration. GWRC, KCDC engaged. Steering Gp formed for Nga Awa. | |
| **READINESS RANKING < 5, then ranked from highest to lowest National Priority Zonation** | | | | | | | |
| Awapoko - Doubtless Bay[C] | 37306 | 5 (7) | 15 | 4 | 0.24 | Regional Council, Fonterra, Priority River. Good community & regional readiness – needs terrestrial investment for traction on sediment issues. | |
| Waikawa | 20675 | 4 (11) | 9 | 3 | 0.30 | Needs to be iwi-led. North side of catchment inside Te Akau Tai Toka Place – ORC Conservation Management Strategy, lowland | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | | catchment needs management for terrestrial biodiversity. | |
| Taieri | 570842 | 147 (63) | 28 | 3 | 0.33 | Nationally & internationally significant Taieri scroll plain, 13 non-mig. galaxiid spp. Connects inland to i) Waipori-Waihola wetland complex (one o' largest remaining fw wetlands in NZ), ii) Te Papanui Conservation Park significant unique terrestrial landscape & biodiversity values throughout - ORC - Eastern Otago & Lowlands/Maukaatua Place identified for integrated conservation management. | |
| Mahurangi | 9727 | 4 (4) | 13 | 5 | 0.34 | AC priority site. Links to regional marine conservation efforts. Dome Valley Waste Management Site R. Consent application affects headwaters w Hochstetter's frogs – community interest, opportunities re mitigation, Signif. NZTA construction affecting forest remnants. | |
| Waihou | 27867 | 2 (45) | 14 | 3 | 0.39 | Reconnecting Northland (He Ripo Kau), Puketi Forest Trust, Te Araroa Trail – significant terrestrial needs in lowland area. | |
| Eglinton | 49343 | 13 (57) | | 3 | 0.39 | In Fiordland National Park & already subject to significant terrestrial management by DOC. Nga Awa will complement this work. | |
| Waitaki | 125512 | 39 (27) | 1 | 5 | 0.52 | River Recovery Project (headwaters), BRAID, BRAG, BRIDGE initiatives, lower Waitaki has signif. terrestrial biodiversity needs. Link to Te Manahuna Aoraki. | |
| Whanganui | 714807 | 53 (34) | 97 | 3 | 0.55 | Kia Wharite (DOC/Horizons) weed & animal pest control proj. plus whio & kiwi recovery over 80,000 ha. Add priority sub-catchments (e.g. | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | | Tangarakau = high value EMU, Mangapura stream, Heao, Ohau etc). Sign. opportunity for catchment-scale landscape programme (to cover tasks such as PCL fencing, private fencing, private predator control, predator free and regional scale pest fish and weed work) with Te Kopuka (catchment strategy group) under Te Awa Tupa Legislation. Whanganui National Park Plan. | |

Table A3: Recommended priority large-scale Ecosystem Management Units (EMU's). All of the top 850 EMUs are needed to meet the Ecosystem IO Objective, so any and all of these sites in this list are worthy additions to meet management objectives.

| Prescription ID | Prescription Name | Region | EI (diff made) | Regional order | Area (ha) |
|---|---|---|---|---|---|
| **300545** | Auckland Island group* | Operations Southern SI | 0.636 | 1 | 57103 |
| **300070** | Whanganui-Mangapurua | Operations Central NI | 0.458 | 1 | 20105 |
| **300003** | Moeraki* | Operations Western SI | 0.428 | 1 | 20926 |
| **300069** | Waitaanga Plateau | Operations Hauraki-Waikato-Taranaki | 0.421 | 1 | 14200 |
| **300192** | Waimana East** | Te Urewera | 0.373 | 1 | 12751 |
| **300270** | Omahuta-Puketi | Operations Northern NI | 0.363 | 1 | 16423 |
| **300139** | Northern Ruahine | Operations Lower NI | 0.357 | 1 | 10913 |
| **300335** | Arthurs Pass | Operations Eastern SI | 0.305 | 1 | 16799 |
| **300316** | Dun Mountain* | Operations Northern SI | 0.302 | 1 | 10919 |
| **300420** | Resolution Island* | Operations Southern SI | 0.485 | 2 | 21279 |
| **300476** | Waituna-Awarua Plains | Operations Southern SI | 0.452 | 3 | 16628 |
| **300557** | Arthur | Operations Southern SI | 0.45 | 4 | 21959 |
| **300556** | Clinton | Operations Southern SI | 0.447 | 5 | 15214 |
| **300071** | Matemateonga - Waitotara | Operations Central NI | 0.441 | 2 | 33808 |
| **300332** | Hohonu | Operations Western SI | 0.423 | 2 | 10644 |

* These sites are embedded mostly or fully in the Ecological Resilience Landscape-scale sites

**Subject to partnership discussion, the site is included because it has high ecological integrity

There are 850 EMU's that provide a coherent portfolio of a representative range of managed ecosystems in New Zealand. A total of 500 of those are currently activated. DOCCM-6258797 lists all of the management units available for future funding and ranks these by their gain in Ecological Integrity (EI diff made). Projects are then re-ranked based on regional representation (regional order) to provide an ordered list of opportunities to discuss further.

The table shows the top 15 of these sites, and any of these sites are valuable additions to help achieve the IOO 1.1 objective. Therefore, these 15 sites should be considered the best potential selection pool.

Further discussion with Operations in regions is needed to confirm the ability to activate management at any or all of these sites.

For simplicity, EMUs that are also embedded in larger Landscape-scale sites are still shown here – because there is merit in working on these if the wider Landscape-scale site is not progressed.

Table A4: Recommended priority large-scale Pest-led projects: A candidate pool of 18 large-scale Pest-led projects that meet the principles of impact avoidance, suppression legacy, assured access and impact severity. Any or all of these projects can be selected. Some projects fall within the boundaries of EMU or Landscape-scale projects, but the projects are retained here because there is merit in activating them, regardless of whether other pressures are managed at these places (i.e., they are likely to be locally eradicated). EI values are not calculated for these, because there is no agreed method about how to assign values for EI gain in sites beyond the current distributional range of the pest (to account to future impact).

| **Theme** | **Target pests, extent and objective** | **Notes** |
|---|---|---|
| Island mammal eradications | Kawau Island exotic mammal eradication | 20 Islands more than 1.5 km from mainland. Of these, the largest are Kawau (2032 ha), Ruapuke (1600 ha), Motiti (1000 ha). Ruapuke (Foveaux Strait) is c. 1600 ha. believed to have Mice and (ship?) rats. But note that the IEAG still considers IEAG Maukahuka the highest priority. |
| Island mammal eradications | Ruapuke Island exotic mammal eradication. | 20 Islands more than 1.5 km from mainland. Of these, the largest are Kawau (2032 ha), Ruapuke (1600 ha), Motiti (1000 ha). Ruapuke (Foveaux Strait) is c. 1600 ha. believed to have Mice and (ship?) rats. But note that the IEAG still considers IEAG Maukahuka the highest priority. |
| Island mammal eradications | Motiti island exotic mammal eradication. | 20 Islands more than 1.5 km from mainland. Of these, the largest are Kawau (2032 ha), Ruapuke (1600 ha), Motiti (1000 ha). Ruapuke (Foveaux Strait) is c. 1600 ha. believed to have Mice and (ship?) rats. But note that the IEAG still considers IEAG Maukahuka the highest priority. |
| Weeds | Mt Richmond Wilding Pine Suppression. | The national wilding pine programme has estimated control costs for most infestations. Due to a funding shortfall, only infestations that had high spread risk were prioritised. However, a number of infestations that were contained, still have ongoing large impacts on some rare ecosystems. Management of wilding pines over the Richmond Range would protect high value EMU (e.g. Red Hills) |
| Weeds | Te Manahuna Aoraki Wilding Pine Exclusion. | The national wilding pine programme has estimated control costs for most infestations. Due to a funding shortfall, only infestations that had high spread risk were prioritised. However, a number of infestations that were contained, still have ongoing large impacts on some rare ecosystems. Despite being the major weed threat, management of wilding pines has not been funded for the Te Manahuna Aoraki programme. |
| Weeds (freshwater) | Senegal tea (*Gymnocoronis spilanthoides*) eradication from NZ | Senegal tea (Gymnocoronis spilanthoides) is a significant weed in freshwater environments. There have been few successful eradications of naturalised plant taxa, but 4 of 5 successes are freshwater plants. Recent national analysis of Regional Pest Management Strategies has indicated that senegal tea is targeted for eradication in almost all regions it is known to occur in. So, the legal framework is in place but coordination and public awareness is required to detect and extirpate small infestations on private land. |

| | | |
|---|---|---|
| Weeds | South Island Madeira vine (*Anredera cordifolia*) and moth plant (*Araujia hortorum*) eradication. | Maderia vine (Anredera cordiifolia) and moth plant (Araujia hortorum) are both significant vine weeds of regenerating forest. They have widespread North Island distributions but are both restricted in the South Island. Recent National analysis of Regional Pest Management Strategies has indicated that these weeds are targeted for eradication in almost all regions where they are known to occur in. So, the legal framework is in place, but coordination and public awareness is required to detect and extirpate small infestations on private land. |
| Weeds | Rangtaiki frost-flat wilding pine supression. | The national wilding pine programme has estimated control costs for most infestations. Due to a funding shortfall, only infestations that had high spread risk were prioritised. However, a number of infestations that were contained, still have ongoing large impacts on some rare ecosystems. Management of wilding pines (especially Pinus contorta) on frost flats in the Bay of Plenty, would have enormous benefit, and support initiatives to transition production forestry to less spread-prone species. |
| Invertebrates | Te Paki Argentine ant exclusion. | Argentine ants are a major pest. Control and eradication has been successful on Islands, but there is a requirement to apply knowledge to mainland infestations. There is a great exemplar project outlined for Te Paki, but other mainland responses are also needed (i.e. infestations are increasing at the top of the South Island). |
| Invertebrates | Wasp wipeout expansion. | The wasp wipe-out has been a successful pest-led control programme targeting German and common wasps but is limited to about 1000 ha sites. There are opportunities to Expand wasp-wipeout by operationalising aerial delivery of long-life gel. Develop tools to forecast seasonal and Regional wasp hum. Expand existing ground tools to new areas and respond to new incursions (Chathams). |
| Wallabies | NZ eradication of pama, swamp and brush tailed rock wallaby. | 5 species of Wallaby have been established in NZ, but three species are currently confined to Kawau Island. By eradicating these species before they become pests on mainland, significant future costs would be avoided. Use existing tools (intensive night shooting) to eradicate 3 species of wallabies from NZ, prevent mainland populations, improve monitoring tools, and improve social licence. Reduction in dama (tammar) wallaby on Kawau would also likely occur. |
| Wallabies | Central North Island dama wallaby containment | Bennetts wallabies are established and expanding, ongoing control required to contain infestation to prevent establishment over entire South Island. |
| Wallabies | Central South Island bennetts wallaby containment | Dama wallabies are established and expanding, ongoing control required to contain infestation to prevent establishment over entire North island. |
| Herpetofauna | Plague skink containment. | Extirpations underway on Great Barrier and in the South Island. May need more resources. Plus, there are likely to be other incursions of exotic herpetofauna. |
| Ungulates | Coromandel Goat exclusion. | Should be considered alongside other goat control programmes. Peninsula is defendable and lack of other ungulates makes this project desirable. |

| | | |
|---|---|---|
| Weeds | Marram grass supression on Stewart Island Western beaches. | Marram (Ammophila arenaria) seed can last 20+ years in sand and current proposal only expands coverage to c. 60% of infestation. Eradication unlikely within 50 years. |
| Weeds (marine) | Chalky inlet Undaria | There is a new incursion of the invasive seaweed Undaria pinnatifida at Chalky inlet. Eradication is being attempted in collaboration with MPI and Environment Southland. In addition to control, technical development is ongoing to support incursions at Breaksea Sound and elsewhere. |

## Appendix 2: Assumptions used in determining landscape-scale site ecological integrity.

There are several assumptions in undertaking these analyses. Some of these come from base EMU data sources:

- EMUs with no pressures listed as requiring management were excluded and did not show within landscape-scale sites.
- If a pressure was not listed because it did not require expenditure, it was recorded as absent from the site, rather than being present (and potentially having an impact) and managed with no cost.
- That using maximum pressure scores fairly reflects likely gains in EI if those individual pressures are removed (e.g., there are no perverse effects such as meso-predator release)

And other assumptions were made by us in our analyses:

- That EI values calculated at EMU level can be applied to landscape scale by straight extrapolation based on same ecosystem type
- That pressure distributions match ecosystem-type distribution beyond EMU borders
- That weighted area mean EI values adequately reflect total gain in EI across the full landscape-scale site (i.e., that there is negligible risk of selection of lower value sites because medium level management impacts (and EI scores) over large areas dominate small areas of very high EI gains).

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