# National Predator Control Programme
# 4-Year Plan

## 2023 – 2027

## Executive summary

The National Predator Control Programme is the Department of Conservation's nationally coordinated, landscape scale predator control programme. It contributes to the implementation of the Aotearoa New Zealand Biodiversity Strategy and is a component of Predator Free 2050.

The goal of the programme is to help ensure a representative range of New Zealand native species and ecosystems remain in a healthy, functioning condition for future generations. This is achieved by controlling rats, stoats, and possums to protect the threatened species populations and ecosystems that are most vulnerable to these predators.

This plan gives an overview of the landscape scale predator control operations currently planned by the Department of Conservation across New Zealand over the next 4 years. The programme is owned by DOC's Deputy Director General National Operations. It is reviewed annually, in response to the outcomes of consultation, improving knowledge, emerging opportunities, beech mast events and the resource levels available for the programme.

The National Predator Control Programme (NPCP) is a building block towards the long-term goal of eradicating predators from New Zealand by 2050. The NPCP's role is to buy time, by using existing predator control tools to prevent the loss of threatened species that are most vulnerable to rat, stoat or possum predation, until new predator eradication methods are developed through Predator Free 2050. We assume a predator suppression programme will be need to be sustained for roughly 10-20 years, until we are ready to shift to large scale predator eradication.

Achieving this will require coordinated effort by regional councils, iwi partners, community groups, research agencies, and the wider pest control industry. One function of this plan is to improve our ability to cooperate with others. This overview of DOC's planned work is a basis for consultation, to improve coordination with other groups. It is expected that this plan will change through that consultation.

The other main purpose of this plan is to improve DOC's operational efficiency through better forward planning and coordination. This will be achieved by;

- Providing longer lead times and more certainty for staff managing predator control operations.
- Ensuring resources are targeted to the highest priority work.
- More efficient, coordinated procurement of predator control services and better liaison with the predator control industry.
- Improved staff skill development, knowledge transfer and risk management.
- Better coordination with other Biodiversity Strategy work streams, i.e. complimentary biodiversity protection, monitoring and research programmes.

This second 4-Year plan (2023-2027) follows the successful completion of the first 4-Year Plan (2018-2022). It combines the previously separate Tiakina Nga Manu and Save Our Iconic Kiwi programmes. It is funded through commitments made in Budgets 2022, 2018, and 2015.

## Aims

This plan supports the achievement of the following overarching goals and strategies;

- Te Mana o te Taiao, the Aotearoa New Zealand Biodiversity Strategy
- Predator Free 2050 (PF 2050) interim objectives.
- DOC's overarching threatened species and ecosystem management systems.
- Various species recovery plans, e.g. kiwi, orange fronted parakeets, whio, kokako, bats, frogs, etc.

## Goals and objectives

**The primary goal of DOC's National Predator Control Programme is to ensure sufficient populations of threatened species are protected until we achieve Predator Free Aotearoa New Zealand.**

Objectives

1. For each managed species, there are enough sites under sustained suppression of rats, stoats, or possums to ensure population resiliency and genetic variability.

**The secondary goal of DOC's National Predator Control Programme is to lead DOC's investment into collaboratively co-ordinated landscape scale operations for rats, stoats and possums.**

Objectives

2. Support the achievement of PF 2050 objectives, by supporting predator control research funded through PF 2050, and building DOC's capacity and capability to support groups undertaking predator control.
3. Increase DOC's engagement with the goals and values of tangata whenua: by assisting local engagement at major predator control sites.
4. Collaborate with other agencies undertaking landscape scale predator control (regional councils, OSPRI, Predator Free 2050 Ltd., non-governmental organisations, community groups, and research agencies).
5. Improve DOC predator control capability and efficacy.
6. Maintain effective relationships with New Zealand's predator control industry.

## Strategy

The main goal for DOC's National Predator Control Programme over the next 4 years is to maintain or improve the condition of nationally significant threatened species populations and ecosystems at risk from rats, stoats, or possums.

Our long-term strategy is to eradicate predators from the mainland of New Zealand by 2050. However, this will not be achieved in the medium-term due to the limitations of our current predator control technology. For this reason, repeated cycles of predator suppression will need to be sustained over the next decade or more. Our interim strategy is to deliver repeated cycles of control, to maintain a network of nationally significant sites in good condition, using currently available tools, to very high quality standards, which will provide the foundation for the eventual eradication of predators from New Zealand through PF 2050.

Our effort will be concentrated on the set of sites shown in the map below, titled "Proposed predator control sites 2023-2027".

This set of sites is based on DOC's overarching biodiversity priorities, the vulnerability of the species and ecosystems we are protecting from rats, stoats or possums, our ability to successfully control predators using existing tools, local community aspirations, synergies with other partners and agencies, and the resources currently available to the programme.

Work will also be directed towards the best opportunities to work in cooperation with others. Achieving Predator Free 2050 is dependent on a coordinated, national predator control effort. We will strengthen DOC's ability to cooperate with others in this work, by sharing an overview of DOC's planned predator control programme and seeking opportunities to work with others, where we share complimentary goals. This means retaining the flexibility to change the operations currently identified in this plan, in response to consultation and emerging opportunities.

Each year's work programme will be determined by the condition of the sites we are protecting. This means work will be driven by monitoring or modelling of threatened species and predator populations, based on a focussed monitoring programme, the results from past management, and predicted developments such as beech, rimu or tussock masting events.

All currently available predator control tools will be used. This means a combination of aerial 1080, ground laid toxins and traps. Specific methods will be chosen on a site by site basis, based on what predator control tactics will be most efficient and effective for local conditions.

The programme will also be used to refine and improve predator control methods. It is expected that considerable investment will be made to develop innovative new methods through PF 2050 funded research. The NPCP's role is not to lead this research, but to provide operational sites that can support the PF 2050 research programme. Rather than direct investment in new tools, our focus will be on field trialling techniques developed by others, and on refining current tools to make them as efficient as possible.

## Scope of work

DOC's National Predator Control Programme is responsible for delivering specific rat, stoat and possum control outputs, which were agreed and funded through targeted predator control allocations made through Budgets 2018, 2022, and 2015. More detail is provided in the initial 2018 Battle For Our Birds business case; DOC-5566056, and the subsequent Budget 2022 cost pressure bid; DOC-6843076.

The programme funds landscape scale predator control operations across all DOC regions through a centrally held pool. This is to ensure resources are directed towards the highest priority work, to achieve economies of scale, to ensure continuity of long-term investment at protected sites, and to better coordinate DOC's predator control programme with other agencies and partners.

The following areas of work are in scope;

- Allocation of nationally held funding for predator control operations that cannot be delivered through local resources.
- Monitoring of sites managed by the programme to identify predator control priorities and tactics as early as possible.
- Coordinated procurement of helicopter and pest control contractors, bait and traps.
- Technical advice and training to improve internal standards, capacity and capability.
- Coordinated communications and media support to communicate DOC's predator control work.
- Risk management advice and support for local operations.
- Identification of research opportunities and coordination with other agencies to improve predator control methods and knowledge.
- Liaison with regional councils, OSPRI and other groups wishing to support PF 2050 or other landscape scale predator control projects.
- Liaison with the Game Animal Council and NZDA at the national level.
- Internal coordination with other DOC workstreams involved in predator control and the implementation of the Aotearoa New Zealand Biodiversity Strategy.

The following areas of work are out of scope;

- Control of pests other than rodents, mustelids and possums to protect vulnerable threatened species populations and ecosystems.
- Predator control operations already funded through locally held resources.
- Small scale predator control operations, typically less than 500 hectares. This is to retain DOC's ability to sustain landscape scale predator control, and because localised predator control operations are addressed through other funding streams.

## Site selection and prioritisation

Predator control sites are selected based on DOC's ecosystem and species ranking criteria. A nationally coordinated process has been run, led by DOC's Biodiversity Group, to identify the best remaining examples of New Zealand's ecosystem types and threatened species populations, which are at high risk from rat, stoat, or possum predation.

From these, NPCP predator control sites are selected to protect a diverse set of ecological management units and Category A, B or C threatened species populations. These are constrained to sites that are highly vulnerable to rats, stoats or possums, and where existing tools can be effectively used to manage those threats.

Work is then scheduled according to urgency criteria. This is a combination of the vulnerability of the species being protected and predator numbers present at the site. The main criteria used are;

- Threatened species classification and ecosystem ranking.
- Current condition of the threatened species population or site.
- Predator abundance (from rodent, mustelid or possum monitoring).
- Recent history and effectiveness of predator control.
- Predicted increases in predator abundance (based on beech mast events, tussock seed set, podocarp fruiting, and predator population modelling).
- Feasibility of delivering effective control.

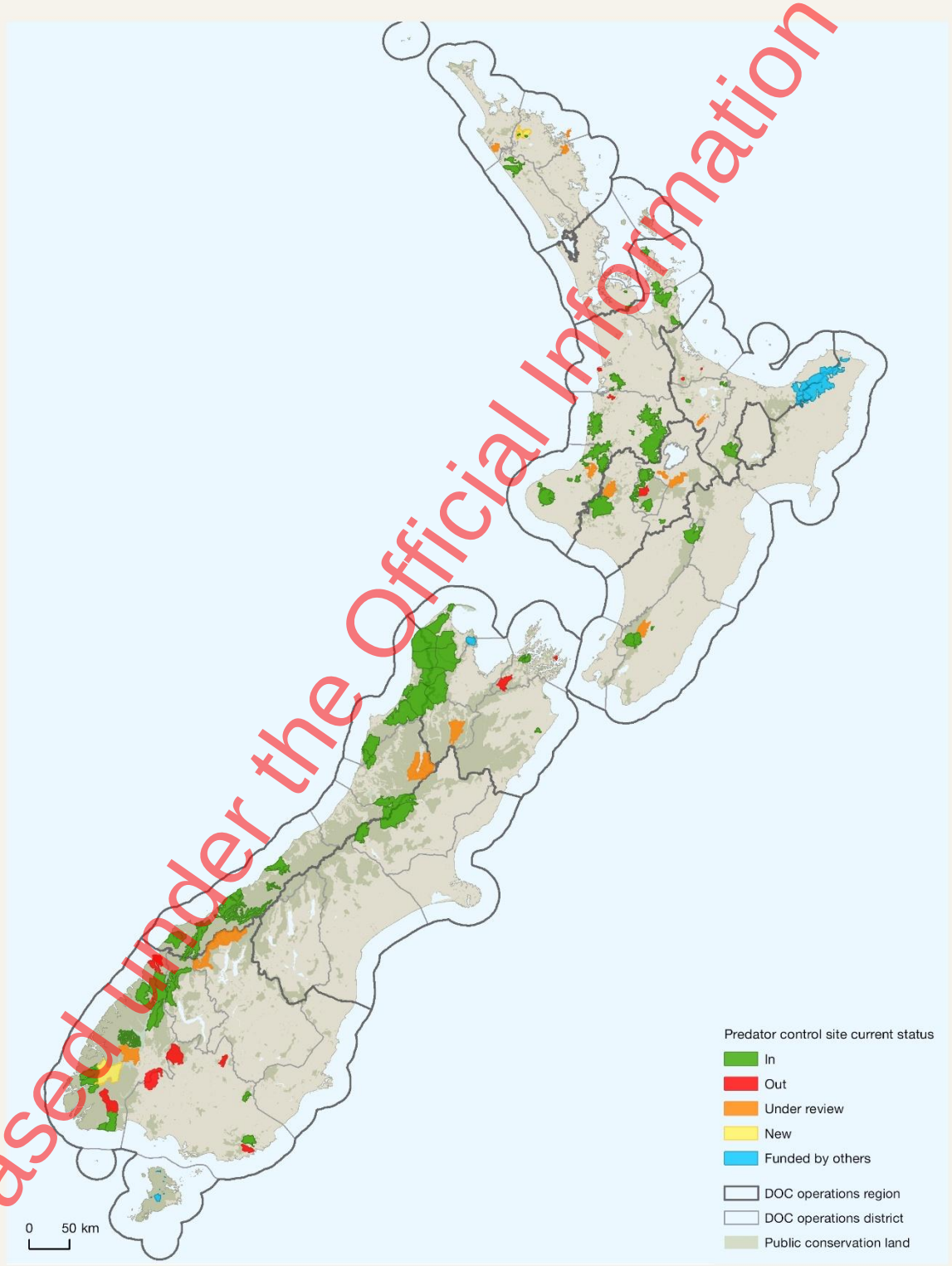
The prioritisation method is described in more detail in DOC-7218034. The list of sites considered for inclusion in the programme is recorded in DOC-7226791.

As a general principle, the priority is to maintain the sites that are already under effective, active management. This recognises the value of the investment already made over preceding years or decades to improve these sites.

There is very limited ability to expand into new sites. This reflects the growth that has already occurred in DOC's predator control programme, through the original Battle for our Birds and Save Our Iconic Kiwi campaigns, which saw the area of land under sustained predator control increase from roughly 770,000 hectares to about 2,000,000 hectares between 2015 and 2020.

DOC is now charged with maintaining the already expanded predator control area, and was funded to do this through a cost pressure funding bid approved through Budget 2022.

The decision to initiate work at a new site would probably mean a corresponding reduction at an existing site. The decision on that trade off will be made based on the criteria above, synergies from working in partnership with others, new knowledge, and DOC's overarching predator control strategy.




Department of Conservation
Te Papa Atawhai

National Predator Control Programme
Proposed predator control sites 2023-27

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New Zealand Government

## Decision making process

The table below sums up the decision making timeline and process used for resource allocation to achieve this plan.

| Approximate timing | Planning | Consultation | Decision makers |
|---|---|---|---|
| | NPCP team are responsible for planning, directed by Biodiversity Group priorities, and supported by Operations staff in regions. | Regional Operations Directors decide responsibility for consultation. | DDG NORS is the overall decision maker for the programme, delegated to the Director National Programmes as Senior Responsible Owner for the programme (NPCP SRO).<br><br>Regional Directors are the decision makers for operations occurring within their region. |
| **April - June** | Annual review of sites predicted to need predator control in the next 4 years.<br><br>Update 4 -Year Plan.<br><br>Update research and monitoring plans. | High level consultation with tangata whenua, community, philanthropic and commercial partners, GAC, NZDA and other key stakeholders. | Regional Directors consider proposed NPCP task assignments for their region;<br>NNI DOC-7136841<br>AK None.<br>HWT DOC-7141491<br>ENI DOC-7141492<br>CNI DOC-7141488<br>LNI DOC-7136816<br>NSI DOC-7124792<br>WSI DOC-7134741<br>ESI DOC-7124241<br>SSI DOC-6694838 |
| **June** | | | Regional Directors approve annual business plan and decide who will lead consultation in each region.<br><br>NPCP SRO approves updated national 4-Year and annual work programmes. |
| **June - December** | Coordinate proposed work programmes with OSPRI, Regional Councils, existing partners, and research agencies. | Site specific consultation with tangata whenua, community, philanthropic and commercial partners, | NPCP SRO approves establishment of contracts with major suppliers. |

| | | | |
|---|---|---|---|
| | | GAC, NZDA and other key stakeholders. | Regional Directors or NPCP SRO decide on DOC's response to major consultation issues.<br><br>Regional Directors or their Operations Managers decide which of their staff will be tasked to lead local operations. E.g. DOC-5487698 |
| **July-June** | Detailed planning and delivery of individual operations. | Detailed consultation with local stakeholders for each operation. | Regional Directors or NPCP SRO decide on DOC permissions for individual operations.<br><br>Operations Managers manage and support local staff tasked with delivery of individual operations. |
| **December - March** | Review of results, lessons learnt, recommendations for improvement. | Report back to partners and stakeholders on programme results and direction. | NPCP SRO approves annual reporting and system improvement work for the following year. |

## Recommended work programme

The work programme recommended over the next 4 years is outlined below, but refer to DOC-3097389 for the up to date version, which holds detailed information about every specific site. This work schedule is live; it is constantly updated and changes regularly.

The plan is based on the strategic direction from Te Mana o te Taiao and Predator Free 2050. Our goal is to protect as many highly threatened species populations as possible, based on DOC's threatened species and ecosystem priorities, using existing predator suppression tools, to buy time while predator eradication technology is developed.

Budget 2022 has set the output targets expected from the funding allocated to this programme. That is to protect roughly 1,800,000 hectares of land from predators, by controlling rats, stoats, and possums across on average 600,000 hectares of land each year.

The next phase of this programme is rationalisation and maintenance rather than growth. The addition of Budget 2022 funding will allow us to sustain predator control across roughly 1,800,000 hectares over the next 4 years, depending on whether another significant beech mast occurs in 2025. That is significantly less than the predator control area we currently have under protection. Consequently, we propose to withdraw from roughly 200,000 hectares of public conservation land now, primarily in SSI. These are the red areas shown in the map above.

Our recommended priorities have been developed through a nationally coordinated process, led by DOC's Biodiversity Group. We reviewed the biodiversity priority and long-term cost of management of all our current and proposed predator control sites, and developed a model to identifying the highest priority sites that can be afforded with current resources.

Predator control sites were ranked based on DOC's ecosystem and species ranking criteria. The starting point was to identify the best remaining examples of New Zealand's ecosystem types and threatened species populations. From these, NPCP predator control sites are selected to protect a diverse set of ecological management units and Category A, B or C threatened species populations. These are constrained to sites and species that are highly vulnerable to rats, stoats or possums, and where existing tools can be effectively used to manage those threats.

The long-term cost of management for each site has been estimated, based on the vulnerability of the species being protected, predicted predator trends over time (e.g. estimated frequency of masts), local site factors, and the knowledge gained from our history of management over the last 5-10 years.

This prioritisation method is described in more detail in DOC-7218034. The list of sites that was ranked by the programme is recorded in DOC-7226791.

Our prioritisation team s9(2)(g)(ii) [redacted], have developed a tool which has greatly assisted our ability to model different site prioritisation scenarios; https://docnewzealand.shinyapps.io/lp_shiny/.

This operational plan is expected to change. It will be updated regularly, in line with DOC's annual business planning cycle, as per the decision making timeline above. It provides a flexible planning framework that can be adapted in response to the outcomes of consultation, beech mast events, species and ecosystem condition, improvements in technology, changing resourcing levels and emerging partnership opportunities.

The detailed annual work programme is held at DOC-2921177 This list is live; it is constantly updated and changes regularly.

# Attachment 1: List of sites proposed for management 2023-2027

| Status | Rank | Region | District | Site | Operation | Method | Calendar 2023 | Calendar 2024 | Calendar 2025 | Calendar 2026 | Calendar 2027 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| In | 1 | NSI | Golden Bay | Kahurangi | Gouland | Air | | 2,700,000 | | | 2,700,000 |
| In | 1 | WSI | Buller | Kahurangi | Heaphy Lowland | Air | 1,257,000 | 1,257,000 | | 1,257,000 | |
| In | 2 | NNI | Kauri Coast | Waipoua | Waipoua-Mataraua | Air | | | 865,000 | | |
| In | 2 | NNI | Kauri Coast | Waipoua | Waima Forest | Air | | | 315,000 | | |
| In | 2 | NNI | Kauri Coast | Waipoua | Waipoua complex ground | Ground | 40,000 | 40,000 | 40,000 | 40,000 | 40,000 |
| In | 3 | WSI | Buller | Kahurangi | Mokihinui | Air | 2,066,000 | | | | 2,066,000 |
| In | 4 | WSI | Buller | Kahurangi | Oparara | Air | 2,180,000 | 2,290,000 | | | 2,290,000 |
| In | 5 | ENI | Whakatane | Whirinaki | Whirinaki | Air | | 1,000,000 | | | 1,000,000 |
| In | 6 | NSI | Golden Bay | Kahurangi | Wakamarama Burnett | Air | | | 1,200,000 | | |
| In | 7 | HWT | King Country | Pureora | Hauhangaroa | Air | | 3,400,000 | | | |
| In | 7 | HWT | King Country | Pureora | Waipapa ground | Ground | 80,000 | | 80,000 | 80,000 | |
| In | 8 | NSI | Golden Bay | Kahurangi | Parapara | Air | | 1,320,000 | | 1,320,000 | |
| In | 9 | CNI | Tongariro | Southern Ruapehu | Rangataua | Air | 550,000 | | | 550,000 | |
| In | 10 | ESI | North Canterbury | Arthurs Pass east | Arthurs Pass east | Air | | 750,000 | 2,500,000 | | |
| In | 10 | ESI | North Canterbury | Arthurs Pass east | OFP ground | Ground | 32,000 | 32,000 | 32,000 | 32,000 | 32,000 |
| In | 11 | HWT | King Country | Pureora | Rangitoto | Air | | | | | 1,100,000 |

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| In | 12 | NSI | Golden Bay | Kahurangi | Cobb | Air | | 2,200,000 | | 2,200,000 | |
| In | 13 | SSI | Te Anau | Eglinton | Eglinton | Air | | 974,000 | 974,000 | | 974,000 |
| In | 14 | WSI | Buller | Kahurangi | New Creek | Air | 2,017,000 | | | 2,017,000 | |
| In | 15 | WSI | South Westland | Landsborough | Landsborough | Air | | | 1,750,000 | | |
| In | 17 | SSI | Te Anau | Clinton | Clinton-Arthur-Cleddau | Air | | 2,000,000 | | | |
| In | 18 | SSI | Te Anau | Waitutu | Waitutu | Air | | 1,000,000 | | | |
| In | 19 | WSI | South Westland | Hope Cascade | Hope Cascade | Air | | | | 1,450,000 | |
| In | 20 | HWT | King Country | Whareorino | Whareorino & Moeatoa | Air | 1,078,000 | | | | |
| In | 20 | HWT | King Country | Whareorino | Whareorino frog block | Air | | | | 50,000 | |
| In | 21 | HWT | Whitianga | Papakai | Papakai | Air | | 525,000 | | | 525,000 |
| In | 22 | WSI | Buller | Punakaiki | Punakaiki | Air | | 1,650,000 | | | 1,650,000 |
| In | 23 | WSI | South Westland | Franz & Fox | Franz & Fox | Air | | | 1,060,000 | | |
| In | 24 | SSI | Murihiku | Catlins | Beresford Range | Air | 900,000 | | | 900,000 | |
| In | 25 | HWT | New Plymouth | Taranaki | Taranaki Mounga | Air | 1,200,000 | | | 1 | |
| Hold | 26 | WSI | Greymouth | Te Maruia | Te Maruia | Air | | 400,000 | | | 1,450,000 |
| In | 27 | WSI | North Canterbury | Arthurs Pass west | Arthurs Pass west/ Otira | Air | | | 1,700,000 | | |
| In | 28 | CNI | Tongariro | Tongariro | Tongariro ground | Ground | 45,000 | 45,000 | 45,000 | 45,000 | 45,000 |
| In | 28 | CNI | Tongariro | Tongariro | Tongariro Kiwi | Air | | | 690,000 | | |
| In | 29 | NSI | South Marlborough | Isolated Hill | Isolated Hill | Air | 222,000 | | | | |
| Hold | 30 | NSI | Nelson Lakes | St Arnaud | St Arnaud Range | Air | | | 900,000 | | |
| In | 31 | HWT | Whitianga | Moehau | Moehau | Air | | | 337,000 | | |
| In | 32 | SSI | Te Anau | Hollyford | Hollyford | Air | 1,760,000 | | | 1,760,000 | |

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|---|---|---|---|---|---|---|---|---|---|---|---|
| In | 33 | NNI | Bay of Islands | Puketi | Puketi kokako ground | Ground | | 75,000 | 75,000 | 75,000 | 75,000 |
| In | 33 | NNI | Bay of Islands | Puketi | Puketi-Omahuta ground | Ground | 80,000 | 60,000 | 60,000 | 60,000 | 60,000 |
| New | 33 | NNI | Bay of Islands | Puketi | Omahuta-Puketi | Air | | | | 1,460,000 | |
| In | 34 | SSI | Te Anau | Wet Jacket | Wet Jacket Pennisula | Air | 1,700,000 | | | 1,700,000 | |
| In | 36 | LNI | Manawatu | Northern Ruahine | Northern Ruahine | Air | 1,000,000 | | | 1,000,000 | |
| In | 37 | SSI | Wakatipu | Dart | Dart Ground | Ground | | 60,000 | 60,000 | | 60,000 |
| In | 37 | SSI | Wakatipu | Dart | Dart-Caples | Air | | 1,223,000 | | | |
| In | 38 | WSI | South Westland | Arawhata | Arawhata | Air | 2,160,000 | | | 2,160,000 | |
| In | 38 | WSI | South Westland | Haast Kiwi | Haast Kiwi | Ground | 262,000 | 262,000 | 262,000 | 262,000 | 262,000 |
| In | 39 | NSI | Sounds | Tennyson | Tennyson Inlet | Air | | | 470,000 | | |
| Out | 40 | NSI | Sounds | Pelorus | Lower Pelorus | Air | | | | | |
| In | 41 | NSI | Golden Bay | Kahurangi | Pakawau-Puponga | Air | | | 144,000 | | |
| In | 43 | NSI | Motueka | Kahurangi | Wangapeka | Air | | | 1,850,000 | | |
| Hold | 44 | CNI | Turangi | Kaimanawa | Kaimanawa - Umukarikari | Air | | | | | 900,000 |
| In | 45 | WSI | Buller | Kahurangi | Kakapo | Air | | 1,330,000 | | 1,330,000 | |
| In | 46 | WSI | South Westland | Abbey Rocks | Abbey Rocks | Air | | | 1,800,000 | | |
| In | 47 | CNI | Whanganui | Whanganui | Matemateonga - Waitotara | Air | | | | 900,000 | |
| Hold | 48 | SSI | Te Anau | Kepler | Kepler | Air | | | | | 1,200,000 |
| New | 49 | SSI | Te Anau | Seaforth-Grebbe | Seaforth-Grebbe | Air | | 2,400,000 | | | 2,400,000 |
| In | 50 | HWT | New Plymouth | Waitaanga | Waitaanga Plateau | Air | | 747,000 | | | 747,000 |

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|---|---|---|---|---|---|---|---|---|---|---|---|
| In | 51 | HWT | Hauraki | Otahu | Otahu Ecological Area | Air | | | 336,000 | | |
| In | 52 | SSI | Te Anau | Murchison | Murchison Mountains | Ground | 100,000 | 100,000 | 100,000 | 100,000 | 100,000 |
| Hold | 53 | CNI | Turangi | Pihanga | Pihanga-Kakaramea | Air | | | 550,000 | | |
| In | 54 | CNI | Tongariro | Erua | Erua wetlands | Air | | | | 519,000 | |
| In | 55 | HWT | King Country | Mapara | Mapara ground | Ground | 50,000 | | | 50,000 | |
| In | 55 | HWT | King Country | Mapara | Mapara | Air | | | 164,000 | | |
| Hold | 56 | SSI | Te Anau | Depth Peak | Depth Peak | Air | | | | | 2,400,000 |
| In | 57 | ESI | North Canterbury | Wilberforce | Wilberforce | Air | | | 930,000 | | |
| In | 58 | ENI | Rotorua | Mokaihaha | Mokaihaha | Air | | 133,000 | | | 140,000 |
| Hold | 59 | ENI | Rotorua | Te Kopia | Te Kopia | Air | | | | | 245,000 |
| In | 60 | HWT | New Plymouth | Hutiwai | Hutiwai Stream | Air | | 894,000 | | | 894,000 |
| Hold | 61 | SSI | Central Otago | Makarora | Makaroa-Wilkin | Air | | 1,000,000 | | | |
| In | 62 | HWT | New Plymouth | Parininihi | Parininihi | Air | 84,000 | | | 84,000 | |
| In | 63 | WSI | South Westland | Haast | Haast TL | Air | | | 450,000 | | |
| In | 64 | ENI | Rotorua | Rotoehu | Rotoehu | Air | 125,000 | | | 125,000 | |
| In | 65 | SSI | Murihiku | Blue Mountains | Blue Mountains Mohua | Air | | | 330,000 | | |
| In | 67 | WSI | South Westland | Copland | Copland | Air | | | | 900,000 | |
| In | 72 | WSI | Greymouth | Roaring Meg | Roaring Meg | Air | | 550,000 | | | 550,000 |
| Hold | 73 | CNI | Whanganui | Whanganui | Whanganui-Mangapurua | Air | | 900,000 | | | |
| In | 74 | HWT | Waikato | Pirongia | Pirongia & Te Kauri Park | Air | | | 740,000 | | 740,000 |
| In | 75 | HWT | Hauraki | Whenuakite | Whenuakite | Air | 120,000 | | | | 120,000 |

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|---|---|---|---|---|---|---|---|---|---|---|---|
| In | 76 | HWT | Hauraki | Southern Forests | Hauraki - Southern Forests | Air | | 950,000 | | | |
| In | 77 | LNI | Wairarapa | Project Kaka | Project Kaka | Air | | | 1,200,000 | | 1,200,000 |
| In | 79 | HWT | New Plymouth | Pouiatoa | Pouiatoa | Air | 348,000 | | | 348,000 | |
| In | 80 | CNI | Tongariro | Hihitahi | Hihitahi | Air | | 150,000 | | | |
| Hold | 81 | LNI | Wairarapa | Project Kaka | Ruamahanga | Air | | | | | 800,000 |
| Hold | 86 | SSI | Central Otago | Matukituki | West Matukituki | Air | | | | | 400,000 |
| Out | 87 | SSI | Murihiku | Catlins | MacLennan Range | Air | | | | | |
| Hold | 90 | NNI | Kaitaia | Warawara | Warawara | Air | | 671,000 | | | |
| In | 91 | LNI | Wairarapa | Pukaha Mt Bruce | Pukaha Mt Bruce | Air | | 120,000 | | | 120,000 |
| Hold | 92 | HWT | New Plymouth | Moki - Makino | Moki - Makino | Air | | | 500,000 | | |
| In | 94 | AKL | Tāmaki Makaurau | Hunua | Mangatawhiri-Vinings | Air | | | | | 50,000 |
| In | 95 | AKL | Tāmaki Makaurau | Hunua | Mataitai Forest | Air | | | | | 50,000 |
| Out | 97 | SSI | Murihiku | Waikaia | Waikaia beech forests | Air | | | | | |
| Hold | 98 | NNI | Bay of Islands | Russell Forest | Russell & Cape Brett | Air | | | | | 600,000 |
| Out | 100 | HWT | King Country | Hauturu-Awaroa | Hauturu-Awaroa | Air | | | | | |
| Out | 100 | HWT | Waikato | Karioi | Karioi | Air | | | | | |
| Out | 100 | NSI | Sounds | Ship Cove | Ship Cove | Air | | | | | |
| Out | 100 | SSI | Murihiku | Eyre Mountains | Eyre Mountains | Air | | | | | |
| Out | 100 | SSI | Te Anau | Hollyford | Lower Hollyford | Air | | | | | |

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|---|---|---|---|---|---|---|---|---|---|---|---|
| Out | 100 | SSI | Rakiura | Mount Anglem | Mount Anglem | Ground | | | | | |
| Out | 100 | SSI | Rakiura | Port Pegasus | Port Pegasus | Ground | | | | | |
| Out | 100 | SSI | Te Anau | Waitutu | Princess Range | Air | | | | | |
| Out | 100 | SSI | Rakiura | Rakeahua | Rakeahua | Ground | | | | | |
| Out | 100 | SSI | Murihiku | Takitimu | Takitimu Mountains | Air | | | | | |
| Out | 100 | ENI | Tauranga | Otawa | Otawa ground | Ground | | | | | |
| Out | 100 | SSI | Rakiura | Stewart Island Dotterel | Stewart Island Dotterel | Ground | | | | | |
| | | | | | | **Total** | **19,456,000** | **33,208,000** | **22,509,000** | **22,774,001** | **27,985,000** |

# Animal pest management in DOC

*This document provides an overview of DOCs animal pest management system to help Operations Managers understand the requirements of their role and what resources are available to them and their staff.*

## Contents

# 1. Introduction

Management of animal pests is carried out by DOC, external agencies and individuals (e.g., OSPRI NZ, community groups, possum hunters).

Operations Managers have roles in making decisions during the operational planning process for DOC operations. They are also involved in, and sometimes are the deciding manager for the legal permission required for DOC and external agencies to conduct this work on land managed or administered by the department. This document provides an overview of the system to help Operations Managers understand the requirements of their role and what resources are available to them and their staff.

The key responsibilities of an Operations Manager include:

- Assigning staff to fulfill the required roles
- Deciding on consultation requirements for DOC operations
- Signing off on variations to standards and exemptions
- Approving completed operational reports
- Making decisions about applications for permissions to use pesticides or traps
- Managing approved permissions

These are described in more detail in the following sections.

### *Outline of this document*

- Section 2 provides information on what is required for pest control operations that are led by DOC.
- Section 3 provides some context around externally led operations. DOC is usually not involved in the planning of operations run by external agencies but may have a varying degree of involvement in community-led conservation projects.
- Section 4 covers the permission process that applies to DOC-led and external operations.
- Section 5 covers the requirements of the DOCgis Pesticides Application and how this links to the publicly available Pesticides Summaries.
- Section 6 provides suggestions and links of where to go for more information and advice.

# 2. DOC-led pest operations

This section outlines key information about pest operations that are led by DOC. This includes operations where DOC engages contractors for the planning or delivery work and those that involve volunteers.

## 2.1. Planning a pest operation

All DOC pest control operations must be planned by following the Operational planning for animal pest operations SOP docdm-1488532. This includes for example goat control, possum control, trials involving the killing of pests, pest control for biodiversity outcomes or to comply with Regional Pest Management Strategies. It was not designed for pest control in and around recreation facilities although legal obligations associated with this type of work are often the same.

This SOP provides operational planners with a step-by-step process (known as the Animal Pest Framework) to support effective planning of animal pest operations. Each step has links to the resources available for staff to use to achieve the deliverable for that step.

Standards are presented in a clear table format within the step that they apply to. The standards meet requirements under various legislation, including the:

- Hazardous Substances and New Organisms Act 1996
- Health and Safety at Work (Hazardous Substances) Regulations 2017
- Agricultural Compounds and Veterinary Medicines Act 1997
- Resource Management Act 1991

The operational planner is the person tasked with delivering the operation and is accountable for meeting the requirements of the SOP. If they wish to vary a requirement, they must get authorisation to do so from the Operations Manager or higher. The manager authorising the variation is accountable for that decision and must document it.

Some operations are delivered by contractors. The role of operational planner then becomes one of site lead and contractor management. If contractors are involved in planning operations for DOC, contract schedules will need to specify clearly what aspects of the SOP are to be done by contractor and what by the site lead.

A 4-day Animal Pest Operational Planning course that covers every step of the Operational Planning for Animal Pest Operations SOP is available to staff. It shows participants how to apply the framework and templates to real projects. It includes short assessments on key steps in the framework. At the end of the training, participants will demonstrate competence in planning a pest operation following the SOP.

It is important to realise that operational planning is not a 'paint by numbers' process. Project management skills, knowledge of ecological principles, local site and community knowledge, and adequate resourcing (including people) are all essential for successfully planning and delivering a pest operation. The animal pest management SOPs are part of a bigger picture of DOC procedures and systems, for example, local engagement plans, procurement requirements, and staff and workload management through proper task assignment and the MOR system.

## 2.2. Using vertebrate pesticides in DOC

Vertebrate pesticides (also referred to as vertebrate toxic agents or VTAs) are used for some animal pest control operations. Vertebrate pesticides are also hazardous substances. DOC systems apply standards and the legislative requirements relevant to our work to make it easier for staff to interpret what they must do to comply.

Prior to handling vertebrate pesticides, it is a requirement of the Health and Safety at Work legislation that staff must have been provided with adequate training, information, and supervision. In addition, users of certain vertebrate pesticides (e.g., 1080, cyanide) must hold a legally required certification. The Vertebrate Pesticides Control Methods course is targeted to field staff involved in controlling animal pests using vertebrate pesticides. The course covers three control methods and a wide range of vertebrate pesticide products commonly used by DOC, reinforcing best practice and providing practical hands-on skills. It also covers the correct use of personal protective equipment. This course is also recommended for staff planning control operations.

The Health and Safety Management Systems (HSMS) Manual and the Management of hazardous substances SOP DOC-6052105 provide the overarching requirements for hazardous substance management in DOC. The Safe Handling of Pesticides SOP docdm-22730 provides the requirements specific to using, storing or transporting vertebrate pesticides.

## 2.3. Operations Manager roles

Other than the normal line accountabilities such as task assignment, Operations Managers have specific roles within the operational planning process for DOC-led pest operations. These are outlined below, with the relevant SOP step provided in the blue box where more information and context is available.

### *Deciding on the level of consultation required for the operation*

The Operations Manager is accountable for deciding what level of consultation will take place and for recording this decision and the reasoning in the communication plan for the operation. There are 3 possible outcomes:

- Consultation on the possible control methods and (later) the effects of the proposed control methods
- Consultation on the effects of the operation
- No consultation (notification only, as this is always required)

This decision is based on knowledge of local communities and issues, and DOCs responsibilities under Section 4 of the Conservation Act.


Preparing phase Step 8 of the Operational Planning for Animal Pest Operations SOP docdm-1488532

### *Assigning key roles to suitable staff members*

Other than the operational planner, there are other key roles in planning animal pest operations which need to be assigned to a suitable staff member. If you do not have staff with the capacity or capability required for these roles, you will need to work with other managers within your region (or beyond) to fill the roles. You should also give urgent attention to upskilling more staff through training and mentorship where appropriate.

To help understand the nature of the work and the skills required, the various roles are explained in the document Key roles in animal pests operational planning docdm-1562274.

The roles are:

#### a) Peer reviewer

All DOC pest operations must have an operational plan that is peer reviewed by someone who is not involved in planning the operation. The purpose of this is to support the operational planner with independent comments and questions early in the process when there is still flexibility for significant improvements if necessary.


Planning phase Step 4 of the Operational Planning for Animal Pest Operations SOP docdm-1488532

#### b) Readiness checker

After the necessary permissions have been obtained and prior to the field work starting, managers can request a readiness check be completed for the operation. The purpose of this check is to increase confidence that everything is ready for the operational phase through an independent review. The person tasked with this check can be the same person who carried out the peer review.


Pre-operational phase Step 7 of the Operational Planning for Animal Pest Operations SOP docdm-1488532

*Post-operational reporting*

An operational report must be completed for all DOC pest operations. Reports are completed in an MS Word template and details are added to a master spreadsheet. Reports completed prior to 1 March 2024 are in the Pestlink database. The Operations Manager reviews the report and any advice supplied prior to approving the operational report by changing the status of the report to 'final'. The Operations Manager identifies actions he or she will take to ensure lessons learned and recommendations are followed up.

Operational reports for aerial 1080 operations must be verified by the Operations Manager within 5 months of when bait was first applied. Failure to meet this standard may result in the Department breaching a legal control under the HSNO Act.


Reporting phase Step 1 of the Operational Planning for Animal Pest Operations SOP docdm-1488532

*Ensuring your staff are adequately trained*

Animal pest management is complex, and staff need to be adequately knowledgeable and experienced to successfully fulfill their roles.

There are several training courses available to staff. These range from short online introductory courses and videos for staff new to animal pest management to 4-day in person courses for staff planning aerial baiting operations. See the intranet page Training courses for animal pest management for further information about the courses available.

If there is not a training course that meets your staff development needs, assist staff with seeking mentorship opportunities within or beyond your region.

## 3. Pest operations by external agencies

DOC is not usually involved in planning operations run by external agencies or their contractors (e.g., OSPRI NZ, possum hunters) and the Operational planning for animal pest operations SOP docdm-1488532 does not apply to them. DOC has varying degrees of involvement in operations run by community groups, and the DOC SOPs may be applied but be aware that these are written for DOC operations so so while legal requirements remain, not every DOC standard will be applicable.

Where a community group or individual is proposing to lead a pest management project on land managed or administered by DOC, the requirements of the Community-led conservation SOP DOC-2752810 must be applied. This includes drawing up a community agreement which clearly defines the working relationship with DOC in relation to health and safety legislation and assigns a relationships manager for the work. Community groups must be made aware that a community agreement can authorize the use of traps accepted on the trap status list DOC-5620413, it does not grant them legal permission required to use vertebrate pesticides on land managed or administered by DOC and that there is a separate process that needs to be followed.

## 4. DOC permission to use pesticides or traps

Permission is required to lay pesticides on land managed or administered by DOC. This is a legal requirement under various acts including the Hazardous Substances and New Organisms Act 1996 and applies to both DOC and externally led operations.

Permission is also required for external operators wanting to lay traps on land managed or administered by DOC. For community groups the permission to use traps can be covered in a community agreement following the Community-led conservation SOP DOC-2752810.

The process and standards for assessing and deciding on permissions is in the Processing applications for vertebrate pesticides and trapping SOP docdm-1490584. This SOP forms the basis for the Instrument of Delegation from the Environmental Protection Authority (EPA) to DOC managers, under which DOC managers decide on permissions under the Hazardous Substances and New Organisms Act 1996. The EPA audits DOC's performance under the Instrument of Delegation. Following this SOP will ensure that decisions made on applications to use pesticides and traps on land managed by DOC are transparent and meet legal and policy requirements.

### 4.1. Pesticide use permissions

DOC permission to use pesticides in ground-based operations are processed by the local office. For most pesticide uses the Operations Manager is the minimum level of approval. Applications for DOC permission for aerial operations are processed through PP&L and Director is the minimum level of approval. Operations Managers and Directors have specific roles within the DOC permission process, including managing permissions after they have been issued.

#### *Assigning an assessor to the operation*

Every application for permission to lay pesticides on land managed or administered by DOC must have an assessor assigned to it. The assessor supports the approving manager in ensuring all DOC permissions have acceptable risk management. The assessor role for ground-based operations is assigned by the operations Manager.

Assessors must meet the requirements stated in the document Key roles in animal pests operational planning docdm-1562274. This includes the need to be independent, so they cannot have been involved in the planning of the operation, and for DOC operations they need to be from a different DOC office or division to meet the standards to manage conflict of interest. This means that the local Operations Manager will need to work with managers from other offices within their region to achieve this. Assessors for National Predator Control Programme (NPCP) operations are assigned though the NPCP team.

The knowledge and skills required to be an assessor for a particular operation largely overlap with those required to competently plan such an operation. This includes knowledge of the relevant method and pest as well as the resources used, e.g., the Pesticide Information Reviews. Following the steps in the Processing applications for vertebrate pesticides and trapping SOP docdm-1490584 is crucial, and the SOP coordinator can be contacted for any clarification on the process.


Section 3 of the Processing applications for vertebrate pesticides and trapping SOP docdm-1490584

### *Deciding on application requirements*

Prior to applying for DOC permission, an applicant will require certain information from DOC. This includes whether they need to complete an assessment of environmental effects (AEE) for their application. For some pesticides uses, an AEE will be required as a national standard but for others it is the approving manager's discretion as to whether one is required. The assessor assigned to the application will be able to advise the manager accordingly.

If the approving manager has identified specific groups that must be consulted, this should also be communicated to the applicant.


Section 3 of the Processing applications for vertebrate pesticides and trapping SOP docdm-1490584

### *Deciding on permissions*

The assessor will provide the approving manager with an assessment report and recommendation. The approving manager makes the decision on whether to approve the permission. This includes considering if the proposed operation meets the purpose and principles of the relevant legislation and if it is in accordance with the applicable management plans and policies.

The manager's decision can differ from the assessor's recommendation (e.g., to approve or decline, operational timing, warning sign locations). The differences and reasons must be recorded in the Application assessment report.

Prior to deciding on an application for permission, managers must ensure that they have the delegated authority for all the legislation under which the permission is being considered. If not, they may need to elevate the decision.


Section 4.2 (ground based) or 5.2 (aerial) of the Processing applications for vertebrate pesticides and trapping SOP docdm-1490584

### *Managing approved permissions*

Permission holders are obliged to supply reports or information during and after operations, in line with the conditions imposed on the permission. This includes:

- Providing 24-hour notice
- Notifying extensions to caution periods
- Notifying conclusion of caution period and warning sign removal
- Providing trial or monitoring reports

For DOC operations the operational planner is responsible for keeping the approving manager informed and completing the required system actions.

For external operations, the permission holders must provide the necessary information to the approving manager who may need to assign systems actions to one of their staff (e.g., updating the information in the DOCgis Pesticides App – see section 5 below).

Operations Managers should consider tasking someone within the local office to take an active role in managing the permissions granted to external groups. A visual control board could be a useful tool for keeping track of the status of all permissions within an office.

*Auditing permissions*

The purpose of auditing is to advise on compliance and enable corrective action and learning. Both DOC and external operations are audited for compliance with the conditions of the DOC permission.

The process and requirements for auditing vertebrate pesticide permissions issued by DOC is in the Processing applications for vertebrate pesticides and trapping SOP docdm-1490584. It is a condition of the delegation that DOC holds from the EPA to audit at least 10% of pesticide permissions issued. Any operation that was issued for a period longer than 1 year must be audited each year that it remains valid.

The Biodiversity Planner for each region selects which permissions are to be audited and notifies the Operations Managers. Each affected manager assigns the task of carrying out the audit to someone who meets the standards as stated in the document Key roles in animal pests operational planning docdm-1562274. The auditor confirms the scope of the audit with the manager, carries out the audit, and provides a written report to the EPA, Operations Manager, and Bio Planner.


Section 8 of the Processing applications for vertebrate pesticides and trapping SOP docdm-1490584

## 5. DOCgis Pesticides App

All DOC pesticide operations and all external pesticide operations on land managed or administered by DOC must be entered into the DOCgis Pesticide App.

The DOCgis Pesticide App exports data directly to DOC Pesticide Summary which is published on the DOC website and updated daily. The purpose of the DOC Pesticide Summary is to:

- Comply with Ministry for Primary Industries (MPI) requirements, so that the document can be used by certified suppliers to verify that wild animals presented to primary processors have been taken from outside of poisoned areas or their associated buffer zones
- Adequately inform interested parties about pesticide operations on lands administered by DOC

If the Pesticide Summary information is incorrect or incomplete the public may not be adequately notified of the presence of pesticides on public conservation land. This could result in the harvesting of contaminated meat for human consumption which has potential for serious consequences. Information that is obviously out of date undermines the public perception of the Pesticide Summary being a trustworthy source of information.

For DOC operations the actions that need to be taken in the DOCgis Pesticides App to ensure that the Pesticides Summary is correct are mostly the responsibility of the operational planner.

For external operations the assessor is responsible for entering the information prior to permission being granted. After the permission has been issued, receiving the required information, and ensuring that the information in the DOCgis Pesticides App is updated is the responsibility of the manager that approved the permission, although they are likely to assign the task to one of their staff.

For all operations (DOC and external) the Regional Pesticides Summary Coordinator is responsible for updating the DOCgis Pesticides App to show that DOC permission has been approved.

The DOCgis Pesticides App sends automated emails to operational planners and Regional Pesticides Summary Coordinators each week listing the status of operations within the system. Regional Directors and Planning & Performance Managers also receive automated email but only for aerial applications.


Section 3 of the Pesticides Summary SOP DOC-2895328

## 6. More information

This document has provided a high-level outline of the requirements. If you have any questions, you can:

- Review the relevant SOP
- Talk to experienced staff within your local office or region
- Contact the relevant SOP coordinator
- Contact a Threats Technical or Science Advisor (see Who's Who in Animal Pests docdm-98043)

### 6.1. Useful links

Threats (Pest management) - DOC Intranet

Community-led conservation SOP DOC-2752810

Key roles in animal pests operational planning docdm-1562274

Management of hazardous substances SOP DOC-6052105

Operational planning for animal pest operations SOP docdm-1488532

Pesticides summary SOP DOC-2895328

Processing applications for vertebrate pesticides and trapping SOP docdm-1490584

Safe handling of pesticides SOP docdm-22730

Training courses for animal pest management - DOC Intranet

Who's who in animal pests docdm-98043

SOP

# Operational planning for animal pest operations SOP

## Contents

# 1. What you need to know

## 1.1. Purpose and scope

The purpose of this SOP is to explain the procedures and standards for planning and managing operations to control or eradicate animal pests by using vertebrate pesticides, broad scale application of insecticides, traps, and hunting. It applies to work (on or off Public Conservation Land) that is led and managed by DOC, whether undertaken by DOC staff, DOC volunteers or contractors to DOC.

This SOP does not apply to:

- Incursion responses on islands when following the Obtaining DOC permission for rodenticide use in island incursions SOP DOC-2751605
- Use of pesticides for rodent or insect control in and around huts, buildings and nurseries
- Use of insecticides where the purpose is not for biodiversity or biosecurity protection (e.g., to manage recreation values)
- Destruction of individual wasp nests or individual ant nests

This supports effective planning of animal pest operations for conservation. Proper planning helps to achieve the project's desired conservation outcomes. This document is intended to ensure that the activity is performed consistently, safely and to meet legislation.

## 1.2. Accountabilities

Managers are accountable for assigning the roles in Section 1.3 to suitable staff members. Once assigned the task by their manager, the staff member is accountable for meeting the standards contained in this SOP.

Managers, or higher levels of management, are authorised to approve variations from the SOP requirements and are accountable for those decisions. They are required to use their professional judgement and to seek advice, or to escalate when in doubt. All decisions should be documented. It is expected that variations from requirements in this SOP will be the exception rather than the norm, and that legal (i.e. legislation and judge-made laws) and health and safety requirements are compulsory. Common sense should prevail in the case of exceptional or emergency field situations.

Please note: the consequences of non-compliance with, and variations from, the SOP requirements are possible legal non-compliance.

The standards meet requirements under various legislation, including the:

- Hazardous Substances and New Organisms Act 1996
- Health and Safety at Work (Hazardous Substances) Regulations 2017
- Agricultural Compounds and Veterinary Medicines Act 1997
- Resource Management Act 1991

## 1.3. Prerequisites

**Operational planners** must have successfully completed the Animal Pests Operational Planning course or be experienced in operational planning of animal pest operations using this SOP. It is recommended that operational planners have experience or knowledge of the relevant method and pest.

**Site leads** for aerial 1080 operations must have successfully completed the Aerial Baiting for Landscape Predator Control Course. The site lead is the person with decision making authority over field operations on the day(s) of aerial baiting. It can be the operational planner, or could be the Incident Controller, or the Air operations manager (the latter two are roles defined in National Predator Control Programme operational plans).

**Peer reviewers** must have successfully completed the Animal Pests Operational Planning course or be experienced in operational planning of animal pest operations. They must have experience or knowledge of the relevant method and pest. They must not have been involved in planning the operation.

**Readiness checkers** must have successfully completed the Animal Pests Operational Planning course or be experienced in operational planning of animal pest operations. They must have experience or knowledge of the relevant method and pest. They must not have been involved in planning the operation. They can be the same person who completed the peer review.

## 1.4. Glossary

Key terms are defined within the relevant sections. Refer to Animal Pests SOP Definitions and FAQs docDM-51708 for a complete definition list.

# 2. Getting started

## 2.1. How this all works

DOC animal pest operations are planned and managed by following the process set out in this SOP. This SOP process is known as the Animal Pest Framework. The start point is that a site and outcomes have been identified for management, and the process consists of the following six phases:

- Preparing phase
- Planning phase
- Pre-operational phase
- Operational phase
- Post-operational phase
- Reporting phase

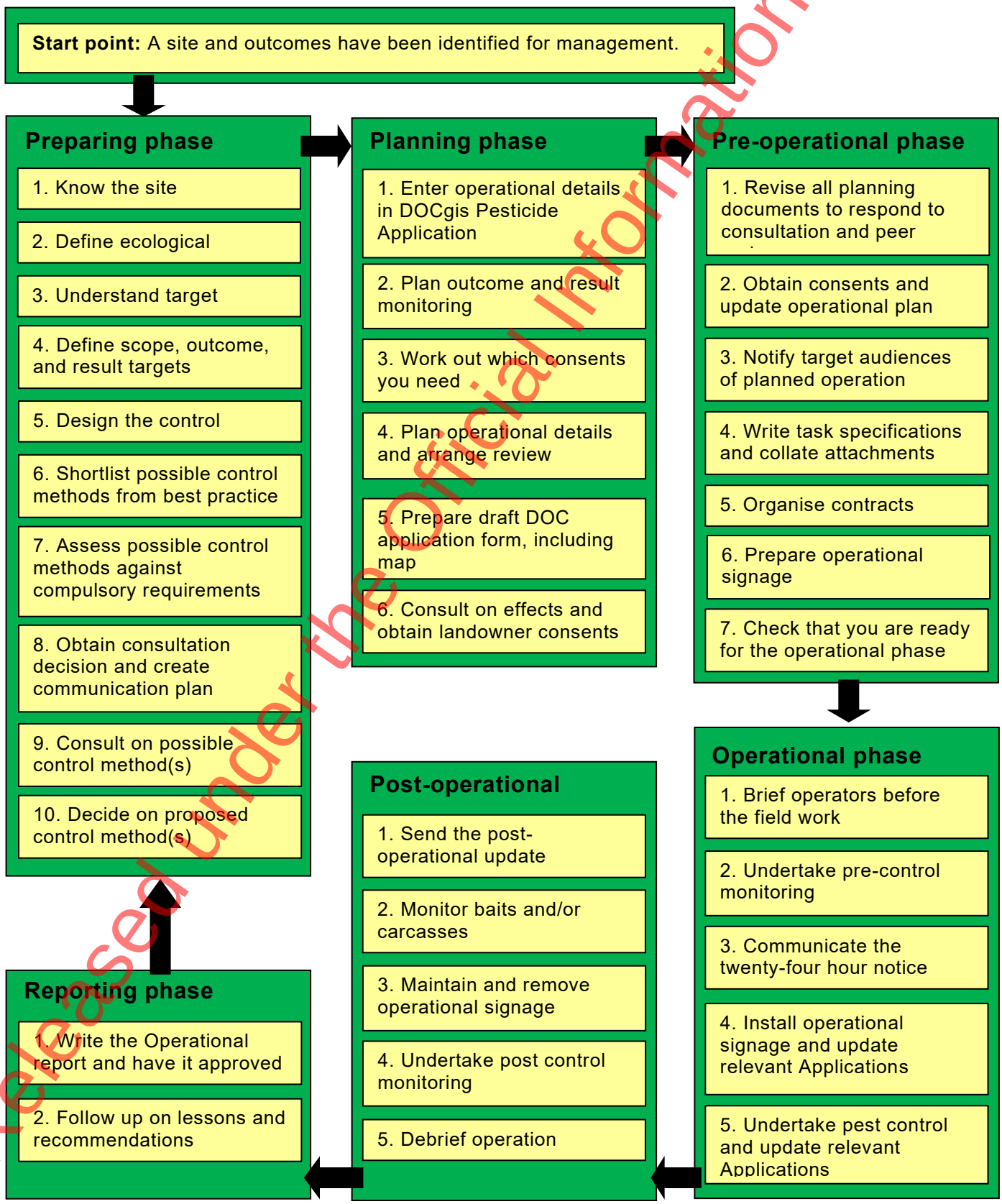
Each phase has several steps. Some steps do not apply to all animal pest operations (e.g., some steps only apply where proposed methods include pesticides) and this is stated at the start of each step. The process is not strictly linear and, in some cases, all the steps in a phase may not be complete before some of the steps in the next phase need to be started.

Standards are stated within the steps of the Animal Pests Framework. These standards must be met for DOC animal pest operations and form the basis for operational readiness checks and audits. A list of all standards from this SOP can be found on the Compliance register template docDM-1475273.

Some steps do not have standards. These steps are recommended for DOC animal pest operations but are not compulsory. In lieu of standards, these steps include points to check that the step has been completed fully.

Standards/requirements of other SOPs and systems (e.g. the Health and Safety Management Systems Manual) are not repeated in this SOP.

The diagram below shows the phases and steps of the Animal Pest Framework.



## 2.2. Who needs to use this and what your responsibilities are

**Operations Manager**

- Assigns roles to staff meeting the requirements in Section 1.3
- Decides what level of consultation will take place and records this in the communication plan in Preparing phase Step 8
- Reviews and approves the operational report in Reporting phase Step 1

**Operational planner**

- Plans, manages and reports on a pest operation, meeting all applicable standards in this SOP.
- Where tasks are contracted out, the contractors are responsible for meeting the applicable standards as included in the contract. The operational planner manages the contract to ensure this happens.

**Peer reviewer**

- Supports the operational planner with independent comments and questions early in the process, when there is still flexibility for significant changes if necessary.
- Provides a written independent review of the operational plan in Planning phase Step 4 before consents are obtained.

**Readiness checker**

- Increases confidence that everything is ready for the Operational phase through an independent review of the operational plan and associated documents in Pre-operational phase Step 7 to identify non-compliance, gaps, and risks.
- Works with the operational planner to develop a plan to remedy the priority issues before the operation goes ahead.

**Senior Planning Advisor, National Operations**

- Follows Reporting phase Step 1 to submit aerial 1080 operational reports to the EPA.

# 3. The Animal Pest Framework

## 3.1. Preparing phase

The Preparing phase is the starting point of the Animal Pest Framework. You have identified a site and outcomes for management.

The Preparing phase has the following steps:

- Step 1: Know the site
- Step 2: Define the ecological problem
- Step 3: Understand the target pest(s)
- Step 4: Define scope, outcome, and result targets
- Step 5: Design the control
- Step 6: Shortlist possible control method(s) from best practice
- Step 7: Assess possible control methods against compulsory requirements
- Step 8: Obtain consultation decision and create communication plan
- Step 9: Consult on possible control method(s)
- Step 10: Decide on proposed control method(s)

Work through the steps to make key decisions about what you are going to do. Steps 1 to 3 are where you gather the information needed to make these decisions. Steps 4 and 5 are where you make these decisions that determine the whole direction of the project.

For National Programmes the deliverables for some of these steps may be provided/proposed through programme-level plans, 'prescriptions', or other guidance. The operational planner should review this against the process and check points for each step. The operational planner is still responsible for meeting any standards for each step.

For eradication operations, scoping informs the first 4 steps within this phase but should have be undertaken well before the start point of this framework. The feasibility assessment informs elements of all steps in this phase.

At the end of the Preparing phase, you will have a proposed pest control method.

### 3.1.1. Preparing phase step 1: Know the site

This step applies to all operations. You can expect it to take 1 – 5 days to complete.

The objectives of this step are:

- To understand all the background information about the site that influences management decisions and make it available to those reviewing the plan.
- To begin your operational plan, where you will record control design, logistics, and project management details.

## Process

**Step 1:** Write down what you know about the site and gather information sources. This includes:

- Conservation values
- Threats (including pest density)
- Issues
- Other management

**Step 2:** Read and make notes for the site description. Identify any gaps to fill.

**Step 3:** Visit the site and talk to people.

**Step 4:** Create an operational plan and complete the site description. The level of detail for your site description should match the size, complexity, and public interest in your operation.

**Step 5:** Consider creating a Project Homepage for the operation, where you can list and hyperlink to all documents related to the project. Documents created during the operational planning process that are in hardcopy form should be scanned into the document management system, with links recorded in the relevant planning document.

**Deliverable:** Your operational plan with the site description completed.

## Standards

1. It is compulsory to have an operational plan for all DOC animal pest control operations. All vertebrate pesticide operations must use the best practice operational plan template as a minimum. Other operations may use another format.
2. Site-led operations for animal pest control are grouped into one operational plan only if all treatment blocks:
    a. Are adjacent (i.e., are at the same location); and/or
    b. Have the same control method(s) across all blocks (even if they are at different locations

    Pest-led operations can be included in one operational plan for a single Region.
3. The operational plan is written to:
    a. Cover the information required by the prompts in the template
    b. Be specific and factual
    c. Align with definitions
    d. Use concise plain English
4. The operational plan includes a site description that covers values, threats, issues and other management at the site.

## Resources

- Your operational plan, created using the appropriate template or one of the examples:
    1. Best practice operational plan template docDM-1475373
    2. WAM hunting operational plan template DOC-7723431
    3. Best practice operational plan aerial 1080 example DOC-5488902
    4. Best practice operational plan bait stations example DOC-5916783
    5. Best practice operational plan DOC200 stoat trapping example DOC-5949271
    6. WAM goat hunting operational plan example DOC-5918086
- Eradication operational planning documents:
    1. Overview of planning pest eradications DOC-7711995
    2. Eradication scoping report template DOC-7756009
    3. Feasibility assessment template DOC-7110779
    4. Project Management Plan template DOC-7754931
    5. Operational design and logistics template DOC-7756004
    6. Task breakdown example spreadsheet DOC-7878965
- Project Homepage: NPCP example DOC-5492427
- Project Homepage: WAM example DOC-7723708
- Visit the site yourself
- Bioweb for inventory data (logon access required)
- The Conservation management strategy applicable to your operation
- Monitoring or survey reports
- People who have lived, worked or hunted in the area
- Historical accounts of the area
- Maps (topographical, geological, vegetation, soil)
- Information management and library (for publications or films relating to the site)
- Pestlink reports (logon access required), previous operational reports DOC-7194322 or office file on management history and past recommendations
- Previous operational plans
- Information on sites and outcomes
- Definitions:
    1. Pest-led operations: In pest-led operations, the aim is to eradicate incursions or prevent the spread of a single target pest.
    2. Site-led operations: Pest operation to protect the natural values of a priority area from the impacts of animal pest species.
    3. Treatment area: The area that will receive pest control. For pesticides this is the area for which permission (DOC and Public Health) is sought or held. This is the area entered into the DOCgis Pesticides Application and used for public notification. Treatment area boundary has a corresponding meaning.

4. Treatment block: A subset of a treatment area. A treatment area is broken down into treatment blocks when blocks are physically separated or when different management methods are applied. Treatment block boundary has a corresponding meaning

### 3.1.2. Preparing phase step 2: Define the ecological problem

This step applies to all operations. You can expect it to take less than 1 hour to complete.

The objective of this step is to develop a complete picture of the problem (i.e., all the pressures on the biodiversity assets you want to protect and how they interact) to give a reality check on the outcome for the project.

#### Process

**Step 1:** Look at the outcomes agreed for this site at the start point.

**Step 2:** Identify the conservation values (from Preparing phase step 1) that you want to protect.

**Step 3:** Identify the biodiversity threats to those conservation values.

**Step 4:** Draw the connections in a simple food web.

**Step 5:** Summarise this in an ecological problem statement.

**Deliverable:** Food web and ecological problem statement.

#### Checkpoints

You will have completed this step when:

- You know what you are trying to achieve (biodiversity or otherwise).
- You have a food web that shows:
  1. The biodiversity conservation values you want to protect.
  2. The biodiversity threats affecting the conservation values at the site.

#### Resources

- Involve DOC science and technical advisors (e.g., from Who's Who in Animal Pests docDM-98043)
- Relevant threatened species recovery plans
- The Conservation management strategy applicable to your operation
- Information management and library for relevant publications (e.g., Ramsay and Veltman 2005, Tompkins and Veltman 2006, Sinclair and Byrom 2006)
- Ecological problem statement examples docDM-1552765

### 3.1.3. Preparing phase step 3: Understand the target pest(s)

This step applies to all operations. You can expect it to take 2 hours to 2 days to complete.

The objective of this step is to understand the strengths, weaknesses, and basic ecology of the target pest(s) to design effective control methods.

#### Process

**Step 1**: Find reference information for each target pest species.

**Step 2:** Read and consider the information. Be cautious of information that is out of date or not relevant to your site (e.g., different threats or management history).

**Step 3:** Gain a better understanding of the breeding and behavioural factors that will affect your project.

**Deliverable:** Notes on the ecology of your target pest(s).

#### Checkpoints

You will have completed this step when:

- You understand the strengths and weaknesses of the target pest(s).
- You have notes on the ecology of your target pest(s).
- You have related the information you gathered to the population of the target pest at your site.

#### Resources

- The Handbook of New Zealand Mammals 3rd edition, editors CM King and DM Forsyth (2021)
- Pestlink reports (logon access required) and previous operational reports DOC-7194322 for past attempts to control this pest at your site or other sites
- Section 3 of the Current agreed best practice document for your target pest
- New Zealand Freshwater Fishes, A Natural History and Guide, by M R McDowall (1990)
- Argentine ants in New Zealand https://argentineants.landcareresearch.co.nz/index.asp
- PF2050 Practical guide to trapping https://www.doc.govt.nz/globalassets/documents/conservation/threats-and-impacts/pf2050/trapping-guide-pf2050.pdf
- Pest detective https://web.archive.org/web/20220121175632/http://pestdetective.org.nz/
- Information management and library for other publications
- Talk to specialists, scientists and others with experience of managing this pest (e.g., from Who's Who in Animal Pests docDM-98043)

### 3.1.4. Preparing phase step 4: Define scope, outcome, and result targets

This step applies to all operations. You can expect it to take less than 1 hour to complete.

The objective of this step is to determine which biodiversity threats identified in Preparing phase step 2 this project will influence. This will help you identify the target pest(s) and set outcome and results targets.

#### Process

**Step 1:** Look at the players in your food web.

**Step 2:** Identify which interactions are critical to your outcome. Decide on the long-term timeframe for achieving the outcome.

**Step 3:** Decide the scope (i.e., which pests will be managed by **this** project). Identify exclusions and linkages to other work.

**Step 4:** Define the logical outcome target to measure. Outcome targets state the measure of success for the natural heritage asset you are managing in a measurable form in a specified period.

**Step 5:** Define the result target needed to achieve this. Result targets state the measure of pest abundance (or reduction) you want to achieve, in a measurable form in a specified period.

**Deliverable:** Scope and targets completed in your operational plan.

#### Standards

1. The operational plan states which pests will be managed and includes the scope, outcome target and result target for this operation.

#### Resources

- Your operational plan
- Your food web from Preparing phase step 2
- Writing SMART targets docDM-340202
- Information management and library for publications on pest density/native response relationships
- Inventory and Monitoring Toolbox https://www.doc.govt.nz/our-work/biodiversity-inventory-and-monitoring/
- Relevant threatened species recovery plans
- Past operational and monitoring reports
- Talk with specialists, scientists and others with experience of managing these assets

### 3.1.5. Preparing phase step 5: Design the control

This step applies to all operations. You can expect it to take 1 – 2 days to complete.

The objective of this step is to plan the timing, scale, and frequency of control to meet your outcome target. This step focuses on the big picture of achieving the outcome, potentially over several operations.

#### Process

**Step 1:** Gather information from previous steps:

- Preparing phase step 1: Current pest density
- Preparing phase step 2: Vulnerability of biodiversity conservation value to target pest
- Preparing phase step 3: Ecology of target pest
- Preparing phase step 4: Outcome and result targets

**Step 2:** Design the control:

- How big? (scale of control needed)
- When? (time of year)
- How often? (planned frequency of control into the future)

**Step 3:** Review the scale and frequency needed to achieve the outcome target, compared to what is specified in your business plan. If this is much larger or more frequent than stated, discuss it with your manager.

**Deliverable:** Control design completed in your operational plan.

#### Standards

The following table contains the standards that must be followed for this step.

1. The operational plan includes a control design which:
    a. Describes the scale of control needed
    b. Identifies the time of year control would have most effect
    c. Predicts the planned frequency of control into the future to achieve and sustain the outcome

#### Resources

- Your operational plan
- The information from work already done in previous steps of the Preparing phase, i.e.:
    1. Site description (in your operational plan)
    2. Food web and ecological problem statement
    3. Notes on the ecology of your target pest(s)
    4. Scope and targets (in your operational plan)

- Information management and library for relevant publications
- Talk with specialists, scientists and others with experience of managing this pest (e.g. from Who's Who in Animal Pests docDM-98043)

### 3.1.6. Preparing phase step 6: Shortlist possible control method(s) from best practice

This step applies to all operations. You can expect it to take less than 1 hour to complete.

The objective of this step is to shortlist control methods that are technically viable for the outcome and result targets set for the site. Community views and other constraints will be considered in later steps to identify the proposed control method(s).

#### Process

**Step 1:** Select your target pest(s) from the list of documents in "Current Agreed Best Practice for Animal Pest Control". For pests not covered by the Current Agreed Best Practice review previous operational reports, consult other publications, and talk with specialists and others with experience managing this pest

**Step 2:** Review the information about various control methods (Section 4 "Choose Your Control Method" of the best practice document) to decide which are technically viable. Consider past control methods used at this site.

**Step 3:** Select possible control methods.

**Deliverable:** Shortlist of possible control methods.

#### Checkpoints

You will have completed this step when:

- You have eliminated control methods that are not suited to:
  1. Your site
  2. Your ecological problem
  3. Your outcome and result targets
  4. The scale and timing of the operation

#### Resources

- Current agreed best practice for animal pest control
- Pestlink reports (logon access required) and previous operational reports DOC-7194322
- Pest management history from Preparing phase step 1
- DOC Pesticide Information Reviews docDM-25413

### 3.1.7. Preparing phase step 7: Assess possible control methods against compulsory requirements

This step applies to all operations. You can expect it to take less than 1 hour to complete.

The objective of this step is to shortlist methods by eliminating any that are not accepted for DOC use or for which you cannot meet compulsory standards.

#### Process

**Step 1:** Identify the policies and SOPs relevant to your shortlisted control methods (e.g., Firearms SOP, Management of Hazardous Substances SOP, Electric Fishing SOP).

**Step 2:** Review the relevant procedures and standards to see if there are requirements you cannot meet. Eliminate those methods from your shortlist.

**Step 3:** If your proposed methods include pesticides, check the Status List to find out if the pesticide use(s) you are considering are accepted for use. Refer to the Status List user guide for information on how to use this resource.

Each accepted pesticide use has a DOC Performance Standard sheet that contains DOC and legal requirements that apply. Review the DOC Performance Standards sheets for the proposed pesticide use(s) to ensure you can meet all compulsory aspects (e.g., product label requirements, qualification requirements, compulsory performance standards and information needs).

**Step 4:** If your proposed methods include traps, use the Trap Status List to find out if the trap system(s) you are considering are accepted for use. Refer to the Status List user guide for information on how to use this resource.

Each accepted trap system has a DOC Performance Standard sheet that contains DOC and legal requirements that apply. Review the DOC Performance Standards sheets for the proposed trap system(s) to ensure you can meet all compulsory aspects (e.g., consistency with the defined trap system, compulsory performance standards and information needs).

**Deliverable:** Shortlist of control methods.

#### Standards

The following standards must be followed for pesticide or traps:

1. Accepted pesticide uses are proposed for operations.
2. Accepted trap systems are proposed for operations (unless the operation or trap use is outside of the scope of the Trap Status List).
3. Operations using pesticide uses or trap systems with compulsory information needs are designed to provide the required information.

#### Resources

- Policies, Standard Operating Procedures and Guidelines intranet page
- Wild Animals Management programme intranet page
- Animal pest management resources intranet page

- Status List docDM-22655
- Trap Status List DOC-5620413
- Status List user guide docDM-95853
- DOC Performance standards sheets (linked from the Status List)
- Target pests for aerially applied 1080 pellets DOC-2649524
- Field Trials for Pest Operations SOP docDM-51573
- Inventory and Monitoring toolbox https://www.doc.govt.nz/our-work/biodiversity-inventory-and-monitoring/
- Definitions:
    1. Pesticide use refers to a specific technique involving one pesticide, its toxic loading, bait type, and application method. For example, aerial application of cereal pellets containing 1.5 g/kg 1080; 8g/kg cholecalciferol hard paste in bait bags
    2. Trap system refers to a specific technique involving one trap type/model and how it is set (this includes additional equipment such as covers). For example DOC 200 in tunnel, double or single set; No.1 double coil spring leghold unpadded, ground set/raised set.

### 3.1.8. Preparing phase step 8: Obtain consultation decision and create communication plan

This step applies to all operations. You can expect it to take 1 – 2 days to complete.

The objective of this step is to make a clear decision about the level of consultation. This is the start of the communication plan for your operation.

#### Process

**Step 1:** Obtain a consultation decision from the Operations Manager. The Operations Manager is accountable for deciding the level of consultation and recording this decision and reasoning in the communication plan. There are three possible outcomes:

- Consultation on the possible control methods and (later) the effects of the proposed control methods.
- Consultation on the effects of the operation.
- No consultation (notification only, as this is always required).

Consultation is compulsory if your operation includes any of the target audiences or methods specified in the standards for this step.

**Step 2:** Create a communication plan for your operation, using the best practice Communication Plan template or another format that meets the standards.

**Deliverable:** Consultation decision recorded in the communication plan.

## Standards

1. The Operations Manager decides what level of consultation (i.e., no consultation, consultation on effects only, or consultation on possible control methods) will take place and records this decision and the reasoning in the communication plan.
2. Consultation on effects with iwi and/or hapū is compulsory for aerial 1080 operations and recommended for other techniques.
3. It is compulsory to consult on effects with all occupiers and (as far as practicable) owners of land included in and adjacent to the proposed treatment area and loading site(s).
4. It is compulsory to consult on effects with all grazing licence holders.
5. For operations using rotenone under the Resource Management (Exemption) Regulations 2017, it is compulsory to consult on effects with the relevant Fish and Game Council.
6. The communication plan identifies:
    a. The decision on consultation
    b. The objectives for consultation and notification
    c. The background to the operation (why it is being done)
    d. The issues (people and communication related) and key messages
    e. A list of communication tools or resources that will be used
    f. Who will be consulted
    g. Who will be notified, including those legally required and stipulated in consents
    h. The purpose of consulting or notifying each target audience
    i. Landowner and occupier consent conditions
    j. Landowner and occupier reference to link to their location on the permission map
    k. Who is responsible and target dates for completion
    l. What method(s) will be used to notify or consult each target audience
7. The communication plan is written before consultation begins.
8. The communication plan is maintained as consultation and notification progress.

## Resources

- Communication plan template user guide docDM-1108789
- Communication plan template docDM-22868
- Communication plan – complex/new operation example docDM-22869
- Communication plan – simple/maintenance operation example docDM-22870
- Consultation Policy olddm-780975

- Consultation Guidelines olddm-780974
- The community engagement plan for your office
- Definitions:
    1. Consultation involves a willingness to adapt the proposed operation as a consequence of the information gained from consultation. According to DOC's Consultation Policy olddm-780974: 'Consultation is a stage in the decision-making process where DOC seeks community and tangata whenua views on issues and proposals. The DOC keeps an open mind about the final decision it might make and makes its final decision after consultation has been completed.'
    2. Notification is informing local community, stakeholders, visitors and users about DOC pest operations and pest operations on lands managed by DOC.
    3. Consultation on possible control methods means that your control method is not yet fixed, i.e. 'This is the issue with possum impacts we're having at this site and here are the technically viable options for possum control we've identified. What are your views on these methods?'
    4. Consultation on effects means that your control method has been decided and is not open for discussion. Open for discussion are the concerns people have about the operation and how modifications to the operational plan may satisfy these concerns.
- Pestlink reports (logon access required) and previous operational reports DOC-7194322 for pest operations affecting the same community
- Understanding the RMA for animal pest operations docDM-96158
- Past communications plans for the same community
- Seek community relations/partnerships advice
- Tiakina Ngā Manu Engagement and Communications 4-year Strategy 2020-2024 DOC-6315626
- NPCP Guide to engaging with our Treaty Partner and communities at place DOC-6290966

## 3.1.9. Preparing phase step 9: Consult on possible control method(s)

This step applies if the decision made in Preparing phase step 8 was to consult on methods. You can expect it to take weeks to months to complete.

The objective of this step is to seek community and tangata whenua views on the possible control methods to be used in the operation. DOC keeps an open mind about the final decision and makes its final decision after consultation is completed.

### Process

**Step 1:** Consult with your target audiences using the consultation tools identified in the communication plan and meeting the standards. Compulsory target audiences for consultation are given in Preparing phase step 8.

**Step 2:** Record the outcomes of consultation by noting all phone calls and visits in the communication plan, including those for people with whom direct contact could not be made. Note the times, dates, full names, and what was said.

It is important to record not just whether a person or group supports the proposed operation, but how they think the proposed operation will impact them and the environment.

It is necessary to understand the relationship of Māori and their culture and traditions with their ancestral lands, water, sites, wāhi tapu, valued flora and fauna, and other taonga. It is therefore important to record (where relevant information is provided):

- Whether the operation likely to impact on the productivity and life-sustaining quantity and quality of traditional Māori food resources (mahinga kai), New Zealand's indigenous flora and fauna, other flora and fauna valued by Māori, water, land, air, natural habitats and ecosystems and other natural resources valued by Māori.
- Whether the operation is likely to impact the protection and enhancement of people, native or valued flora and fauna, land, waterways, air, traditional Māori values and practices, and the Māori knowledge system and world view.
- Whether the operation likely to impact on the ongoing capacity and capability of Māori to develop economically; and on the ongoing participation of Māori in the generation of economic benefit, and the burden of economic cost.
- Whether the operation is likely to impact the ongoing management by Māori of their cultural and natural resources, Ongoing rights of Māori to develop culturally, socially, spiritually and physically; the implementation of the Treaty principles, and land.

**Deliverable:** Communication record completed for consultation on possible methods.

## Standards

1. Visits or phone calls are used where landowner/occupier consent is being sought.
2. A Consultation fact sheet covering the following information about the proposed operation is given to all target audiences, or the information is communicated to them in other ways:
    a. Location and size of proposed treatment area
    b. Why control is needed at that site (covering values, pest problem, and intended conservation outcome)
    c. Past monitoring information demonstrating the benefits of pest control (if available for that site/species)
    d. Purpose of the consultation and any parameters that are fixed, including seeking to understand how the target audience considers the proposed operation could affect them, the indigenous flora and fauna and other natural resources, their ability to protect and manage and use those resources, and how it could impact their wellbeing
    e. Opportunities for consultation
    f. Likely timeframe of the proposed operation

g. Details of the permissions required and the consultation/notification process

h. The job title and organisation of the person responsible for the operation, and the address and phone number of their office. If these are details of a contractor, also include details of the local DOC office.

i. A map of the proposed treatment area that clearly shows the boundaries. Include districts, roads and other commonly known features that may identify the place

3. A record is kept of all phone calls and visits in the communication plan, including those for people with whom direct contact could not be made.

4. The outcomes of consultation are recorded in the communication plan.

### Resources

- Your communication plan
- Consultation fact sheet template docDM-22872
- Consultation fact sheet example docDM-22874
- NPCP Guide to engaging with our Treaty Partner and communities at place DOC-6290966
- NPCP resources for engagement and communication DOC-5998295
- WAMP resources for engagement and communication DOC-7624668
- Wilson and Cannon (2005) Community consultation processes for aerial 1080 applications Science for Conservation No 247 https://www.doc.govt.nz/globalassets/documents/science-and-technical/sfc247.pdf
- Seek community relations advice

## 3.1.10. Preparing phase step 10: Decide on proposed control method(s)

This step applies to all operations. You can expect it to take 1 – 2 days to complete.

The objective of this step is to make a clear decision about which control method(s) will be used to achieve the outcome targets. This decision marks the end of the preparing phase.

### Process

**Step 1:** Look at the shortlists of possible control methods from Preparing phase steps 6 and 7.

**Step 2:** Review consultation outcomes from Preparing phase step 9, if completed.

**Step 3:** Review past control methods used at this site. If using pesticides, check the DOC Pesticide Information Review for relevant information (e.g., efficacy differences between similar products) and seek advice from technical specialists if necessary.

**Step 4:** Decide on the proposed control methods and enter them into your operational plan.

**Deliverable:** Proposed control methods entered in your operational plan.

### Checkpoints

You will have completed this step when:

- You have decided on the proposed control method(s) for the site and entered them into your operational plan.

### Resources

- Your operational plan
- Shortlist of possible control methods from Preparing phase steps 6 and 7
- Consultation outcomes in communication plan from Preparing phase step 9, if completed
- Management history from Pestlink reports (logon access required) and previous operational reports DOC-7194322 for this site
- DOC Pesticide Information Reviews docDM-25413

## 3.2. Planning phase

In the Planning phase, you plan the details of how you will carry out the operation.

The Planning phase has the following steps:

- Step 1: Enter operational details in DOCgis Pesticides Application
- Step 2: Plan outcome and result monitoring
- Step 3: Work out which consents you need
- Step 4: Plan operational details and arrange review
- Step 5: Prepare draft DOC application form, including map
- Step 6: Consult on effects and obtain landowner consent

You start with a proposed control method, and after working through the steps, you are ready to act on your operational plan by the end of the phase.

### 3.2.1. Planning phase step 1: Enter operational details in DOCgis Pesticides Application

This step applies when proposed methods include pesticides. You can expect it to take less than 1 hour to complete.

The objective of this step is to ensure that information about the proposed operation is available on the DOCgis Pesticides Application.

## Process

**Step 1:** Define the treatment area and treatment block(s) in the DOCgis Pesticides Application. You may need to capture a new shape or amend an existing shape.

**Step 2:** Complete all the required information for the treatment area and each defined treatment block. Use the Caution period calculator to determine the recommended caution period for each treatment block. These details can be refined and updated as planning progresses.

**Step 3:** Decide and set the status:

- Proposed – publish: Your proposed operation will be visible on the external viewer of the Pesticide Summary.
- Proposed – don't publish: Use this status if there is sensitivity around the proposed operation. It will not be visible on the external viewer of the Pesticide Summary.

The DOC Pesticide Summary is a list of pesticide operations on lands administered by DOC. It is published on the DOC website and updated daily.

The purpose of the DOC Pesticide Summary is to:

- Comply with Ministry for Primary Industries (MPI) requirements, so certified suppliers can verify that wild animals presented to primary processors have been taken from outside of poisoned areas or their associated buffer zones.
- Adequately inform interested parties about pesticide operations on lands administered by DOC.

If the Pesticide Summary information is incorrect or incomplete, the public may not be adequately notified of the presence of pesticides on public conservation land. This could result in the harvesting of contaminated meat for human consumption, which has serious potential consequences.

If the proposed treatment block(s) are not published at this stage, they must be published by the end of the Pre-operational phase step 1.

**Deliverable:** Treatment block(s) where pesticides are proposed as the control method are defined in the DOCgis Pesticides Application.

## Standards

1. All the proposed treatment block(s) that include pesticides are accurately defined in the DOCgis Pesticides Application.
2. The information in the DOCgis Pesticides Application is kept up to date throughout the operation.

## Resources

- Your operational plan
- Pesticide summary information for operational planners DOC-5920806
- Caution period calculator docDM-690617
- DOCgis Pesticides Application

- DOCgis Pesticides Application user guide
- DOCWiki https://docwiki.depcon.internal/wiki/Pesticide_Application
- GIS analyst support for aerial operations
- Definitions:
    1. The caution period is the timeframe (usually number of months) after the last date of bait application or bait removal when DOC expects that the risk of pesticide residues to the public will have passed.
    2. Buffer zone (hunting): The area outside the boundaries of the treatment area from which meat for human consumption should not be procured. The definition from the Animal Products Notice: Production, Supply, and Processing is "the land situated between the boundaries of an area of land that has been exposed to poison and an area of land where it is acceptable for animals to be procured, measured as a straight line on a horizontal plane".

### 3.2.2. Planning phase step 2: Plan outcome and result monitoring

This step applies to all operations. You can expect it to take 1 – 5 days to complete.

The objective of this step is to design result monitoring and begin the process for outcome monitoring.

#### Process

**Step 1:** Use the outcome and result targets you developed in Preparing phase step 4.

**Step 2:** Find the best methodology in the Inventory and Monitoring Toolbox. Review your targets to match your method choice.

**Step 3:** Follow the methodology standards to plan the monitoring and how data will be recorded and analysed. If someone else is managing the outcome monitoring, give them the information they need for their monitoring project plan.

**Deliverable:** Proposed monitoring entered in your operational plan, and result and/or outcome monitoring plan.

#### Checkpoints

You will have completed this step when:

- Your operational plan outlines the proposed monitoring and refers to any separate plans.
- Monitoring plans explain how monitoring will be carried out, recorded, and analysed for this project.

#### Resources

- Outcome and result targets in your draft operational plan
- Inventory and Monitoring Toolbox https://www.doc.govt.nz/our-work/biodiversity-inventory-and-monitoring/

- Talk with specialists, scientists and others with relevant monitoring experience
- Current agreed best practice for animal pest control
- Definitions:
    1. Result monitoring: In the context of animal pest operations this means monitoring undertaken to determine changes in pest animal abundance or to estimate pest animal abundance after a control operation to compare against a predetermined target.
    2. Outcome monitoring: The measurement of change of the characteristic of interest of a natural heritage asset. This type of monitoring provides information about whether outcome targets have been achieved.

### 3.2.3. Planning phase step 3: Work out which consents you need

This step applies to all operations. You can expect it to take less than 1 hour to complete.

The objective of this step is to identify the consents you need so you can plan to obtain them.

#### Process

**Step 1:** Identify the consents you need for your proposed animal pest operations using the flow charts and information in docDM-1475279.

**Step 2:** Record the required consents in your operational plan.

**Step 3:** If using pesticides, update the compliance information for your treatment area in the DOCgis Pesticides Application.

**Step 4:** Update your communication plan to include the parties from whom you need consent.

**Deliverable:** Required consents recorded in your operational plan. If using pesticides, compliance information completed for your treatment area in the DOCgis Pesticides Application.

#### Standards

1. The consents needed for an operation are identified correctly in the operational plan, and if pesticide uses are proposed, in the DOCgis Pesticides Application.
2. Land occupier consent is identified where there are any holders of grazing licences, lessees or other occupiers within the area included in the operation (e.g. access ways). The only exception is where the terms of the grazing licence specify that DOC can manage the land without their consent. In these cases, licensees must be notified.
3. Landowner consent is identified where the operation includes riparian strips and paper roads to be obtained from the relevant District or City Council.
4. For resource consent, a Certificate of Compliance is sought from the consent authority for controversial operations or advice.

### Resources

- Working out which consents you need for animal pest operations docDM-1475279
- Understanding the RMA for animal pest operations docDM-96158
- Seek advice from DOC RMA planning and legal staff
- Your operational plan
- Your communication plan
- Your treatment area in the DOCgis Pesticides Application

## 3.2.4. Planning phase step 4: Plan operational details and arrange review

This step applies to all operations. You can expect it to take 1 – 2 weeks to complete.

The objective of this step is to complete the remaining sections of the operational plan and have it peer reviewed.

### Process

**Step 1:** Complete the remaining sections of your operational plan. Make sure you understand and apply the requirements of other relevant SOPs and systems (e.g., the Management of Hazardous Substances SOP, performance standard sheets for trap systems, procedures for firearm use). Consider the potential and/or actual effects the operation could have on native species, domestic animals and non-target feral animals. Ensure the plan will keep any such risks and effects at an acceptable level.

**Step 2:** If using pesticides, review your treatment blocks in the DOCgis Pesticides Application. Add or update any information about the control method that may not have been decided until now (e.g., bait size).

**Step 3:** Have your draft operational plan peer reviewed.

**Deliverable:** Peer-reviewed operational plan.

### Standards

1. The operational information for treatment blocks is clearly separated in each section of the plan where differences exist between them.
2. The operational plan includes at least one map as an appendix to the plan, showing the treatment blocks.
3. The operational plan states the timeframe of the plan in the scope.
4. The operational plan is peer reviewed by someone who meets the requirements in section 1.3

### Resources

- Your operational plan
- Your treatment block(s) in the DOCgis Pesticides Application

- Trapping application intranet page
- Trapping application https://trap.nz/
- Performance standard sheets for any trap systems that you are using
- Peer review template docDM-318907
- Past operational plans, Pestlink reports (logon access required ) and previous operational reports DOC-7194322 for relevant operations
- Management of Hazardous Substances SOP DOC-6052105
- Method best practice from the Current agreed best practice document for your target pest
- Eradication best practice document and planning tools
- Guidelines for aerial 1080 baiting #1: Bucket calibration DOC-2651373
- Guidelines for aerial 1080 baiting #2: Managing air operations DOC-2651365
- Guidelines for aerial 1080 baiting #3: Considerations for setting up a helicopter loading site for aerial baiting using cereal pellets docDM-1560571
- Protection of drinking water – guidance (Appendix 5 of Guidelines for Issuing Permissions for the Use of Vertebrate Toxic Agents) https://www.health.govt.nz/system/files/2011-11/guidelines-for-issuing-permissions-for-the-use-of-vertebrate-toxic_agents-29_july.pdf
- Animal pest welfare in firearm and live capture operations
- Hunting safely (ground) one-page SOP docDM-673812
- Hunting safely (ground) technical document docDM-751751
- Helicopter aerial hunting SOP DOC-6262530
- Firearms SOP DOC-5960893
- Wild animal detection dog-handler team SOP DOC-6615586
- The safety plan for your operation developed through Risk Manager

### 3.2.5. Planning phase step 5: Prepare draft DOC application form, including map

This step applies when proposed methods include pesticides. You can expect it to take 5 – 10 days to complete.

The objective of this step is to draft a DOC application form with an assessment of environmental effects (AEE) (if required) to give consent providers and affected parties under the RMA the information they need to evaluate your proposed operation.

#### Process

**Step 1:** For ground-based operations, inform the DOC manager who will be making the decision on your application for DOC permission about your upcoming operation. Ask them to assign a staff member who meets the requirement in the Processing applications for vertebrate pesticides and trapping SOP docDM-1490584 to be the assessor. They will need to coordinate with managers from other offices in the region.

For all aerial operations, an assessor will be assigned by the National Predator Control Programme (NPCP) team when you submit your application.

**Step 2:** Check the AEE National Standards column of the Status List docDM-22655 to see the AEE requirements. An AEE is required when:

- The AEE National Standards column states that 'an AEE is required' for one or more pesticide uses in the proposed operation; or
- The AEE National Standards column states that 'an AEE may not be required if' certain specifications are met, and not all specifications can be met for all pesticide uses in the proposed operation; or
- The proposed operation meets all specifications for all pesticide uses, but the approving manager (or Operations Manager) decides to require an AEE.

If an AEE may be required at the discretion of the approving manager, ask the assigned assessor to obtain this decision from the approving manager. For aerial operations, seek advice from the NPCP Aerial Permissions Advisor.

Where an AEE is required, you need to either:

- Complete the AEE section of the DOC application form docDM-95868; or
- If resource consent is required, attach the completed Resource Management Act (RMA) AEE form docDM-96227 to your DOC application.

**Step 3:** Draft your DOC application form to use pesticides docDM-95868. Copy and paste the DOC Performance Standards sheet(s) to cover all pesticide uses and trap systems involved into Appendix 1 of the DOC application form. Complete the grey-shaded boxes on these sheets. The estimated caution period will be set when your application is assessed. Consider additional performance standards to manage risks for your operation and record these on your Performance Standards sheet(s).

Draft a map that meets the standards given in the application form. If you are not using the DOCgis Pesticides Application to create the permission map, ensure you still enter all required information for your treatment blocks into the DOCgis Pesticides Application (e.g., water intakes, warning signs).

Where the AEE section must be completed, ensure that the potential and actual effects of all pesticide uses are considered. Consult with DOC specialists as needed.

**Step 4:** If preparing an RMA AEE to apply for resource consent, obtain approvals from affected persons under section 95E of the RMA wherever possible. If they have given their approval, they are no longer considered affected persons, and effects on them do not have to be considered by the consent authority (under section 95D(e) of the RMA). They do not have to be notified of the application if a limited notification process is required by the consent authority.

Check whether the consent authority has a form letter for section 95E approvals and/or if they would be happy for you to use the Section 95E approval form. Attach affected person approvals as part of Appendix 3 to the AEE.

**Step 5:** Have your DOC application form peer-reviewed. The peer reviewer of your application form could be the same person who peer reviewed your operational plan. This step is compulsory for:

- Hand-laid or aerial Pestoff Rodent Bait 20R (pesticide uses 45 or 46)

- Cube root slurry (pesticide uses 100 or 101)
- Xstinguish Argentine Ant Bait / Vanquish Pro (pesticide use 113)

You may decide that a peer review is a good idea for high-profile operations or in other situations.

**Deliverable:** Draft DOC application form, with assessment of environmental effects included where required.

## Standards

1. One application is written for each operational plan (i.e. the same grouping standards as in Preparing phase step 1 apply).
2. The DOC application form uses the current version of the correct MS Word template. All sections of the form are complete, using 'N/A' as required.
3. The DOC application form is written to:
    a. Cover the information required by the prompts in the template
    b. Be specific and factual
    c. Align with definitions
    d. Use concise plain English
    e. Use references that are specific and traceable—if a reference is not traceable (e.g., unpublished manufacturer report), include it as an appendix
    f. Include the correct DOC Performance standards sheets to cover all pesticide uses and trap systems involved
    g. Use additional performance standards that are specific and auditable, and can be justified
    h. Include the Assessment of Environmental Effects section where this is required
4. The operational information for treatment blocks is clearly separated in each section of the DOC application form where differences exist between them.
5. The DOC application form:
    a. Includes at least one map as Appendix 2, meeting the standards given on the DOC application form
    b. Uses more than one map if the amount of detail becomes too visually cluttered to be clearly understood
6. The DOC application form is peer reviewed by someone who meets the requirements in Section 1.3 where the proposed operation involves:
    a. Hand laid or aerially applied Pestoff Rodent Bait 20R (pesticide uses 45 or 46);

b. Cube root slurry (pesticide uses 100 or 101); or

c. Xstinguish Argentine Ant Bait/Vanquish Pro (pesticide use 113).

### Resources

- DOC application form to use pesticides docDM-95868
- DOC application form with AEE example DOC-2313380
- Resource Management Act (RMA) AEE form docDM-96227
- RMA AEE example: Possum control in Mount Malihbu Scenic Reserve docDM-96243
- Status List docDM-22655, including PAG risk assessments and DOC Performance standards sheets
- Trap Status List DOC-5620413, including TTAG risk assessments and DOC Performance standards sheets
- Current agreed best practice for animal pest control
- DOC Pesticide Information Reviews docDM-25413
- Understanding the RMA for animal pest operations docDM-96158
- Section 95E approval form docDM-748579
- Seek advice from DOC planning and legal staff and council staff
- Other sources of advice – technical specialists, scientists, stakeholders, and landowners
- Caution period calculator docDM-690617
- Processing Applications for Vertebrate Pesticides and Trapping SOP docDM-1490584
- Your treatment block(s) in the DOCgis Pesticides Application

## 3.2.6. Planning phase step 6: Consult on effects and obtain landowner consent

This step applies if you decided to consult on effects in Preparing phase step 8 or if you need landowner consent. You can expect it to take weeks to complete.

The objectives of this step are:

- To seek community and tangata whenua views on the effects of the preferred control method and the proposed treatment boundary. DOC is open to discussing any concerns people have about the operation and how modifications to the operational plan may address these concerns.
- Obtain landowner and occupier consents.

## Process

**Step 1:** Consult with your target audiences using the tools identified in the communication plan. Compulsory target audiences for consultation on effects (from the standards in Preparing phase Step 8) are:

- Iwi and/or hapū for aerial 1080 operations
- All occupiers and (as far as practicable) owners of land included in and adjacent to the proposed treatment area and, if applicable, loading sites
- All grazing licence holders
- The relevant Fish and Game Council for operations using rotenone under the Resource Management (Exemption) Regulations 2017

Use of the Landowner/occupier visit plan and record template docDM-22881 is recommended. Ensure the boundary on your draft map is correct and that the map is large and clear enough to distinguish all boundaries and relevant features.

**Step 2:** If you need consent from any landowners/occupiers (as identified in Planning phase step 3), request this during your consultation with them. Be clear about what you need their consent for, which could be:

- To conduct the operation on their land
- For access onto or across their land
- For a helicopter loading site

Ask each person or group for a written statement giving consent for the operation. They may add conditions to this consent. Consider how these conditions might impact your operational plan and amend it as necessary.

It is recommended to get written consent using the Standard letter of consent from landowners or occupiers docDM-95913. (This does not cover section 95E RMA approvals for resource consent obtained in Planning phase step 5).

If consent is refused and an agreement cannot be reached, the Minister of Conservation may authorise entry to kill wild animals or wildlife under certain circumstances (under section 16 of the Wild Animal Control Act 1977 and section 59 of the Wildlife Act 1953). This is decided by the Director Operations or Deputy Director-General of DOC.

**Step 3:** Record the outcomes of consultation by documenting all phone calls and visits in the communication plan, including those with whom direct contact could not be made. Note the times, dates, full names, and what was said. It is important to record not just whether a person or group supports the proposed operation, but how they think the proposed operation will impact them and the environment.

It is necessary to understand the relationship of Māori and their culture and traditions with their ancestral lands, water, sites, wāhi tapu, valued flora and fauna, and other taonga. It is therefore important to record (where relevant information is provided):

- Whether the operation likely to impact on the productivity and life-sustaining quantity and quality of traditional Māori food resources (mahinga kai), New Zealand's indigenous flora and fauna, other flora and fauna valued by Māori, water, land, air, natural habitats and ecosystems and other natural resources valued by Māori.

- Whether the operation is likely to impact the protection and enhancement of people, native or valued flora and fauna, land, waterways, air, traditional Māori values and practices, and the Māori knowledge system and world view.
- Whether the operation likely to impact on the ongoing capacity and capability of Māori to develop economically; and on the ongoing participation of Māori in the generation of economic benefit, and the burden of economic cost.
- Whether the operation is likely to impact the ongoing management by Māori of their cultural and natural resources, Ongoing rights of Māori to develop culturally, socially, spiritually and physically; the implementation of the Treaty principles, and land.

Complete the conditions/agreements/risk or threats column for those granting consent or for those identified as having risks or threats. Ensure there is a way to link each consent obtained with the relevant piece of land shown on the DOC permission map (e.g., assign a reference number). Even if you only get verbal consent, note the times, dates, full names, and what was said. This ensures you have a record of contact and consent sought.

If using pesticides, update the required compliance information in the DOCgis Pesticides application.

**Step 4:** If using pesticides, include the following pages as a consultation record to include as Appendix 3 of your DOC Application Form:

- Introduction
- Consultation on possible methods (if applicable)
- Consultation on effects (if applicable)
- Toolkit

**Deliverable:** Communication record completed for consultation on effects and landowner/occupier consents obtained.

## Standards

1. Appropriate consultation takes place with landowners and occupiers prior to seeking their consent.
2. Visits or phone calls are used where landowner/occupier consent is being sought.
3. All landowner and/or occupier consents are received before the operation proceeds.
4. Landowners and occupiers are consulted when there are changes to the operation after consent has been granted.
5. The operational plan is consistent with all landowner and occupier consent conditions.
6. The communication plan records all landowner and occupier consent conditions and any other agreements made and includes a reference to link their location to the permissions map.
7. Consultation on effects includes ensuring that treatment block boundaries, including sensitive boundaries and exclusion zones are appropriate and correct.
8. A Consultation fact sheet covering the following information about the proposed operation is given to all target audiences, or the information is communicated to them in other ways:

a. Location and size of proposed treatment area

b. Why control is needed at that site (covering values, pest problem, and intended conservation outcome)

c. Past monitoring information demonstrating the benefits of pest control (if available for that site/species)

d. Details of the control method chosen and why

e. Purpose of the consultation and any parameters that are fixed, including seeking to understand how the target audience considers the proposed operation could affect them, the indigenous flora and fauna and other natural resources, their ability to protect and manage and use those resources, and how it could impact their wellbeing

f. Opportunities for consultation

g. Likely timeframe of the proposed operation

h. Details of the permissions required and the consultation/notification process

i. Key facts about the method

j. Risks and mitigation

k. The job title and organisation of the person responsible for the operation, and the address and phone number of their office. If these are details of a contractor, also include details of the local DOC office

l. A map of the proposed treatment area that clearly shows the boundaries. Include districts, roads and other commonly known features that may identify the place

9. A record is kept of all phone calls and visits in the communication plan, including those for any parties with whom direct contact could not be made.

10. The outcomes of consultation and obtaining landowner consents, including any risks and threats identified, are recorded in the communication plan.

## Resources

- Your communication plan
- Communication plan – complex/new operation example docDM-22869
- Communication plan – simple/maintenance operation example docDM-22870
- Landowner/occupier visit plan and record template docDM-22881
- Consultation fact sheet template docDM-22872
- Consultation fact sheet example docDM-22874
- Consultation fact sheet NPCP template DOC-6174650
- Consultation fact sheet NPCP example DOC-7177104
- NPCP resources for engagement and communication DOC-5998295

- NPCP Guide to engaging with our Treaty Partner and communities at place DOC-6290966
- WAMP resources for engagement and communication DOC-7624668
- Protection of drinking water – guidance (Appendix 5 of Guidelines for Issuing Permissions for the Use of Vertebrate Toxic Agents) https://www.health.govt.nz/system/files/2011-11/guidelines-for-issuing-permissions-for-the-use-of-vertebrate-toxic_agents-29_july.pdf
- Generating a concessionaires list DOC-6278584
- Wilson and Cannon (2005) Community consultation processes for aerial 1080 applications Science for Conservation No 247 https://www.doc.govt.nz/globalassets/documents/science-and-technical/sfc247.pdf
- Standard letter of consent from landowners/occupiers docDM-95913
- Seek community relations advice
- Your treatment block(s) in the DOCgis Pesticides Application

## 3.3. Pre-operational phase

In the Pre-operational phase, finalise your operational plan and organise everything you need before starting the field work.

The Pre-operational phase has the following steps:

- Step 1: Revise all planning documents to respond to consultation and peer review
- Step 2: Obtain consents and update operational plan
- Step 3: Notify target audience of planned operation
- Step 4: Write task specifications and collate attachments
- Step 5: Organise contracts
- Step 6: Prepare operational signage
- Step 7: Check that you are ready for the operational phase

Work through each step, noting that some can be done in parallel. By the end of this phase, you will have everything in place to start the field work.

### 3.3.1. Pre-operational phase step 1: Revise all planning documents to respond to consultation and peer review

This step applies to all operations. You can expect it to take 1 day to complete.

The objectives of this step are:

- To gather all feedback and create a revised operational plan.
- If using pesticides, to prepare a final DOC application form.
- To ensure accurate information about the proposed operation is shown on the Pesticides Summary.

## Process

**Step 1:** Review feedback from the Planning phase. This includes:

- Peer review of your operational plan (Planning phase step 4)
- Peer review of your DOC application form (Planning phase step 5)
- Consultation on effects (Planning phase step 6)

**Step 2:** Decide what changes are necessary as a result. Create a record of the actions you will take in response to feedback, including your reasoning if no action is taken.

**Step 3:** Revise all documents and the map.

**Step 4:** If using pesticides, check that the details and dates for your treatment block(s) in the DOCgis Pesticides Application are still accurate and update them if necessary. If the status is still "Proposed – don't publish," change it to "Proposed – publish" so that it is visible on the external viewer of the Pesticides Summary. Be aware that treatment block(s) will be automatically retired if the start date in the DOCgis Pesticides Application is reached before the DOC permission is approved.

**Deliverables:** An updated operational plan and DOC application form (if required) with map ready to submit. The proposed treatment block(s) using pesticides are visible on the Pesticide Summary.

## Standards

1. A file note or other record shows what actions, if any, will be taken to respond to consultation and peer review feedback. A reason is given where no action will be taken.
2. The operational plan, DOC Application form (if required) and associated maps are consistent with each other. All changes arising from peer review and consultation are completed.
3. If using pesticides, the information in the DOCgis Pesticides Application accurately reflects the proposed operation and the status of the treatment block(s) are set to "Proposed – publish".

## Resources

- The communication record for your operation
- Your draft DOC Application Form
- Your draft operational plan
- Feedback from peer review
- Seek advice from your manager, technical specialists or community relations specialists in making decisions, as appropriate
- Your treatment block(s) in the DOCgis Pesticides Application

### 3.3.2. Pre-operational phase step 2: Obtain consents and update operational plan

This step applies when proposed methods include pesticides. You can expect it to take 2 – 8 weeks to complete.

The objective of this step is to obtain the consents identified in Planning phase step 3, so the conditions can be included in the operational plan and communication plan.

#### Process

**Step 1:** Prepare applications for the consents required, as identified in Planning phase step 3. These might include applications for public health permission or EPA permission to use sodium nitrite. Consider peer review for consent applications. The DOC application form was already prepared in Planning phase step 5. Landowner and occupier consents have already been obtained in Planning phase step 6.

**Step 2:** Submit applications to consent providers. To apply for DOC permission for ground-based operations, submit your DOC application form with all the required appendices as stated on the form to the assessor identified in Planning phase step 5. To apply for DOC permission for aerial operations, submit your DOC application form with all the required appendices as stated on the form to the National Predator Control Programme team at npcplogistics@doc.govt.nz

**Step 3:** When consents are received, review the conditions to identify any conditions you did not expect or have not planned for. Assess the impact of these conditions on your operation, considering budget (dollars and hours), timing, operational targets, additional risks, and conflicts with other consents. Decide whether you can proceed with the operation under these conditions. If the conditions are not workable, your options are:

- Seek to adjust the condition(s) by presenting a case to the consent authority.
- Change the method of your proposed operation (e.g., change the pesticide), which will require revisiting all consents and your operational plan.
- Cancel the operation, which is an extreme response and requires consultation with your manager.

If you can accommodate the conditions, amend your operational plan and communication plan accordingly. This may include changes to the budget and timing and may require approval from your manager.

If you receive formal notification from the Ministry of Health that public health permission is not required, ensure the qualifying points in the letter are correct and that your operational details match the information provided in the application form.

**Step 4:** Update the required compliance information in the DOCgis Pesticides Application. The assessor will send a copy of the DOC permission to the Regional Pesticides Summary Coordinator, who will add the link to the DOCgis Pesticides Application and update the status of the treatment block(s) to “will be laid.” Check that all operational details, including the start date, in the DOCgis Pesticides Application match the DOC permission and make corrections if necessary. The start date can be amended if the operation is delayed.

**Step 5:** This step is compulsory if control methods include aerially applied pesticides and optional otherwise. Create a compliance register for your operation using the Compliance register template docDM-1475273.

Copy and paste any conditions, agreements, risks, or threats from your communication plan (completed in Planning phase step 6) into your compliance register for those granting landowner/occupier consent, with whom agreements have been made, or for whom you have identified risks or threats. As other consents are received, copy and paste all conditions into your compliance register. At a minimum, complete columns A to F of the "Conditions" sheet. This may be used for a readiness check (in Pre-operational phase step 7) or audit (in Operational phase step 5) of your operation.

**Deliverables:** Consents obtained for the operation. A compliance register created for aerial operations.

### Standards

1. All required consents are obtained before the operation proceeds.
2. Consent approvers are consulted when there are changes to the operation after consent/permission has been granted.
3. A compliance register must be created for all aerial pesticide operations following the instructions in the Compliance register template docDM-1475273 and must include all conditions and agreements that apply to the operation.
4. The operational plan is consistent with all consent conditions and agreements made.

### Resources

- Compliance register template docDM-1475273
- Compliance register example aerial operation docDM-1572651
- Compliance register example bait station operation DOC-6017602
- Your applications for consents
- Your consents when these are obtained
- Your operational plan
- Your communication plan
- Your treatment block(s) in the DOCgis Pesticides Application
- Ministry of Health application form and guidance on public health permissions for VTAs https://www.health.govt.nz/publications/guidelines-for-issuing-permissions-for-the-use-of-vertebrate-toxic-agents
- Environmental Protection Authority Application for Permission website https://www.epa.govt.nz/industry-areas/hazardous-substances/making-an-application/permissions/

## 3.3.3. Pre-operational phase step 3: Notify target audience of planned operation

This step applies to all operations. You can expect it to take 1 – 4 weeks to complete.

The objective of this step is to inform the local community, stakeholders, visitors, and users about DOC pest operations.

## Process

**Step 1:** Open the Pre-operational notification page of your communication plan. Carefully review all the standards below, as the legal requirements for target audiences, timeframes, and notification methods differ between control methods. Most standards relate to vertebrate pesticides as these are prescribed by law. Ensure any other target audience identified for notification in consent conditions or from consultation agreements is included.

**Step 2:** Create notification tools according to the Toolkit page of the communication plan.

**Step 3:** Notify target audiences of the planned operation. If anyone requests a repeat of the pre-operational notification, agree on a timeframe and ensure this is recorded and actioned.

**Step 4:** Record outcomes in your communication plan.

**Deliverable:** Communication record completed for pre-operational notification.

## Standards

The following standards are for compulsory target audiences for pesticide operations.

1. For operations involving vertebrate pesticides, land occupiers and (as far as practicable) owners adjacent to the treatment area and if applicable loading site(s) are included in the pre-operational notification.
2. The Medical Officer of Health (MOH) is included in pre-operational notification for operations involving pesticides that do not require public health permission.
3. For aerial 1080 operations the officer in charge of the local police station is included in pre-operational notification.
4. For operations using Double Tap™ (D+C Pellet Bait) land occupiers and (as far as practicable) owners 'within the vicinity' of the treatment area are included in the pre-operational notification.
5. For operations targeting feral cats using para-aminopropiophenone (PredaStop for Feral Cats™), land occupiers and (as far as practicable) owners within 3km of the proposed treatment area are included in the pre-operational notification.
6. For operations using Magfume™, the nearest communications centre of Fire and Emergency New Zealand and anyone else who may be affected by the fumigation, is included in the pre-operational notification.
7. For operations using encapsulated sodium nitrite the following audiences are included in pre-operational notification:
    a. any veterinarians operating in the area, and
    b. the officer in charge of the local police station.

The following standard is for producing a fact sheet and applies to all methods.

8. A Notification fact sheet covering the following information about the operation is given to all target audiences, or the information is communicated to them in other ways:
    a. Location and size of the treatment area

b. Why control is needed at that site (covering values, pest problem, and intended conservation outcome)

c. The details of the control method (if using pesticides include toxic loading, bait type, and application method)

d. Why this control method was chosen

e. Intended dates of application/operation

f. Key facts about the method, including risks and mitigation

g. Details of the permissions required and the consultation/notification process

h. What to do if poisoning is suspected (if using pesticides)

i. The job title and organisation of the person responsible for the operation, and the address and phone number of their office

j. A map of the treatment area that clearly shows the boundaries. Include districts, roads and other commonly known features that may identify the place

The following standards are for timing of notification an apply to all methods.

9. Any mailout or email is completed a minimum of 2 weeks before the intended date of operation and prior to any public notice. Email may only be used where the tracking option for the email is set to 'request a read receipt for this message'.

   When notifying clubs or other organisations, a longer period before the operation will be needed to allow for the information to be passed on to members.

10. For any operation involving 1080 or PredaStop™ for Feral Cats (para-aminopropiophenone), the pre-operational notification is 'given with sufficient prior notification but no more than 2 months before' the pesticide is laid.

11. For any operation involving Double Tap™ (D+C Pellet Bait), the pre-operational notification is 'given with sufficient prior notification, no less than 24 hours, but no more than 2 months before' the pesticide is laid.

12. For any operation involving encapsulated sodium nitrite, the pre-operational notification is 'given with sufficient prior notification but no more than 1 month before' the pesticide is laid.

The following standards are for public notice for aerial pesticide operations.

13. Public notice is used for all aerial applications of 1080 or pindone. The public notice appears in a newspaper available in the areas in which the substances will be applied.

14. The public notice includes the following:

    a. The name of the pesticide, bait type and method of applying the bait.

    b. The date of intended pesticide application.

c. A basic map showing treatment boundaries and any commonly known features (e.g. districts, roads) that may identify the place. If a map would not have sufficient features to identify the location of the control area, a written description of the treatment area may be used. The written description includes the boundaries of the treatment area, districts, roads, and other commonly known features that may identify the place.

d. The location or locations where the public may view maps of the treatment areas and the times when such maps may be viewed.

e. The job title and organisation of the person responsible for the application, and the address and phone number of their office.

f. The most relevant information from the Notification fact sheet for your operation.

15. Any public notice is published in a period that complies with all consent conditions for the operation. If consents do not specify a timeframe, the notice is 'given with sufficient prior notification but no more than 2 months before' the pesticide is laid. This is generally taken to mean at least 2 weeks ahead of the intended application date. If the operation is then delayed, re-notification and re-publication can be done as close as a few days prior to the aerial application.

The following standards apply if using the RMA Exemption regulations as determined in Planning phase step 3.

16. If using the Resource Management (Exemption) Regulations 2017, the relevant regional council is given written notification of the operation.

17. The notification includes the following information:

a. the objectives of the operation

b. the vertebrate pesticide, pre-feed, or repellent to be used

c. the bait, delivery method, application rate, or lures to be used

d. a map showing the boundaries of each treatment block(s)

e. the location of any warning signs for each treatment block

f. the period during which the operation will occur in each treatment block

g. the name and contact details of the person in control of the field work (usually the operational planner)

18. The notification is given as early as practicable, but no later than 48 hours, before the operation (including pre-feeding) starts, and repeated if there are changes to the information provided therein.

The following standards are for communication records and applies to all methods.

19. A record is kept of all notification in the communication plan, including those for any parties with whom direct contact could not be made.

20. A record of the dates and publications where public notices appeared is kept in the communication plan.

21. The outcomes of notification are recorded in the communication plan.

### Resources

- Your communication plan
- Notification fact sheet template docDM-22877
- Notification fact sheet example docDM-22879
- Notification fact sheet NPCP template DOC-6174666
- Notification fact sheet NPCP example DOC-7078346
- NPCP resources for engagement and communication DOC-5998295
- NPCP Guide to engaging with our Treaty Partner and communities at place DOC-6290966
- WAMP resources for engagement and communication DOC-7624668
- Generating a concessionaires list DOC-6278584
- Visit plan and record example docDM-22881
- Consent conditions relating to notification

## 3.3.4. Pre-operational phase step 4: Write task specifications and collate attachments

This step applies to all operations. You can expect it to take 2 days to complete.

The objective of this step is to write task specifications that detail how the task is to be done and the standards that apply. This ensures tasks can be delegated effectively, as everyone is clear on what is expected.

### Process

**Step 1:** Review the task list in your operational plan and identify those that need task specifications.

**Step 2:** Modify relevant example task specifications to suit your operation or create your own using the Task specifications template docDM-313054. Identify the people and equipment needed.

**Step 3:** Gather all required attachments.

**Deliverable:** Task specifications for tasks that need them.

### Checkpoints

You will have completed this step when:

- Your task specifications include all applicable standards and consent conditions.

- Your task specifications have been added to the operational pan and are ready for briefing field staff in the Operational phase.
- The standards in the Management of Hazardous Substances SOP have been applied whenever pesticides are moved or stored.

### Resources

- Task specification template docDM-313054
- Example task specifications from Current agreed best practice for animal pest control
- Task specifications from other similar operations
- Your operational plan
- Management of Hazardous Substances SOP DOC-6052105
- Animal pest welfare in firearm and live capture operations

## 3.3.5. Pre-operational phase step 5: Organise contracts

This step applies to all operations if any tasks will be contracted out. You can expect it to take 6 – 10 weeks to complete.

The objective of this step is to secure any contracts required for your operation in line with the Procurement and Supplier Management SOP.

### Process

**Step 1:** Identify any tasks in the operational plan that will be contracted out from Planning phase step 4.

**Step 2:** Create a Description of Services for the contract by:

- Modifying your task specification or an example task specification from Current Agreed Best Practice; or
- Using an example from the Procurement and Supplier Management SOP

Review the consent conditions that apply to your operation by checking the lists of conditions you copied into the compliance register in Pre-operational phase step 2. Ensure the contract aligns with all consent conditions and SOP standards.

**Step 3:** Follow the Procurement and Supplier Management SOP to plan and carry out the sourcing process (most likely tendering) and secure the contract.

**Deliverable:** Signed contract(s) needed for your operation.

### Checkpoints

You will have completed this step when:

- All contracts are in place for your operation and any associated monitoring.

### Resources

- Procurement and Supplier Management SOP docDM-912450
- Procurement SOP quick reference guide docDM-1011955
- Procurement online DOCLearn training modules
- Procurement and purchasing pre-drafted contracts intranet page
- Example task specifications from Current agreed best practice for animal pest control
- Your operational plan
- Working with contractors intranet page

## 3.3.6. Pre-operational phase step 6: Prepare operational signage

This step applies to all operations. You can expect it to take 2 weeks to complete.

The objectives of this step are:

- To ensure signs meet all standards. The number, size, and location of signs must comply with all consent conditions.
- To accurately record details of signs in the DOCgis Pesticides Application if using pesticides.

### Process

**Step 1:** Decide what signage is required for your operation. For example, you may need to warn visitors about a hazard and the precautions they need to take or convey other information such as closure notices for public walkways or other land. If using pesticides, follow the process and standards in this SOP for creating, installing, maintaining, and removing warning signs, as they meet the legal requirements. For other control methods or information signs, refer to the "How to order DOC signs" intranet page for information on producing these.

**Step 2:** If using pesticides, design signs using the warning sign template(s) corresponding to your pesticide use(s) on the Status List docDM-22655. Obtain the necessary information to complete the required fields. If the phone number on the sign is for a DOC office or Customer Service Centre, ensure the people receiving the call have enough information to direct the call to the person in control of the fieldwork. You will also need loading site signs if planning an aerial operation. The template and standard for these are on the Performance Standard sheets for the relevant pesticide uses.

**Step 3:** If using pesticides, add the proposed sign locations and details to your treatment block(s) in the DOCgis Pesticides Application (if not already done). Use the warning signs shown on your permissions map to identify locations and types of signs.

**Step 4:** Procure signs. Tally the number and size of signs you need, based on your sign register. Consider including extra signs for replacements. Decide on the type of sign production you want (e.g., corflute, vinyl, PVC digital print, UV ink print, laminated). Externally produced signs must be ordered through the Department's contracted supplier, Blue Star. See the "How to order DOC signs" intranet page for the link to the online ordering system. You can also use the system to create an online proof of a sign to print and laminate yourself.

**Deliverable:** Signs, and if using pesticides, accurate sign information on the DOCgis Pesticides Application.

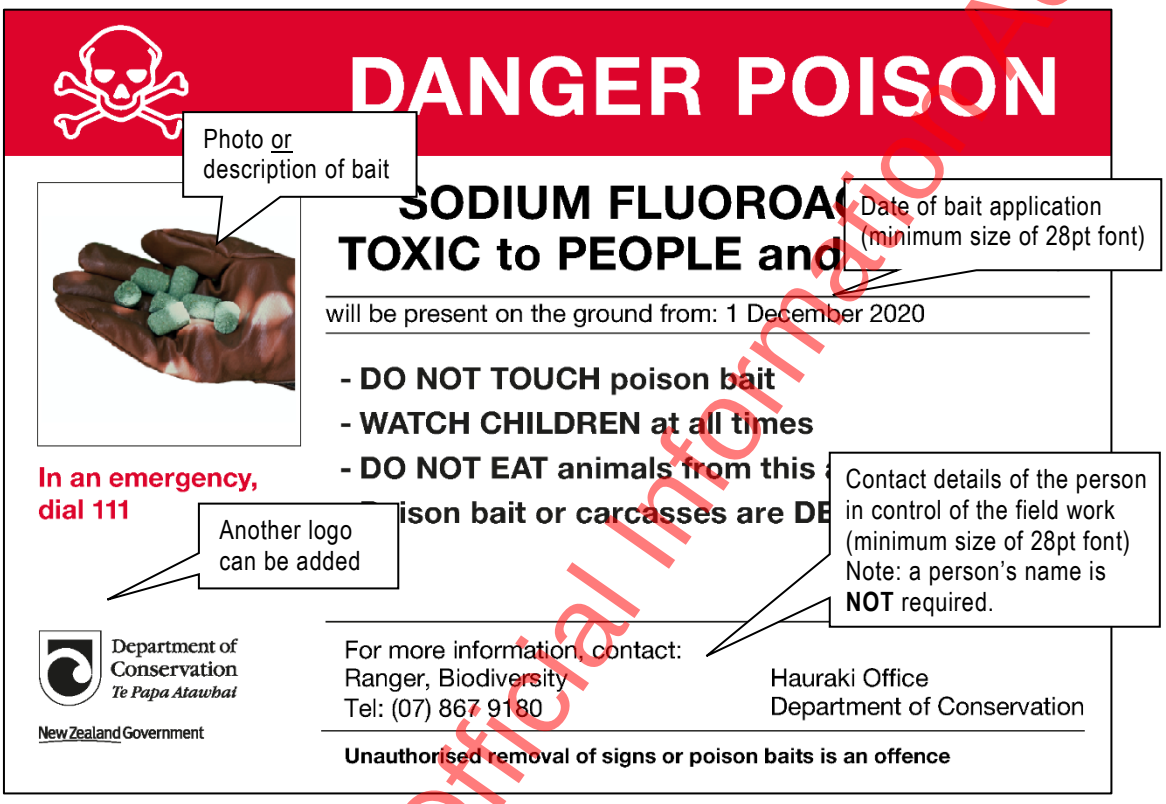
## Standards

The following standards must be followed for pesticide warning signs.

1. Warning signs of any design other than the one linked from the Status List must not be used.
2. Only the fields listed below may be changed. No other content or formatting may be altered.
    a. Contact details of the person in control of the field work (usually the operational planner), their job title as specifically as possible (e.g. Ranger Biodiversity), the phone number where they can be contacted during normal business hours, and the name of their organisation and office/division. The minimum size for this information is 28pt font.
    b. Date of bait application (if known) or leave blank to write in when the signs are installed. The minimum size for this information is 28pt font.
    c. Bait description or clear photo of bait, to show someone what they might encounter
    d. Another organisation's logo may be added if relevant
3. Signs located at normal points of entry (as shown on permissions map) are to be at least A3 in size. Warning signs in other places can be A4 in size.
4. The sign locations and details in the DOCgis Pesticides Application are complete and kept current with dates that signs are installed, checked and removed.

## Resources

- How to order DOC signs
- Status List docDM-22655
- Your consents and the approved DOC permission map
- Performance standards sheets for relevant pesticide uses
- Your treatment block(s) in the DOCgis Pesticides Application
- Graphic below showing an example sign with notes on which fields may be edited




### 3.3.7. Pre-operational phase step 7: Check that you are ready for the operational phase

This step applies to all operations. You can expect it to take 2 – 10 days to complete.

The objective of this step is to ensure everything is ready for the operational phase to begin.

#### Process

**Step 1:** Review the tasks in the operational plan to identify any that have not been completed to standard.

**Step 2:** Work with the person assigned to each task to ensure it is completed.

**Step 3:** If using pesticides, check your DOC permission to see if a readiness check is required. If not using pesticides (or if a readiness check is not required by the DOC permission), consider arranging a readiness check of your preparedness. Ask a colleague meeting the requirements in Section 1.3 to carry out the readiness check. Provide the readiness checker with a compliance register for your operation. You will have prepared this in Pre-operational phase step 2 for aerial operations. For other operations, follow process step 5 of Pre-operational phase step 2 to create one now.

The readiness checker reviews all your planning documentation and records their compliance observations in your compliance register against:

- All standards from the Preparing, Planning, and Pre-Operational phases
- Any standards from consents, agreements, or contracts that can be evaluated at this stage
- Any risks/threats that should have been addressed by this stage
- The task list of your operational plan

**Step 4:** Update the operational plan and associated documents. If you are using pesticides and your operation is delayed, update the start date for your treatment block(s) in the DOCgis Pesticides Application.

**Deliverables:** All Pre-operational tasks in the operational plan completed. Updated compliance register, where a readiness check was completed.

### Checkpoints

You will have completed this step when:

- All Pre-operational tasks in the operational plan have been completed to standard. You are ready for the Operational phase.

### Resources

- Your operational plan
- Your prepared compliance register (use the compliance register template docDM-1475273)
- Compliance register example aerial operation docDM-1572651
- Compliance register example bait station operation DOC-6017602
- Eradication readiness check report template DOC-7878544
- Your treatment block(s) in the DOCgis Pesticides Application

## 3.4. Operational phase

The Operational phase involves carrying out the fieldwork.

The Operational phase has the following steps:

- Step 1: Brief operators before field work
- Step 2: Undertake pre-control monitoring
- Step 3: Communicate the twenty-four hour notice
- Step 4: Install operational signage and update relevant Applications
- Step 5: Undertake pest control and update relevant Applications

Follow each step but note that some steps can be done at the same time. By the end of this phase, you will have completed the pest control.

### 3.4.1. Operational phase step 1: Brief operators before field work

This step applies to all operations. You can expect it to take less than 1 hour to complete.

The objectives of this step are:

- To ensure that field staff, volunteers, and contractors understand their responsibilities.

- If using pesticides, to provide the approved DOC permission map to the field supervisor (for ground operations) or the aerial contractor and brief them on the location of sensitive boundaries and exclusion zones.

## Process

**Step 1:** Gather the planning documents relevant to field staff. Brief field staff, volunteers, and contractors on their roles in the operation.

**Step 2:** If using pesticides, brief the field supervisor (for ground operations) or the aerial contractor on operational boundaries to meet the standards. For aerial pesticide applications, fly the boundaries as required by the standards. For sensitive boundaries that are hard to see from the air, mark key points on the ground beforehand with coloured tape, flags, or other markers to ensure they are visible from the aircraft.

**Step 3:** Plan and carry out job safety analysis and toolbox talks according to the Health and Safety Management Systems Manual.

**Step 4:** Keep a record of all briefings, including the date and any relevant information or issues.

**Deliverable:** Record of who has been briefed on what.

## Standards

The following standards must be followed for operations using pesticides.

1. Prior to ground based pesticide application, the field supervisor:
    a. Receives a copy of the map
    b. Is briefed regarding the location of sensitive boundaries and exclusion zones by the operational planner (or a person nominated by them)
2. A navigational guidance system is used for all aerial operations.
3. Prior to aerial pesticide application the aerial contractor:
    a. Receives a digital copy of the aerial application boundary and exclusion zones, and uploads these to the onboard GPS system prior to applying pesticide
    b. Flies the boundaries of the aerial application area and exclusion zones with the operational planner (or a person nominated by them) to confirm that the electronic boundary is correct and familiarise themselves with the boundary (the approving manager can exempt certain boundaries from this requirement)
    c. Is briefed regarding the location of sensitive boundaries and exclusion zones, and outlines their sowing plan to ensure that these boundaries will not be breached, to the satisfaction of the operational planner
    d. Receives copies of all relevant consents and approvals, and a hard copy of the map

### Exceptions

The approving manager can allow exemptions to the requirement to fly certain boundaries provided they meet all the following criteria:

- They are not considered to be sensitive boundaries for any reason
- They adjoin treatment areas for which all required permissions are held
- They are readily distinguishable from the air (e.g. bushline)

The approving manager can allow exemptions to fly all the boundaries for a rotenone operation where it is not practical due to the size and obvious boundaries of the application area.

## Resources

- Your operational plan, including task specifications
- Your DOC permission map
- Management of Hazardous Substances SOP DOC-6052105
- Animal pest welfare in firearm and live capture operations
- Health and Safety Management Systems intranet page:
- Hazard and risk management docDM-235267
- Information, training and supervision docDM-231274
- PCBU and contractor management docDM-836257
- Definitions
    1. Aerial application area: The area over which bait is to be aerially applied. This is the shape file given to the pilot to be flown. May have exclusion zones or no fly zones within its perimeter. It doesn't include the areas of the buffers.
    2. Aerial application boundary: The boundary of the area where bait is to be aerially applied. May be buffered in from the treatment area boundary.
    3. Approving manager: The DOC manager who approved the application for DOC permission

# 3.4.2. Operational phase step 2: Undertake pre-control monitoring

This step applies when monitoring is planned. You can expect it to take 2 days to several weeks to complete.

The objective of this step is to establish baseline data for result and/or outcome monitoring, as planned in Step 2 of the Planning phase.

## Process

**Step 1:** Implement your result monitoring and outcome monitoring plans.

**Step 2:** Record the data according to the planned data quality standards.

**Deliverable:** Pre-control monitoring data.

### Checkpoints

You will have completed this step when:

- Your pre-control monitoring data has been recorded according to the relevant monitoring plan.

### Resources

- Your operational plan
- Your result monitoring plan
- Your outcome monitoring plan

## 3.4.3. Operational phase step 3: Communicate the twenty-four hour notice

This step applies when it is part of your communication plan. You can expect it to take 1 – 2 hours to complete.

The objective of this step is to inform the people identified in the communication plan that the operation is about to begin.

### Process

**Step 1:** Open the 24-hour notice page in your communication plan.

**Step 2:** Contact the target audience identified and notify them that the operation is about to occur, using the notification tools specified in your communication plan.

**Step 3:** Record the actual dates and outcomes in the communication plan.

**Deliverable:** 24-hour notice communication record.

### Standards

1. Compulsory target audiences for twenty-four hour notice:
    a. For operations involving vertebrate pesticides, land occupiers and (as far as practicable) owners adjacent to the treatment area and if applicable aerial loading site(s) are included in the twenty-four hour notice
    b. For operations involving vertebrate pesticides, all consent providers are included in the twenty-four hour notice, and close liaison is maintained throughout the operation
    c. Anyone identified for twenty-four hour notification in consent conditions is included in the twenty-four hour notice
    d. Anyone who was promised a twenty-four hour notice during consultation is included in the twenty-four hour notice
2. The twenty-four hour notice is completed in the period specified in any relevant consent conditions (usually 24–48 hours prior to bait application).

3. The twenty-four hour notice is done by visit, phone call, text message or email. Text message or email are only used if:
    a. The recipient has stated that this is their preferred method of contact
    b. The content standard is still met
    c. Contact details are provided for any questions/issues
    d. The recipient replies to the message to acknowledge it has been received
4. Compulsory content for twenty-four hour notice:
    a. The planned start date of the operation
    b. Timing of any closures of tracks or loading sites
    c. If using pesticides, a reminder (from the Notification fact sheet) that the presence of warning signs indicates pesticide residues may still be present in baits or animals
    d. If using pesticides, the risk message not to take animals for eating applies to the buffer zone of the operations, as well as the treatment area itself
5. The dates and outcomes of notification are recorded in the communication plan.

### Resources

- Your communication plan

## 3.4.4. Operational phase step 4: Install operational signage and update relevant Applications

This step applies to all operations. You can expect it to take 1 day to complete.

The objectives of this step are:

- To install signs at the correct locations to communicate risk messages and other information.
- Accurate information about pesticide operations is shown on the Pesticides Summary.

### Process

**Step 1:** If using pesticides, write the date of bait application on all warning signs once the start date of the operation is finalised.

**Step 2:** Install signs at all the required locations. For pesticides, these are the locations shown on the DOCgis Pesticides Application and DOC permission map.

**Step 3:** If using pesticides, check that the details for your treatment block(s) in the DOCgis Pesticides Application are still accurate and update if necessary. Set the status of the virtual signs to "actual" and change the status of the treatment block(s) to "have been laid".

**Deliverables:** Correct signs installed at required locations. Treatment block(s) for pesticide operations are shown on the Pesticide Summary as bait having been laid.

### Standards

The following standards must be followed for pesticide warning signs.

1. Signs located at normal points of entry (as shown on Permissions map) are to be at least A3 in size. Warning signs in other places can be A4 size.
2. Install signs as close as possible before the start of bait application (i.e. on the day before where possible).
3. Sign installation is accurately recorded in the DOCgis Pesticides Application.
4. The information in the DOCgis Pesticides Application accurately reflects the operation and the status of the treatment block(s) is set to “have been laid” as close as possible before the start of bait application (i.e. on the day before where possible).

### Resources

- Your set of signs for the operation
- Your treatment block(s) in the DOCgis Pesticides Application

## 3.4.5. Operational phase step 5: Undertake pest control and update relevant Applications

This step applies to all operations. You can expect it to take 1 day to months to complete.

The objectives of this step are to:

- To meet result targets in your operational plan by following the plan and associated task specifications.
- If using pesticides, to have a complete record of all bait application within the DOCgis Pesticide Application.
- Accurate information about pesticides operations is shown on the Pesticides Summary.

### Process

**Step 1:** The project team completes tasks as delegated in the operational plan, meeting task specifications.

**Step 2:** Address any immediate incident investigation and reporting requirements. For pesticides, this includes reporting bait spills or misapplications (i.e., bait laid outside intended treatment area for which consent is held) as specified on the relevant safe handling sheet. Also check permission conditions for incident reporting requirements.

It may be prudent to report other significant incidents (e.g., non-target deaths) before the Reporting phase. Seek advice from your manager or a Technical Advisor Threats if unsure.

**Step 3:** If using pesticides, the approving manager for your DOC permission may choose to monitor compliance of your operation. If not using pesticides (or if the approving manager does not opt to audit), consider asking a colleague to carry out an audit. This can be done by an independent person who knows this SOP. Provide the auditor with a compliance register for your operation. You will have prepared this in Pre-operational phase Step 2 for aerial pesticide operations. For other operations, follow process Step 5 of Pre-operational phase Step 2 to create one now.

**Step 4:** For pesticide operations, add the details of actual bait application (including pre-feeding) and bait removal/destruction to your treatment block(s) in the DOCgis Pesticides Application within 2 weeks of the fieldwork occurring. For aerial operations, the GIS team will add the treatment data, but it is still the operational planner's responsibility to ensure this happens. Actual bait application must be recorded for the block boundaries to be copied to Operational Activity Actuals. If more than 5% of a block does not receive treatment (e.g., due to poor weather), amend the block boundaries in the DOCgis Pesticides Application accordingly. For aerial applications, maintain the buffers as part of the treatment area.

Ensure the end date of the treatment block(s) in the DOCgis Pesticides Application is correct. For pesticide uses where the bait is left to degrade, it will be the last date of bait application. For pesticide uses where bait must be removed or destroyed at the end of the operation, it will be the date this occurred. This must be done manually as recording bait removal/destruction does not automatically update the end date for a treatment block.

**Step 5:** Record field notes on the operation in preparation for operational reporting, especially any specific issues encountered and practices that differed from what was planned. These could include:

- Timing
- Equipment
- Weather problems
- Contractor performance
- Feedback from people involved in the operation
- Incidents and complaints

**Deliverable:** Pest control completed as specified in the operational plan. Relevant pages completed in your compliance register. If using pesticides, details of actual bait application for each treatment block are available in the DOCgis Pesticides Application.

## Standards

1. If using pesticides, details of actual bait application and removal/destruction are entered for each treatment block in the DOCgis pesticides Application.
2. If using pesticides, the end date for each treatment block in the DOCgis Pesticides Application correctly reflects the actual end date of the operation.
3. All operational information needed for the operational report is recorded.

### Resources

- Your operational plan, including task specifications
- Metservice learning centre https://about.metservice.com/our-company/learning-centre/how-to-read-weather-maps
- NPCP weather forecasting for operational purposes DOC-2929845
- Management of Hazardous Substances SOP DOC-6052105 and relevant safe handling sheet
- Health and Safety Management Systems intranet page: Incident reporting, recording and investigation docDM-25389
- Your prepared compliance register (compliance register template docDM-1475273)
- Compliance register example aerial operation docDM-1572651
- Compliance register example bait station operation DOC-6017602
- Catch Per Unit Effort (CPUE) best practice guidance DOC-10484338
- Your treatment block(s) in the DOCgis Pesticides Application
- DOCgis Pesticides Application user guide https://intmap.doc.govt.nz/AppResources/UserGuides/Pesticides/index_Pesticides.html

## 3.5. Post-operational phase

The post-operational phase starts once the pest control is completed and answers the question, "What happened?"

The Post-operational phase has the following steps:

- Post-operational phase step 1: Send the post-operational update
- Post-operational phase step 2: Monitor baits and/or carcasses
- Post-operational phase step 3: Maintain and remove operational signage
- Post-operational phase step 4: Undertake post-control monitoring
- Post-operational phase step 5: Debrief operation

Work through each step but note that some steps can be done in parallel. By the end of this phase, you will have everything you need to write the operational report.

### 3.5.1. Post-operational phase step 1: Send the post-operational update

This step applies to all operations. You can expect it to take 1 day to complete.

The objective of this step is to inform people that the operational phase has finished and remind them of key risk messages.

## Process

**Step 1:** Open the post-operational update page in your communication plan.

**Step 2:** Notify your target audiences that the operation has occurred, using the post-operational notification tools identified in your communication plan.

**Step 3:** Record the actual dates and outcomes in the communication plan.

**Step 4:** Complete any remaining details in your communication plan and then convert your plan into a communication record (refer to Standard 5).

**Deliverables:** Post-operational update completed, and communication plan updated and converted into a communication record.

## Standards

1. Compulsory target audiences for post-operational notification:
    a. Any target audience identified for notification in consent conditions
    b. The communications centre of Fire and Emergency New Zealand, and any affected persons that were given pre-operational notification, are included in the post-operational update for operations using Magfume™
2. Mailouts or emails are used for all target audiences identified for post-operational update in the communication plan.
3. Compulsory content for post-operational notification:
    a. The details of the control method (if using pesticides include toxic loading, bait type, and application method)
    b. The date when operation/pesticide application finished
    c. Any results to date
    d. Restatement of what to do to avoid or mitigate risks of the operation (from the Notification fact sheet)
    e. If using pesticides, the estimated caution period
    f. If using pesticides, a reminder (from the Notification fact sheet) that the presence of warning signs indicates that pesticide residues may still be present in baits or animals
4. For any pesticide operation applying the Resource Management (Exemption) Regulations 2017: No later than 20 working days after the last date of application the relevant regional council is given written notification with the following information:
    a. A map showing the boundaries of where each application occurred (i.e. the map of the treatment area from the DOCgis Pesticides Application which may have been updated in Operational phase Step 5)
    b. The period during which each application occurred

5. A communication record of the consultation and notification that took place is produced, including:

    a. Actual dates when consultation and notification was undertaken

    b. Outcomes of consultation and notification, including any complaints and how they were addressed

    c. References to resources used (e.g. document management system reference number)

### Resources

- Your communication plan
- Post-operational update example docDM-22889
- Post-operational update NPCP template DOC-7624959
- Post-operational update NPCP example DOC-7675086
- NPCP Guide to engaging with our Treaty Partner and communities at place DOC-6290966
- NPCP resources for engagement and communication DOC-5998295
- WAMP resources for engagement and communication DOC-7624668
- Communication record example docDM-22871

## 3.5.2. Post-operational phase step 2: Monitor baits and/or carcasses

This step applies when using pesticides, if specified on the Performance standards sheets. You can expect it to take months to complete.

The objectives of this step are:

- To determine when the risk of public exposure to pesticides has passed
- To maintain accurate caution period information in the Pesticide Summary
- Monitoring endpoints are met before concluding the caution period.

### Process

**Step 1:** Identify the number of sites to be sampled. Use the Land Environments New Zealand (LENZ) level 1 data accessible through the DOCgis (Geographical Information System). Monitor bait and carcass decay rates at one site for each level 1 land environment present.

Alternatively, monitor bait and carcass decay rates at one site for every 750 m of vertical height within your treatment area, and at least one site where average annual rainfall varies by more than 1500 mm.

If a monitoring site is remote or difficult to access, use a similar site at the same altitude outside the treatment area as a surrogate. Use non-toxic baits if you do not have the necessary permissions to lay pesticides for the surrogate area.

**Step 2:** The start point for bait and carcass monitoring is the same as the start point for the caution period (i.e., either the last date of bait application or when baits are removed or destroyed). Place baits and carcasses at each site at this time. Photograph baits and carcasses from a fixed position to create a record of the start point for monitoring.

**Step 3:** Check baits and/or carcasses once the minimum caution period has elapsed to determine if the estimated caution period can be shortened. If all endpoints have been reached, the estimated caution period can be shortened and concluded. If not, continue monitoring until the end of the estimated caution period to determine which of the following applies:

- If all endpoints have been reached, conclude the caution period.
- If all endpoints have not been reached, extend the estimated caution period. Decide on a new estimated caution period and advise the approving manager for your DOC permission in writing. Update the estimated caution period for your treatment block(s) in the DOCgis Pesticides Application. Continue monitoring and re-extend the caution period until all endpoints have been reached. This is when the caution period is concluded.

Photograph carcasses every time they are checked from a fixed position to create a record of decay over time. Baits are only photographed at the start point and endpoint.

Toxicological analysis can be used to confirm expiry of the caution period if you suspect that the remaining bait or carcass is non-toxic.

**Step 4:** When the caution period has concluded, provide the approving manager for your DOC permission with a bait and carcass monitoring report that meets the standards.

**Deliverables:** Conclusion of the estimated caution period and bait and carcass monitoring report saved to the document management system. Accurate caution period information for your treatment block(s) on the Pesticide Summary.

## Standards

1. The number of monitoring sites is reasonable when evaluated against the LENZ level 1 data (i.e. one site for each environment present) or the range of climates represented at the site.

2. At each bait monitoring site, the number and placement of baits meets the following standards:

    a. Hand laid baits: Three to six baits are monitored at each site. These are enclosed in wire mesh with holes no more than 8 mm x 8 mm, to prevent them being eaten by rodents. Place them on the ground to allow soil decomposers to access them. Place them under vegetation that is most typical of the denser cover in the treatment area. Place them on colder aspects (e.g. southern), to measure the slowest rate of decay.

    b. Bait in bait bags: If bait bags containing toxic bait are to be left in the field, three to six bait bags are to be monitored at each site. These are enclosed in wire mesh with holes no more than 8 mm x 8 mm and placed in a similar manner to the bait bag placement used in the operation.

3. At each carcass monitoring site, the number and placement of carcasses meets the following standards:

    a. Use possum carcasses except where impractical (e.g. rat control in a possum-free area) or where larger animals are easier to source and monitor (e.g. goats or deer). At least two possum carcasses need to be monitored at each site.

    b. Carcasses can be sourced from anywhere but need to be reasonably fresh carcasses with no major open wounds. They do not have to be protected from rodents, but secured to prevent pigs, dogs, or cats from taking them (e.g. inside a possum cage trap pinned to the ground).

    c. Place the carcass on the ground to allow soil decomposers to access them. Place them under vegetation that is most typical of the denser cover in the treatment area. Place them on colder aspects (e.g. southern), to measure the slowest rate of decay.

4. The caution period is concluded when the minimum caution period has elapsed, and the following monitoring endpoints have been reached:

    a. Baits have completely disappeared, or only a few separated particles of grain or wax flakes remain

    b. For carcasses, all soft tissue has disappeared and only bones, skin and fur remain

5. The treatment block(s) in the DOCgis Pesticides Application are updated with the new estimated caution period if it is extended.

6. The approving manager is notified when the caution period is shortened, extended or concluded. Notification includes supplying the bait and/or carcass monitoring report.

7. Compulsory bait and carcass monitoring results are recorded in a report saved to the document management system. This report includes:

    a. Operation name

    b. Pesticide uses in the operation

    c. Caution period start date

    d. Date endpoint(s) reached for each monitoring site

    e. Photos for the first and final monitoring visit to each monitoring site

    f. A statement of whether the treatment area was 'dry' (i.e. <600mm rainfall/year or low rainfall during the monitoring period)

    g. A statement of whether mean temperature in the 6 months following the operation was <10 degrees

## Resources

- Your approved Performance standards sheets for each pesticide use
- Task specifications for this task from your operational plan

- DOCgis https://intmap.doc.govt.nz/internalmaps/index.html?viewer=docgis
- NIWA Climate Database: https://data.niwa.co.nz/
- Definitions:
    1. The caution period is the timeframe (usually number of months) after the last date of bait application or bait removal when DOC expects that the risk of pesticide residues to the public will have passed.
    2. The minimum caution period is the shortest legally compliant caution period that can apply to a particular pesticide use.
    3. The estimated caution period is the caution period established in the DOC permission for an operation and communicated in the DOC Pesticide Summary. The estimated caution period can be subject to bait and/or carcass monitoring, which can result in the period being extended or shortened.
- Craddock, P. 2003: Environmental breakdown of Pest-Off® poison bait (20ppm brodifacoum) at Tāwharanui Regional Park, North of Auckland. Report prepared for Northern Regional Parks, Auckland Regional Council (unpublished), Entomologica Consulting. Auckland, New Zealand. 25pp docDM-311798
- Bait and carcass photographic record example docDM-1481478
- Your treatment block(s) in the DOCgis Pesticides Application

### 3.5.3. Post-operational phase step 3: Maintain and remove operational signage

This step applies to all operations. You can expect it to take months to complete.

The objectives of this step are:

- To ensure that signs are always visible and legible throughout the operation.
- If using pesticides, to remove warning signs when the caution period has expired and to remove the operation from the Pesticide Summary.

#### Process

**Step 1:** Check signs, either by scheduling it alongside other work or by planning specific checks. Repair or replace signs as needed after vandalism or storm damage.

**Step 2:** Remove signs when the risks have passed or when the information they convey is no longer required. For pesticide warning signs, this is after the caution period has concluded (as specified on the performance standards sheets for your operation and may depend on bait and/or carcass monitoring).

**Step 3:** If using pesticides, retire the treatment block(s) in the DOCgis Pesticides Application to remove the operation from the Pesticides Summary. Retiring the treatment block will change the status of all virtual warning signs associated with that block to "removed". Ensure you have added all required information and links to other documents before retiring the treatment area/blocks, as this cannot be done afterwards.

**Step 4:** If using pesticides, notify the approving manager for your DOC permission in writing that signs have been removed.

**Deliverable:** If using pesticides, all warning signs are removed when the caution period has expired, and the treatment block(s) are removed from the Pesticide Summary. For other methods, signs are removed when no longer required.

### Standards

The following table contains the standards that must be followed for this step for pesticide warning signs.

1. Warning signs are always visible and legible throughout the operation.
2. Warning signs are to be checked frequently enough to comply with all relevant consent conditions.
3. Signs are removed when the caution period is concluded. The approving manager is notified of this in writing.
4. When the caution period is concluded the status of the virtual signs in the DOCgis Pesticides Application is changed to "removed" and the treatment block(s) are retired.

### Resources

- Your bait and/or carcass monitoring report
- Caution period definitions:
    1. The caution period is the timeframe (usually number of months) after the last date of bait application or bait removal when DOC expects that the risk of pesticide residues to the public will have passed.
    2. The minimum caution period is the shortest legally compliant caution period that can apply to a particular pesticide use.
    3. The estimated caution period is the caution period established in the DOC permission for an operation and communicated in the DOC Pesticide Summary. The estimated caution period can be subject to bait and/or carcass monitoring, which can result in the period being extended or shortened.
- Your treatment block(s) in the DOCgis Pesticides Application

## 3.5.4. Post-operational phase step 4: Undertake post-control monitoring

This step applies when monitoring is planned. You can expect it to take 2 days to several weeks to complete.

The objective of this step is to re-measure the same parameters you established in Step 2 of the Operational phase. Follow the monitoring plans agreed upon in Step 2 of the Planning phase.

### Process

**Step 1:** Implement your result monitoring and outcome monitoring plans.

**Step 2:** Record the data according to the planned data quality standards.

**Step 3:** Analyse the data.

**Deliverable:** Post-control monitoring data analysed.

### Checkpoints

You will have completed this step when:

- Your post-control monitoring data has been recorded and analysed according to the relevant monitoring plan.

### Resources

- Your operational plan
- Your result monitoring plan
- Your outcome monitoring plan

## 3.5.5. Post-operational phase step 5: Debrief operation

This step applies to all operations. You can expect it to take 2 – 3 hours to complete.

The objective of this step is to identify lessons learned from the operation to improve planning for the next operation. Include these lessons in the operational report.

### Process

**Step 1:** Review the operational plan and discuss with the project team how the operation went.

**Step 2:** Identify lessons learned from all phases of the operation.

**Step 3:** Discuss and agree on the lessons.

**Step 4:** Create a record of the agreed list.

**Deliverable:** Record of lessons from this operation.

### Checkpoints:

You will have completed this step when:

- You have a record of lessons that can be used when writing the operational report and when planning the next operation.

### Resources

- Your operational plan
- The project team—consider involving relevant science or technical advisors
- Consider using a facilitator for the debrief
- Tips on running a good debrief docDM-366280
- NPCP debrief template DOC-5492238

## 3.6. Reporting phase

In the Reporting phase, you answer the question, "What did you do?"

The Reporting phase has the following steps:

- Step 1: Write the Operational report and have it approved
- Step 2: Follow up on lessons and recommendations

By the end of this phase, you will know what you would do differently next time.

### 3.6.1. Reporting phase step 1: Write the Operational report and have it approved

This step applies to all operations (except tahr control). You can expect it to take 1 week to complete.

The objectives of this step are:

- To finalise the operational report to plan future operations at your site and nationally. This is your opportunity to communicate lessons from the project and contribute to best practice.
- To fulfil the legal requirement to have a record of use for certain vertebrate pesticides and meet the aerial 1080 reporting requirements.

#### Process

**Step 1:** Write the operational report using the Operational report template DOC-7129705 or for WAM hunting operations DOC-7723946. Gather the information collected from this operation (e.g., consultation record, consents, field notes, debrief minutes) and previous operational reports. Ensure all incidents are documented in the operational report. Consider peer review of the draft, especially if there are incidents, complaints, or deviations from the planned operation. Add details of the operational report to the Operational reporting master spreadsheet DOC-7194322.

For aerial pesticide operations, check that the GIS Analyst has combined the GPS data files showing the bait application flight lines, and the aircraft secondary positional information with the bait log details and loaded these to the NATIS1 GIS database. For aerial 1080 operations, ask the GIS Analyst to save the map for the EPA aerial 1080 report to the S drive.

For pesticide operations, add the operational report docCM number to your treatment area in the DOCgis Pesticides Application. This needs to be done before retiring all the treatment blocks attached to the treatment area.

**Step 2:** The Operations Manager reviews the report and any advice supplied before approving the operational report by changing the report status to ‘final’ and entering their name and the date in the ‘Approved by’ field.

**Step 3:** For aerial 1080 operations, send an email with the finalised operational report as an attachment and the docCM number of the communications plan to 1080reports@doc.govt.nz for the Improvement Advisor, National Operations s9(2)(g)(ii) [redacted] to review and submit to the EPA.

This must occur within the timeframe stated in Standard 2 to allow the required report to be submitted to the EPA within the 6-month legal timeframe. Advise the Improvement Advisor, National Operations of any aerial 1080 operation carried out jointly with another agency to determine which agency will be submitting the report to the EPA.

**Step 4:** For aerial 1080 operations, the Improvement Advisor, National Operations reviews and amends the copy of the operational report if necessary and submits it to the EPA within 6 months of the first date baits were aerially applied. Follow the instructions in EPA Aerial 1080 report instructions docDM-382846.

**Deliverable:** Approved operational report.

## Standards

1. An operational report is written for all DOC pest operations (except tahr control).
2. For aerial 1080 operations, the report is completed and approved by the Operations Manager within 5 months of the first date baits were aerially applied. The Improvement Advisor, National Operations is emailed (1080reports@doc.govt.nz) the finalised report as an attachment and the docCM number of the communications plan with the subject line 'Operational report for EPA website' within this timeframe.
3. For all other DOC pest operations, the report is completed and approved by the Operations Manager:
    a. Within 2 months after result monitoring is completed;
    b. Where there is no result monitoring, within 2 months after outcome monitoring is completed; or
    c. Annually
4. All sections of the Operational report are completed, using 'N/A' for those not needed. The operational information for treatment blocks is clearly separated in each section of the report where differences exist between them.
5. The Operational report is written to:
    a. Cover the information required by the instructions in the template
    b. Be specific and factual
    c. Align with definitions
    d. Use concise plain English
    e. Use references that are specific and traceable, and only where the template instructions allow for them
6. The Operational report includes at least one map, as a document management system link or a description of the file location (e.g. DOCgis Pesticides Application or S drive).
    a. The map shows the following as a minimum:
    b. Map number and series (e.g. T17 NZMS 260)

c. The external boundary of the treatment area (shade along the inside of the boundary)

d. DOC land boundaries relevant to the operation

e. Name of treatment area

f. Land tenure and adjacent owners, including leased land

g. Any areas excluded from the treatment area (e.g. public water supplies, pā sites)

7. For pesticide aerial operations, the GPS data files showing the bait application flight lines, and the aircraft secondary positional information are combined with the bait log details and loaded to the NATIS1 GIS database.

8. One Operational report is written for each operational plan (i.e. the same grouping standards as in Preparing phase step 1 apply).

9. The details of the operational report are entered into the Operational reporting master spreadsheet.

### Resources

- Operational report template DOC-7129705
- Operational report template: WAM hunting operations DOC-7723946
- Operational reporting master spreadsheet DOC-7194322
- Operational report example: aerial 1080 DOC-7166335
- Operational report example: bait stations DOC-7187410
- Operational report example: WAM goat ground hunting DOC-7189506
- Operational report example: stoat trapping DOC-7263674
- EPA aerial 1080 report instructions docDM-382846
- EPA aerial 1080 reporting requirements map DOC-7478923
- EPA aerial 1080 report example: DOC-7287755
- Your treatment area in the DOCgis Pesticides Application

## 3.6.2. Reporting phase step 2: Follow up on lessons and recommendations

This step applies to all operations if recommendations were identified. You can expect it to take 1 day to complete.

The objective of this step is to follow up on any new information recorded and recommendations made in the operational report.

### Process

**Step 1:** Go to the Lessons Learned and General Recommendations section of the operational report.

**Step 2:** Identify what you can do to share any new information and progress each recommendation.

**Step 3:** Follow through with these actions.

**Deliverable:** New information communicated and recommendations followed up.

## Checkpoints

You will have completed this step when:

- Recommendations have been followed up.
- Any new information about pesticides or traps, or changes recommended to DOC Animal Pests systems, has been shared with the Landscape Threats Advice team in the Terrestrial Biodiversity Group. For example:
    1. Results related to information needs on the DOC Performance Standards sheets
    2. Reports or publications not currently covered by a DOC Pesticide Information Review
    3. Effects on non-target species observed
    4. Results of field trials for any animal pest control method included in Current Agreed Best Practice
    5. Suggestions for improvements to SOPs
    6. Results from pesticide residue testing
    7. Suggested alternatives to personal protective equipment or other improvements to Safe handling sheets
    8. Suggestions for improvements to Current Agreed Best Practice
- You have considered media opportunities and other ways to continue community engagement.

## Resources

- Your Operational report
- The relevant Pesticide Information Review docDM-25413
- Current agreed best practice for animal pest control: updating best practice
- Vertebrate Pesticide Residue Database SOP docDM-33461
- Non-target capture record form DOC-6158657
- Tiakina Ngā Manu Engagement and Communications 4-year Strategy 2020-2024 DOC-6315626
- National Predator Control Programme: Guide to engaging with our Treaty Partner and communities at place DOC-6290966

# 4. Document records

## 4.1. Complete list of resources

### Forms, templates, and examples

- Bait and carcass photographic record example docDM-1481478
- Communication plan template docDM-22868
- Communication plan template user guide docDM-1108789
- Communication plan – complex/new operation example docDM-22869
- Communication plan – simple/maintenance operation example docDM-22870
- Communication record example docDM-22871
- Compliance register template docDM-1475273
- Compliance register example aerial operation docDM-1572651
- Compliance register example bait station operation DOC-6017602
- Consultation fact sheet example docDM-22874
- Consultation fact sheet template docDM-22872
- Consultation fact sheet NPCP template DOC-6174650
- Consultation fact sheet NPCP example DOC-7177104
- DOC application form to use pesticides docDM-95868
- DOC application form with AEE example DOC-2313380
- Ecological problem statement examples docDM-1552765
- Eradication feasibility assessment template DOC-7110779
- Eradication operational design and logistics template DOC-7756004
- Eradication project Management Plan template DOC-7754931
- Eradication readiness check report template DOC-7878544
- Eradication scoping report template DOC-7756009
- Eradication task breakdown example spreadsheet DOC-7878965
- Landowner/occupier visit plan and record template docDM-22881
- National Predator Control Programme debrief template DOC-5492238
- Non-target capture record form DOC-6158657
- Notification fact sheet template docDM-22877
- Notification fact sheet example docDM-22879
- Notification fact sheet NPCP template DOC-6174666
- Notification fact sheet NPCP example DOC-7078346
- Operational plan template: best practice docDM-1475373
- Operational plan template: WAM hunting DOC-7723431
- Operational plan example: aerial 1080 DOC-5488902

- Operational plan example: bait stations DOC-5916783
- Operational plan example: DOC200 stoat trapping DOC-5949271
- Operational plan example: WAM goat hunting DOC-5918086
- Operational report template DOC-7129705
- Operational report template: WAM hunting operations DOC-7723946
- Operational report example: aerial 1080 DOC-7166335
- Operational report example: bait stations DOC-7187410
- Operational report example: WAM goat hunting DOC-7189506
- Operational report example: stoat trapping DOC-7263674
- Operational reporting master spreadsheet DOC-7194322
- Peer review template docDM-318907
- Post-operational update example docDM-22889
- Post-operational update NPCP template DOC-7624959
- Post-operational update NPCP example DOC-7675086
- Project Homepage: NPCP example DOC-5492427
- Project Homepage: WAM example DOC-7723708
- Resource Management Act (RMA) AEE form docDM-96227
- RMA AEE example: Possum control in Mount Malihbu Scenic Reserve docDM-96243
- Section 95E approval form docDM-748579
- Standard letter of consent from landowners/occupiers docDM-95913
- Task specification template docDM-313054

## Resources

- Catch Per Unit Effort (CPUE) best practice guidance DOC-10484338
- Caution period calculator docDM-690617
- Craddock, P. 2003: Environmental breakdown of Pest-Off® poison bait (20ppm brodifacoum) at Tāwharanui Regional Park, North of Auckland. Report prepared for Northern Regional Parks, Auckland Regional Council (unpublished), Entomologica Consulting. Auckland, New Zealand. 25pp docDM-311798
- DOC Pesticide Information Reviews docDM-25413
- EPA aerial 1080 report instructions docDM-382846
- EPA aerial 1080 report example DOC-7287755
- EPA aerial 1080 reporting requirements map DOC-7478923
- Generating a concessionaires list DOC-6278584
- Guidelines for aerial 1080 baiting #1: Bucket calibration DOC-2827796
- Guidelines for aerial 1080 baiting #2: Managing air operations DOC-2651365
- Guidelines for aerial 1080 baiting #3: Considerations for setting up a helicopter loading site for aerial baiting using cereal pellets docDM-1560571

- NPCP Guide to engaging with our Treaty Partner and communities at place DOC-6290966
- NPCP resources for engagement and communication DOC-5998295
- NPCP weather forecasting for operational purposes DOC-2929845
- Overview of planning pest eradications DOC-7711995
- Pesticide summary information for operational planners DOC-5920806
- Status List (pesticides) docDM-22655
- Status List (traps) DOC-5620413
- Status List user guide docDM-95853
- Target pests for aerially applied 1080 pellets DOC-2649524
- Tiakina Ngā Manu Engagement and Communications 4-year Strategy 2020-2024 DOC-6315626
- Tips on running a good debrief docDM-366280
- Understanding the RMA for animal pest operations docDM-96158
- WAMP resources for engagement and communication DOC-7624668
- Who's Who in Animal Pests docDM-98043
- Wilson and Cannon (2005) Community consultation processes for aerial 1080 applications Science for Conservation No 247 https://www.doc.govt.nz/globalassets/documents/science-and-technical/sfc247.pdf
- Working out which consents you need for animal pest operations docDM-1475279
- Writing SMART targets docDM-340202

## Intranet/websites

- Animal pest management resources intranet page
- Animal pest welfare in firearms and live capture operations
- Argentine ants in New Zealand https://argentineants.landcareresearch.co.nz/index.asp
- Bioweb (logon access required)
- Current agreed best practice for animal pest control
- DOCgis https://intmap.doc.govt.nz/internalmaps/index.html?viewer=docgis
- DOCgis Pesticides Application
- DOCgis Pesticides Application user guide
- DOCWiki https://docwiki.depcon.internal/wiki/Pesticide_Application
- Environmental Protection Authority Application for Permission website https://www.epa.govt.nz/industry-areas/hazardous-substances/making-an-application/permissions/
- Eradication best practice document and planning tools
- Health and Safety Management Systems intranet page
- How to order DOC signs

- Information management and library intranet page
- Inventory and Monitoring toolbox https://www.doc.govt.nz/our-work/biodiversity-inventory-and-monitoring/
- Metservice learning centre https://about.metservice.com/our-company/learning-centre/how-to-read-weather-maps
- Ministry of Health application form and guidance on public health permissions for VTAs https://www.health.govt.nz/publications/guidelines-for-issuing-permissions-for-the-use-of-vertebrate-toxic-agents
- NIWA Climate Database https://data.niwa.co.nz/
- Pest detective https://web.archive.org/web/20220121175632/http://pestdetective.org.nz/
- Pestlink (logon access required)
- PF2050 Practical guide to trapping https://www.doc.govt.nz/globalassets/documents/conservation/threats-and-impacts/pf2050/trapping-guide-pf2050.pdf
- Policies, Standard Operating Procedures and Guidelines intranet page
- Procurement and purchasing pre-drafted contract intranet page
- Protection of drinking water – guidance (Appendix 5 of Guidelines for Issuing Permissions for the Use of Vertebrate Toxic Agents) https://www.health.govt.nz/system/files/2011-11/guidelines-for-issuing-permissions-for-the-use-of-vertebrate-toxic_agents-29_july.pdf
- Risk Manager
- Trapping application https://trap.nz/
- Trapping application intranet page
- Weather websites (e.g. www.metvuw.com; www.metservice.co.nz)
- Wild Animals Management programme intranet page
- Working with contractors intranet page

## SOPs/guidelines/policies

- Animal Pests SOP Definitions and FAQs docDM-51708
- Aerial 1080 in kea habitat SOP DOC-2612859
- Consultation Guidelines olddm-780974
- Consultation Policy olddm-780975
- Field Trials for Pest Operations SOP docDM-51573
- Firearms SOP DOC-5960893
- Helicopter aerial hunting SOP DOC-6262530
- Hunting safely (ground) one-page SOP docDM-673812
- Hunting safely (ground) technical document docDM-751751
- Management of Hazardous Substances SOP DOC-6052105

- Obtaining DOC permission for rodenticide use in island incursions SOP DOC-2751605
- Processing Applications for Vertebrate Pesticides and Trapping SOP docDM-1490584
- Procurement and Supplier Management SOP docDM-912450
- Use of second generation anticoagulants policy docDM-97398
- Vertebrate Pesticide Residue Database SOP docDM-33461
- Wild animal detection dog-handler team SOP DOC-6615586

## 4.2. Document history

| Date | Details | Document ID and version | Amended by |
|---|---|---|---|
| 2/06/2015 | Effective date of new SOP | 1.0 | s9(2)(g)(ii) |
| 17/08/2015 | Change to pre-operational notification requirements for PAPP | 1.1 | s9(2)(g)(ii) |
| 17/09/2015 | Change to standard for pre-operational notification to MOH and other edits | 1.2 | s9(2)(g)(ii) |
| 21/10/2015 | Change to process for Pre-operational phase step 2 to clarify compulsory elements of the compliance register. | 1.3 | s9(2)(g)(ii) |
| 25/11/2015 | Amended scope (application of SOP to community groups). Change to 24 hour notice standards. | 1.4 | s9(2)(g)(ii) |
| 9/02/2016 | Job title changes as a result of the Pilot implementation. Resources added to Preparing phase step 7 and Planning phase step 3. | 1.5 | s9(2)(g)(ii) |
| 3/11/2016 | Incorporate requirements of DOCgis Pesticides Application. Grouping standards moved to Planning step 1. | 1.6 | s9(2)(g)(ii) |
| 10/03/2017 | Change to exemption for flying the boundary (all the criteria must be met). New standards and information about the Resource Management (Exemption) Act. Other minor clarifications. | 1.7 | s9(2)(g)(ii) |

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|---|---|---|---|
| 6/04/2017 | Distinguish between treatment area and aerial application area for Operational Step 1. Change Reporting Step 1 to “always applies” as it contains legal standards. Reword standards and information about the Resource Management (Exemption) Act. | 1.8 | s9(2)(g)(ii) |
| 5/05/2017 | Public notice standard for viewing detailed map amended as Pesticide Summary map may not be sufficient as it does not include private land (if any). | 1.9 | s9(2)(g)(ii) |
| 31/07/2017 | Minor updates to links and resources. | 1.10 | s9(2)(g)(ii) |
| 11/10/2017 | Update to Pestlink reporting requirements, job titles, and add links to incident reporting requirements. | 1.11 | s9(2)(g)(ii) |
| 28/11/2017 | Updates from new Health and Safety at Work (Hazardous Substances) Regulations 2017. | 2.0 | s9(2)(g)(ii) |
| 6/11/2018 | Change to standard for maintaining warning signs. Add definition of broad scale use of insecticides to the scope. | 2.1 | s9(2)(g)(ii) |
| 29/04/2019 | Warning sign template changed. | 2.2 | s9(2)(g)(ii) |
| 29/07/2019 | Revise op plan template and examples. New step in Planning phase for DOCgis Pesticides App. Deleted audit information not relevant to operational planning from Operational phase step 5 and added more information about DOCgis Pesticides App. Move Post-operational update step to beginning of post-operational phase. Change to standard for public notice. | 3.0 | s9(2)(g)(ii) |
| 5/09/2019 | Move standard to confirm treatment boundaries during consultation from Preparing Step 8 to Planning Step 6. Add information on compulsory audiences to Planning step 6. | 3.1 | s9(2)(g)(ii) |
| 9/10/2019 | Standard relating to zinc phosphide use removed, as this is no longer a registered product. | 3.2 | s9(2)(g)(ii) |

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|---|---|---|---|
| 14/01/2020 | Requirements for consultation and notification fact sheets included in standards (instead of compulsory templates). Added link to Tiakina Ngā Manu communication resources. Added notification standards for D+C. | 3.3 | s9(2)(g)(ii) |
| 30/01/2020 | Treatment blocks in DOCgis Application to be decreased in size if more than 5% of the block does not actually receive treatment. | 3.4 | s9(2)(g)(ii) |
| 29/07/2020 | RMA exemption post-operational reporting mapping standard expanded for clarity. | 3.5 | s9(2)(g)(ii) |
| 29/09/2020 | Update hyperlinks (DOCgis, outdoor sign manual) and clarify how an assessor should be assigned to an operation. | 3.6 | s9(2)(g)(ii) |
| 15/03/2021 | Add requirements for implementation of trap performance standards from TTAG risk assessments. Operational phase step 5: Add further prompts for incident reporting. Pestlink reporting: requirement for map to be sent to Bio planners removed as they will obtain it directly from GIS team; docCM number for communications plan to be sent. DOGgis Pest app: treatment data for aerial ops entered by GIS team, files saved to NATIS1. Add links: TNM Engagement Strategy, TNM Engagement Guide, and Generating a concessionaire list. | 3.7 | s9(2)(g)(ii) |
| 19/04/2021 | Update Planning phase step 5 and Pre-operational phase step 6 to reflect that applications for DOC permission for aerial operations are processed through SPT. Planning phase step 6 - risks and threats to be recorded in communication plan. All steps relating to consultation updated on advice from Legal (seeking information, recording decisions and outcomes). Add link to GMC templates. | 3.8 | s9(2)(g)(ii) |
| 27/09/2021 | Update scope to exclude some rodent incursion responses. | 3.9 | s9(2)(g)(ii) |

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|---|---|---|---|
| | Add project homepage example. Update steps to expand on adding. agreements/risks to compliance register. Revise visit plan and record template. Add prompt to update DOCgis Pest App in Planning phase step 4. Other minor clarifications/corrections. | | |
| 12/11/2021 | Add possible resources to be used in Preparing phase steps 8 & 10. Update hyperlinks. Rearrange notification standards to make them easier to read. Add to warning sign standard that an organisation/office name is required (previously shown on graphic in standard but not in the wording). Clarify deliverables and standards for several steps where actions are required to be taken in the DOCgis Pest App. | 3.10 | s9(2)(g)(ii) |
| 2/06/2022 | Add link to MOH guidance on protection of drinking water supplies to Planning phase steps 4 & 6. Update standards for consultation/notification of adjoining landowners to include loading site. | 3.11 | s9(2)(g)(ii) |
| 15/09/2022 | Change TNM to National Predator Control Programme. Preparing phase step 7: add information about the process for unregistered pesticide uses. Planning phase step 4: add links to resources relevant to hunting operations. Pre-operational phase step 2: Added information for when a public health permission is not issued. Reporting phase step 1: prompt to add Pestlink reference number to DOCgis Pesticides Application prior to retiring all the treatment blocks. | 3.12 | s9(2)(g)(ii) |

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|---|---|---|---|
| 10/08/2023 | Add resources to Planning phase step 4 (trap.nz), Operational phase step 5 (NPCP weather resources) and Post-operational phase step 5 (NPCP debrief template). Pre-operational phase step 6 – add information to process step 1. Post-operational phase step 3 – add information to process step 3. Correct minor formatting issues and update job titles. | 3.13 | s9(2)(g)(ii) |
| 31/10/2023 | Update hyperlinks to intranet pages for current agreed best practice | 3.14 | s9(2)(g)(ii) |
| 12/02/2024 | Update intranet links | 3.15 | s9(2)(g)(ii) |
| 1/03/2024 | Changes to replace Pestlink with new Operational reporting template. Various minor wording changes, including changing step names to better include non-pesticide operations. | 3.16 | s9(2)(g)(ii) |
| 2/07/2024 | Add hyperlinks to NPCP post-op update template & example, WAMP communication resources, and PF2050 trapping guide. | 3.17 | s9(2)(g)(ii) |
| 3/09/2024 | Add hyperlinks to Wild Animal Management Programme homepage example, and operational plan & report templates. Completed aerial 1080 post-operational reports to be sent to Regional Planner LNI (interim measure until roles are formally re-assigned following restructure). | 3.18 | s9(2)(g)(ii) |
| 4/10/2024 | Completed aerial 1080 post-operational reports to be sent to Senior Planning Advisor, National Operations. | 3.19 | s9(2)(g)(ii) |
| 26/11/2024 | Reference to Bio planner changed to Regional Pesticides Summary Coordinator. Add prompt to Reporting phase Step 1 to ask GIS Analyst for aerial 1080 report map to be saved to the s drive. | 3.20 | s9(2)(g)(ii) |

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|---|---|---|---|
| 28/01/2025 | Update intranet page hyperlink for ordering signs and remove link to Outdoor sign manual as this is no longer listed on the Policies & Procedures intranet page. | 3.21 | s9(2)(g)(ii) |
| 14/10/2025 | Update details for where to send aerial permission applications. Replace references to Safe handling of pesticides SOP with Management of hazardous substances SOP. Add links to templates for eradication planning. | 3.22 | s9(2)(g)(ii) |
| 16/02/2026 | Simplification and transfer into new template as part of the Shared Services Improvement Project. | 4.0 | s9(2)(g)(ii) |
| 6/03/2026 | Contact name and email address for aerial 1080 reports updated. | 4.1 | s9(2)(g)(ii) |

## About this document

| | |
|---|---|
| **Disclaimer** | This document has been written for Department of Conservation (DOC) staff and contractors. As a result, it includes DOC-specific terms and refers to internal documents that are only accessible to DOC staff and contractors. It is being made available to external groups and organisations to demonstrate departmental best practice. As these procedures have been prepared for the use of DOC staff and contractors, other users may require authorisation or caveats may apply. Any use by members of the public is at their own risk and DOC disclaims all liability for any risk. |
| **Document Coordinator** | s9(2)(g)(ii), Senior Technical Advisor, Landscape Threats Advice, Terrestrial Biodiversity Group |
| **Document Owner** | s9(2)(g)(ii), Landscape Threats Advice Manager, Terrestrial Biodiversity Group |
| **Approved for use by** | s9(2)(g)(ii), **Deputy Director-General, Biodiversity, Heritage & Visitors Group**<br><br>Date: 20/02/2026<br><br>*DOC-10677781* |
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| **Classification** | UNCLASSIFIED |
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# Sodium fluoroacetate

## Pesticide Information Review

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9(2)(g)(ii)

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**This report may be cited as:**

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**Version History:**

| Version | Date Written | Change/Reason for Change |
|---|---|---|
| 2025/1 | 25/07/2025 | New information added to sections 2.5.4, 3.2.1, 5.2.2 |
| 2024/2 | 09/09/2024 | Section 3.2.1 and 3.2.3 updated with information on kea. Information added to 3.2.1 (kea and gull deaths) and 4.2.1 (tahr kills) from historic carrot operation. New information on bykill rate of stoats and feral cats added to 6.2.4. |
| 2024/1 | 08/02/2024 | Section 1.4 updated with product registrations. Section 2.5.4 updated with residue test results. Information added to section 3.2.1 with deaths of Southern Black Backed gulls, rowi and kea. Information added to section 3.2.3 from kea monitoring in Otira Taipo and Arthur's Pass West operations, Information on tahr survival trial through aerial 1080 operation added to section 4.2. |
| 2022/3 | 16/09/2022 | Information on weka added to sections 3.1 & 3.2. Pestex and Prodeer bait added to sections 4.2 and 6.2.Bait degradion info added to section 2.1.1. |
| 2022/2 | 01/06/2022 | Information on honey bees added to sections 2.5.4; 4.2.1. |
| 2022/1 | 24/01/2022 | Information on southern black-backed gulls added to sections 3.2.1 & 3.2.3 |
| 2021/4 | 13/10/2021 | New information included in sections 1.8.3 (absortion, metabolism, excretion); 2.1.2 (solubility); 3.1.1 & 3.1.3 (earthworms and soil microorganisms); 5.1.1(lethal dose estimates); 5.1.8 (sub-lethal effects on blood chemistry & organ function); 5.1.9 (refs from poisoning cases in humans); 6.1.1 (animal welfare impacts). |
| 2021/3 | 26/07/2021 | New information added to section 2.5.5 on persistence of 1080 in bone marrow of carcasses; 4.2.1 information on recorded by-kill of feral deer populations and by-kill of whitetail deer. |
| 2021/2 | 25/06/2021 | Corrected mistake in section 3.2.3. re number of aerial/handlaid operations where NI Brown Kiwi have been monitored. |

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|---|---|---|
| 2021/1 | 13/01/2021 | Updated section 3.2.1 with new information for kea and takahe; New information added to section 3.2.3 for kea, rock wren and takahe. |
| 2020/1 | 24/04/2020 | New information added in section 2.2.1 for breakdown of feral cat 1g/kg 1080 baits; 3.2.1 and 3.2.3 updated with new information from kea monitored through 1080 cereal pellet operations. |
| 2019/1 | 1/11/2019 | New information included in section 3.2.1 (Table 7, new records for kea and whio); information added to section 3.2.2 (1080 positive whio scat samples); Information added and revised in section 3.2.3 (whio monitored through cereal pellet operations, kea monitored through cereal pellet operations, monitoring forest birds in Rolleston and Alexander Ranges). Updated $LD_{50}$ for norway rat in 6.2.1. Updated Table 11, section 3.2.2. |
| 2018/6 | 21/12/2018 | Updated kea information in section 3.2.3 |
| 2018/5 | 6/11/2018 | Updated sections 2.1.1 (dust); 2.5.4; 4.2.2 (captive reared whio); 3.2.3 |
| 2018/4 | 9/10/2018 | Updated 1.6 Historical Development and Use section, inserted new section 1.7 Natural Occurrence, information about dust in Section 2.1.1., information about breakdown products in water in section 2.3.1, updated 5 Human Health |
| 2018/3 | 30/08/2018 | Corrected spelling mistakes and updated 'Effects on native non-target' summary |
| 2018/2 | 06/06/2018 | Information about No Possums® 1080 gel moved to Appendix 1; Efficacy data for aerial operations updated |
| 2018/1 | 15/05/2018 | Update information in Sections 2.5.4, 3.2.1 and 4.2.1 |
| 2017/3 | 4/9/2017 | Updated field efficacy data 6.2.4 for possums, rats, mice and stoats. |
| 2017/2 | 4/08/2017 | Updated information in Sections 2.5.4, 3.2.1, 3.2.2, 3.2.3 (short-tailed bats). Corrected scientific names. |
| 2017/1 | 12/07/2017 | Updated information in Sections 2.2.1, 2.5.4, 3.2.2, 3.2.3 & 4.2.1 (kea) |
| 2016/2 | 14/12/2016 | Updated information in Section 2.3.1. |
| 2016/1 | 15/08/2016 | Updated information in Section 3.2.3 about Archey's frogs. |
| 2015/2 | 23/12/2015 | Noted that No Possums® 1080 gel has been de-registered |

| | | |
|---|---|---|
| 2015/1 | 30/06/2015 | Efficacy data in Section 6.2.4 for possums, rats, mice, rabbits and stoats updated. |
| 2014/3 | 15/12/2014 | New data on trout in Sections 2.5.1.and 2.5.2 |
| 2014/2 | 12/12/2014 | Formatting changes, and updates to Sections 3.2 and 6.2 |
| 2014/1 | 29/08/2014 | New data on soil breakdown (Section 2.2.2), water samples (Section 2.3.1), native non-targets (3.2.3), and revised overview for native non-targets |
| 2013/1 | 18/09/2013 | New information on kea (Sections 2.5.4, 3.2.1 and 3.2.3) and morepork, kaka, robins, tomtits, grey warbler and riflemen (3.2.3). |
| 2012/3 | 23/10/2012 | New information on fernbirds (Sections 2.5.4, 3.2.1 and 3.2.3) & bees (4.2.1) |
| 2012/2 | 17/10/2012 | New information on 1080 residues in magpies (*Pica pica*) in 2.5.4, and $LD_{50}$ for magpies in 4.1.1. |
| 2012/1 | 12/04/2012 | New information on 1080 in water 2.3.1, 2.3.2, and 2.3.3, and 3.2.1 (snails), corrected formatting and Table numbers. |
| 2011/2 | 17/10/2011 | New information (kea) 3.2.3 |
| 2011/1 | 13/1/2011 | New information on fish and aquatic invertebrates 3.2.3 |
| 2010/2 | 31/08/2010 | New information (kiwi) 3.2.3 |
| 2010/1 | 3/08/2010 | New information 2.5.2, 3.2.2 & 3.2.3 |
| 2009/7 | 15/12/2009 | 3.2.3 (skinks and weka); 5.1.7, 6.2.4 (Rats) |
| 2009/6 | 1/09/2009 | Corrected number of operations monitored by Thomas et al. (2004) in section 2.1.1 |
| 2009/5 | 13/8/2009 | New information in sections 2.5.4 (Quail) & 4.2.1 (0.2% carrot and 0.04% oat operations). |
| 2009/4 | 20/7/2009 | Rewrote sections 2.3.1, 2.4.2 and 2.4.3 based on new information. |
| 2009/3 | 13/07/2009 | New information in Section 3.2.2 (falcon); 6.2.4 (Mice) |
| 2009/2 | 19/05/2009 | New information in Section 6.2.2 (Mice) |
| 2009/1 | 17/02/09 | New information in Sections 2.5.1 & 2.5.4 (deer); 3.2.1 & 3.2.3 (Kakariki) |
| 2008/1 | 18/09/08 | New information in Sections 2.5.2; 2.5.4; 3.2.1 & 3.2.3 (kea); 4.1.4; 4.2.1; & 6.2.4 |
| 2006/2 | 10/08/06 | New information in section 3.2.3 (paste baits) |

| | | |
|---|---|---|
| 2006/1 | 15/3/06 | New information in sections 2.1.1; 2.5.5; 3.2.3; & 6.2.4. |
| 2005/2 | 17/03/05 | New information in sections 2.1.1; 2.4.2; 2.5.2; & 6.2.4. |
| 2005/1 | 18/01/05 | Up dated Section 1.4 pesticide uses |
| 2004/2 | 8/10/2004 | Residue and non-target native and feral animal information from Speedy (2003) included |
| 2004/1 | 15/9/2004 | Original document |

# Contents

# Overview

## *Introduction*

Sodium monofluoroacetate (1080) is the most widely used poison for possum control in New Zealand for situations where possum numbers need to be reduced rapidly over large areas. Vertebrate pesticides containing 1080 are also registered for the control of rabbits, wallabies, deer, goats, cats and rodents. The manufactured 1080 used in toxic baits is chemically identical to the toxic compound found in some poisonous plants, and highly toxic fluoroacetate-producing plants are globally distributed. In plants, fluoroacetate appears to be a secondary plant compound that is biosynthesised at high concentrations as a chemical defence mechanism against browsing invertebrates and vertebrates.

Monofluoroacetate is converted within animals to fluoroacetate, which inhibits the tricarboxylic acid cycle. This results in accumulation of citrate in the tissues and plasma, energy deprivation, and death. Sodium monofluoroacetate (1080) is absorbed through the gastrointestinal tract or via the lungs if inhaled. Monofluoroacetate is not readily absorbed through intact skin, but it can be absorbed more readily through cuts and abrasions.

## *Fate in the Environment*

1080 in baits may be defluorinated in 1–2 weeks under favourable conditions. However, under less favourable conditions breakdown may take several weeks and, in extreme cold and drought, 1080 residues could persist in baits for several months.

Degradation of 1080 is slow in soil and sediments, taking 1-4 weeks under favourable conditions. The rate of degradation will be influenced by the presence of soil or litter micro-organisms, and temperature, soil moisture and rainfall. Sodium monofluoroacetate is highly water soluble so leaching out of soil will occur.

While the concentration of 1080 in deionised (sterile) water remains relatively constant and independent of temperature, 1080 degradation occurs within 1-2 weeks in natural water. Temperature, and the presence of aquatic plants and microbes all affect 1080 degradation in aquatic environments. Water samples have been collected from streams following numerous pest control operations using 1080. 96.6% of these samples contained no residues of 1080. Where residues were found most of these had less than 1 $\mu g\ l^{-1}$ 1080. Where higher 1080 residues have been found in water, the samples were mostly from very small streams and/or associated with the presence of bait, during aerial operations.

While plants can take up 1080, it is unlikely to be in large amounts. If taken up, 1080 residues persist less than 38 days in plants.

1080 has a relatively short half-life in sub-lethally dosed animals and it is metabolised and eliminated from living animals within days. However, it can persist in carcasses for months. The rate of degradation of 1080 in carcasses will depend on moisture, temperature and the presence of micro-organisms.

### *Effects on Non-Target Native Species*

Based on the few studies of native species available, and the large number of non-native species studied (Part 4) suggests 1080 is likely to be toxic to most native animals. There is wide variation in sensitivity between taxonomic groups with mammals more sensitive than birds and invertebrates (on a weight for weight basis). Sub-lethal effects have been demonstrated for native invertebrates in the laboratory. The small size of many native species (relative to the target pests) means that toxic baits used for pest control are capable of causing harm to almost any animal that eats the bait. Therefore, the level of exposure to the bait becomes important in determining the effects on non-target native species in the field.

Most information on non-target exposure to 1080 bait relates to aerial poisoning as this is thought to be the "worst case scenario" for studying non-target effects. Hand laid baits are sometimes used to approximate aerial poisoning in studies. Bait station studies are scarce. It could be assumed that native species are not more at risk using bait stations than distributing the same bait type aerially.

There are records of a range of native bird species found dead after aerial poisoning operations and many of these individuals have contained residues of 1080. However, when records are discounted from:

- operations which did not meet current bait quality standards (e.g. using unscreened, un-dyed carrot bait with berry fruit lures) or
- those animals which did not have detectable 1080 residues,

the Vertebrate Pesticide Residue Database (VPRD) between 1994-2018 recorded only 44 poisoned individuals representing 11 native species across all bait types used in aerial and handlaid operations. No conclusions about population effects can be drawn from this information but it is useful to focus further studies. Some native species (mainly invertebrates) have contained 1080 residues when sampled, an indication of potential risk to insectivores from secondary poisoning.

Loss of individuals in a population of native species as a consequence of 1080 poisoning can have variable significance to the long-term viability of the population depending on the context. Those animals with a large population and/or a high rate of increase can compensate for small loses. Poison-related mortality may be replacing deaths from predation or winter starvation. Threatened species usually have a poor ability to recover from additional mortality, making the consequences theoretically more concerning.

There have been numerous studies examining the effects of aerial poisoning on native non-target populations over the last 20 years. 24 species of native birds, particularly threatened species, have been monitored. None of the studies have identified population level mortality which threatened the viability of the species, although the only reliably calculated mortality rates are for kokako, kiwi, kaka and fernbirds. The upper 95% mortality rates for kokako, kiwi, and kaka are all less than 3.5%. The mean mortality rate for fernbirds is 9.4%.

Limited monitoring of short tailed bats and native frogs has not indicated detectable mortality due to aerial 1080 poisoning.

Invertebrate populations have been monitored in nine aerial poisoning operations and none have shown significant population effects on any species studied, nor is there evidence to suggest poisoned invertebrates are a significant factor in secondary poisoning of other animals. Long term monitoring of native land snails indicates substantial benefits to threatened populations in sites treated with aerial poisoning.

The risks 1080 operations pose to aquatic species is considered very low. Fish are very tolerant to 1080. Additionally, 1080 contamination of water is rarely found during 1080 operations and is at an extremely low level when it has occurred. No mortality of longfin eels, köaro or upland bullies was observed during experiments where high densities of cereal 1080 pellets were placed in water just upstream of them. Eels and koura have survived experimental feeding of cereal 1080 pellets, and eels have survived feeding on possum tissue containing 1080. There have also been no detectable effects on aquatic invertebrate communities in field studies when 1080 baits were placed at high densities in streams.

### *Effects on Domestic and Feral Animals*

There is wide variation between species in their susceptibility to 1080 poisoning. Dogs are especially vulnerable and highly likely to die if they eat 1080 baits or scavenge animals killed by 1080. Larger animals such as cattle need several possum baits to receive a lethal dose but deaths have been reported where animals have access to baits, including those contained in bait stations.

Sub-lethal effects at realistic dose rates have been recorded in sheep and other species, typically affecting the heart. Exposure to prolonged high doses resulted in mild foetal abnormalities in pregnant rats and damaged sperm in male rats but no mutagenic properties were found. No antidote is currently available for 1080 poisoning although veterinary treatment can be successful.

Feral deer population mortality from aerial poisoning operations targeting possums and rats has been highly variable. Across a number of 1080 cereal pellet operations deer mortality estimates were more often classed as low (0-33%) when sowing rates were at or below 1.5kg/ha and potentially at those sites that had been previously treated within 5 years. Field trials have indicated that deer-repellent baits can reduce the level of deer mortality relative to when non-repellent baits are used.

Birds are generally less susceptible to 1080 than mammals but introduced birds such as blackbirds and chaffinches are found dead after aerial poisoning operations. Lizards and fish appear quite tolerant of 1080, according to research on overseas species.

Although 1080 is toxic to honeybees, baits used in pest control are generally not attractive to honeybees. However, this may not be the case if honeybees are particularly hungry, and food resources are scarce. On occasion and under these conditions honeybees have been observed collecting and storing cereal pellet bait material in hive frames as a substitute for pollen. Tests of honey from affected hives found no trace of 1080. Paste baits containing 1080 were reformulated in the 1990s to reduce their attractiveness to bees.

### *Human Health*

The estimated lethal dose of 1080 in humans lies in the range of 0.7 and 10.0 mg $kg^{-1}$. Sodium monofluoroacetate (1080) is absorbed through the gastrointestinal tract or via the lungs if inhaled. Monofluoroacetate is not readily absorbed through intact skin, but it can be absorbed more readily through cuts and abrasions. The onset clinical signs usually range from 30 minutes to about 2-3 hours. Signs of poisoning include nausea, vomiting, and abdominal pain initially, followed by respiratory distress, anxiety, agitation, muscle spasms, stupor, seizures, and coma.

1080 is not a mutagen and is unlikely to be a carcinogen. It has sub-lethal effects on reproduction and is classified as a teratogen.

There is no effective antidote for 1080 poisoning in humans and any treatment given is largely symptomatic and supportive.

### *Operational*

1080 is considered to have medium humaneness for possums, however there has been little formal research into the humaneness of 1080 on other target species. Most deaths of pest species occur 8 – 48 hours after ingestion of a lethal dose.

All the registered target species have relatively high susceptibility to 1080. The short latent period means that bait shyness can develop in animals receiving a sub-lethal dose. Mice exhibit a marked avoidance of 1080 which is likely to result in control operation failures.

The majority of pest control operations using 1080 have target pest kills of greater than 80%.

# 1. Introduction

Sodium monofluoroacetate (1080) is the most widely used poison for possum control in New Zealand for situations where possum numbers need to be reduced rapidly over large areas. Vertebrate pesticides containing 1080 are also registered for the control of rabbits, wallabies, deer, goats, cats and rodents. The manufactured 1080 used in toxic baits is chemically identical to the toxic compound found in some poisonous plants, and highly toxic fluoroacetate-producing plants are globally distributed. In plants, fluoroacetate appears to be a secondary plant compound that is biosynthesised at high concentrations as a chemical defence mechanism against browsing invertebrates and vertebrates.

Monofluoroacetate is converted within animals to fluorocitrate, which inhibits the tricarboxylic acid cycle. This results in accumulation of citrate in the tissues and plasma, energy deprivation, and death. Sodium monofluoroacetate (1080) is absorbed through the gastrointestinal tract or via the lungs if inhaled. Monofluoroacetate is not readily absorbed through intact skin, but it can be absorbed more readily through cuts and abrasions.

## *1.1. Chemical name*

Sodium monofluoroacetate

## *1.2. Synonyms*

Sodium fluoroacetate, Monofluoroacetate, Compound-1080, 1080 ('ten-eighty')

## *1.3. CAS Numbers*

62-74-8

## *1.4. Registered pesticides containing 1080 available in New Zealand*

**0. 2 % 1080 Pellets** (2 g $kg^{-1}$ 1080), Pesticide use numbers: 21, 22, 23

**Pronature Possum & Rodent Pellet (previously 0.15% 1080 Pellets)** (1.5 g $kg^{-1}$ 1080), Pesticide use numbers: 1, 2, 3, 98

**0.08 % 1080 Pellets** (0.8 g $kg^{-1}$ 1080), Pesticide use numbers: 7, 8, 9

**0.08 % 1080 Rodent Pellets** (0.8 g $kg^{-1}$ 1080), Pesticide use numbers: 10, 11, 12

**0.04% 1080 Pellets** (0.4 g $kg^{-1}$ 1080), Pesticide use numbers: 13, 14

**1080 solution** (200 g $l^{-1}$ 1080), Pesticide use numbers: 5, 6, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 37

**0.10% 1080 Feral Cat Bait** (1.0 g $kg^{-1}$ 1080), Pesticide use numbers: 38, 115

**10% 1080 Gel** (100 g $kg^{-1}$ 1080), Pesticide use numbers: 15

**5% 1080 Gel** (50 g $kg^{-1}$ 1080), Pesticide use numbers: 16

**Pestoff Exterminator Paste** (1.5 g $kg^{-1}$ 1080), Pesticide use numbers: 35, 36

**Pestoff Professional 1080 Possum Paste 0.08%** (0.8 g $kg^{-1}$ 1080), Pesticide use numbers: 41

**Pestoff Professional 1080 Possum Paste 0.15%** (1.5 g $kg^{-1}$ 1080), Pesticide use numbers: 42, 96

Pestoff Professional 1080 Possum & Rabbit Paste 0.06% (0.6 g $kg^{-1}$ 1080), Pesticide use numbers: 44

**Pestex** (1.5 g $kg^{-1}$ 1080), Pesticide use numbers: 140, 141, 142

Pestex DR (1.5 g $kg^{-1}$ 1080), Pesticide use numbers 149, 150, 151

Prodeer Possum and Rat Bait (1.5 g $kg^{-1}$ 1080), Pesticide use numbers 145, 146, 147, 148

Note: **No Possums® 1080 gel** was de-registered in 2015. Information about this product is contained in Appendix 1 (doc-2534486).

## *1.5. Chemical and physical properties*

The empirical formula of 1080 is $C_2H_2FNaO_2$ (Figure 1). It has a molecular weight of 100.3. In its pure form 1080 is an odourless, colourless, non-volatile powder that decomposes at about 200°C. Although the compound is often said to be tasteless, dilute solutions are thought to taste like weak vinegar. Sodium monofluoroacetate is very water-soluble but has low solubility in organic solvents such as ethanol and oils. Monofluoroacetates are chemically stable, hence 1080 as a pure compound in powder form — or when prepared in an aqueous stock solution — will not readily decompose.

This section is from Eason and Wickstrom (2001).

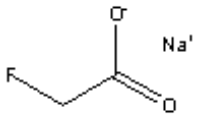


Figure 1. **The chemical structure of sodium fluoroacetate.**

## 1.6. Historical development and use

Sodium monofluoroacetate was first patented as a rodenticide in the late 1930's, with commercial use starting in the United States in 1944 to control gophers, ground squirrels, prairie dogs, field mice, and commensal rodents. In New Zealand the first trials were carried out in 1954, and by 1957 its use had become widespread. Currently in New Zealand the principal target species is possums and rodents. It is also registered for use against rabbits, wallabies, deer, goats and cats. 1080 was also used in a fish-based paste to control wasps in the late 1990s.

Recently, fluoroacetate has been investigated as a biomedical tool. Sodium fluoroacetate has been found to have a positive inotropic effect, increasing the muscular contractions of the heart (Korth et al., 1978), and could be used in studies of therapies for congestive heart failure (Eason, 2018). Radio-labelled fluoroacetate has also been trialled in positron emission tomography (PET) scanning for imaging glial metabolism (Marik et al., 2009), studying cerebral ischemia (Mizuma et al., 2013) and detecting cancer cells (Ponde et al., 2007).

## 1.7. Natural Occurrence

Manufactured 1080 for use in toxic baits is chemically identical to the toxic compounds found in some poisonous plants, with naturally produced 1080 inducing the same signs and symptoms in animals (de Moraes-Moreau et al., 1995). In plants, monofluoroacetate appears to be a secondary plant compound that is biosynthesised at high concentrations as a chemical defence mechanism against browsing invertebrates and vertebrates.

Highly toxic fluoroacetate-producing plants are globally distributed. Research in the 1940s identified monofluoroacetate, the active toxin in 1080, as the toxicant in the South African plant gifblaar, which has long been recognised as a hazard to livestock. Monofluoroacetate has also been identified as the toxic agent in many other poisonous plants, such as rat weed, native to Brazil (de Moraes-Moreau et al., 1995); and ratsbane, native to Africa (Atzert, 1971). Monofluoroacetate also occurs naturally in about 40 plant species in Australia (Twigg, 1994; Twigg et al., 1996a; Twigg et al., 1996b; Twigg et al., 1999).

Levels of monofluoroacetate can reach very high levels in these plants. For example, air-dried leaves of *Gastrolobium bilobum* (heart-leaf poison) and *G. parviflorum* (box poison), two Australian plants, can contain up to 2600 mg $kg^{-1}$ of monofluoroacetate, and seeds of *G. bilobum* can have in excess of 6500 mg $kg^{-1}$ of monofluoroacetate (Twigg, 1994; Twigg et al., 1996a; Twigg et al., 1996b; Twigg et al., 1999). The highest monofluoroacetate concentration so far reported from a plant is 8000 mg $kg^{-1}$ in the seeds of the East African *Dichapetalum braunii* (O'Hagan et al., 1993).

While most studies assessing monofluoroacetate concentrations in plants have focused on those species that are highly toxic to mammals, it would appear that the ability of plants to synthesise monofluoroacetate is more widespread than generally supposed. Monofluoroacetate occurs at extremely low concentrations in some Finnish plants (Vartiainen and Kauranen, 1980), in tea leaves (Vartiainen and Kauranen, 1984)

and guar gum (Twigg et al., 1996b; Vartiainen and Gynther, 1984) and puha (Ogilvie et al., 2006). Additionally, some plants when exposed to fluoride ions, can biosynthesise low levels of fluoroacetate. Fluorocitrate, the toxic metabolite of monofluoroacetate, has also been detected in tea leaves (Peters and Shorthouse, 1972). Fluoroacetate biosynthesis can also occur in some bacteria, notably *Streptomyces cattleya* (O'Hagan and Harper, 1999). In parts of Australia where fluoroacetate contain plants are common, native herbivores and seed-eaters have developed a high level of resistance to fluoroacetate compared to the same species elsewhere in Australia were plant species do not contain fluoroacetate. In South Africa the caterpillar of the moth, *Sindrus albimaculatus* (which feeds on *Dichapetalum cymosum*), can not only detoxify fluoroacetate, but also accumulates it and uses it as a defence against predation (Meyer and O'Hagan, 1992).

## *1.8. Toxicology and pathology*

### 1.8.1. Mode of action

Monofluoroacetate is converted within animals to fluorocitrate, which inhibits the tricarboxylic acid cycle. This results in accumulation of citrate in the tissues and plasma, energy deprivation, and death. Synthesis of fluorocitrate occurs in the mitochondria, and the fluorocitrate formed inhibits mitochondrial aconitate hydratase. There is also evidence to suggest that fluorocitrate inhibits citrate transport into and out of mitochondria, and that fluorocitrate has an inhibitory effect on succinate dehydrogenase. The high levels of citrate concentration that occur during monofluoroacetate intoxication can also have an inhibitory effect on the glycolytic enzyme, phosphofructokinase.

Death from monofluoroacetate poisoning is caused by the inhibition of energy production which, in turn, results in either cardiac or respiratory failure. Fluorocitrate is commonly described as a specific metabolic inhibitor of glial cells in the brain. Glial cells are thought to be important for extracellular fluid ion and pH regulation, and the control of breathing (Erlichman et al., 1998).

This section is from Eason and Wickstrom (2001).

### 1.8.2. Pathology

Known target organs in animals following 1080 exposure include the heart, lungs, liver, kidney, testes, and foetus (Annison et al., 1960; Buffa et al., 1977; Chi et al., 1996; Chung, 1984; Eason et al., 1999; Gregg et al., 1998; McTaggart, 1970; Savarie, 1984; Schultz et al., 1982; Sullivan et al., 1979; Trabes et al., 1983; Twigg et al., 1988). The pathological changes observed at post-mortem appear to be largely the result of progressive cardiac failure with congestion of the abdominal viscera and lungs. Examination of monofluoroacetate-poisoned mammals usually reveals cyanosis of mucous membranes and other tissues. Diffuse visceral haemorrhage has been described in some animals, particularly cattle. Subepicardial haemorrhages on the epicardium and endocardium as well as on the epiglottis and trachea have been observed in sheep and possums poisoned with monofluoroacetate. The presence or

absence of tissue damage is likely to be dose-related, and subepicardial haemorrhages have been observed in rabbits receiving a lethal dose of monofluoroacetate but not in those receiving a sub-lethal dose. It is apparent that the target organs vary to some extent in different species, which may relate to the citrate response in different species, or the metabolic activity in different tissue. In birds a target organ appears to be wing muscle (Ataria et al., 2000) as well as the heart, which is a more common target in other species.

This section is from Eason and Wickstrom (2001).

### 1.8.3. Absorption, metabolism, and excretion

Sodium monofluoroacetate (1080) is absorbed through the gastrointestinal tract or via the lungs if inhaled. Monofluoroacetate is not readily absorbed through intact skin, but it can be absorbed more readily through cuts and abrasions.

After oral or intravenous dosing of laboratory rodents, 1080 is rapidly absorbed and distributed through the soft tissues and organs (Egeheze and Oehme, 1979; Hagan et al., 1950; Sykes et al., 1987). This contrasts with the action of commonly used anticoagulant rodenticides, such as brodifacoum, which preferentially bind to liver cells (Bachmann and Sullivan, 1983). Sodium monofluoroacetate is excreted as unchanged fluoroacetate and a range of non-toxic metabolites (Gal et al., 1961; Schaefer and Machleidt, 1971). Approximately 30% of a dose of 1080 administered to rats was excreted unchanged in the urine over 4 days (Gal et al., 1961). At least seven unidentified metabolites other than fluoroacetate and fluorocitrate, the toxic metabolite of 1080, were also detected in rat urine (Gal et al., 1961).

Administration of $^{14}C$-labelled fluoroacetate to rats showed that fluorocitrate, the toxic metabolite of 1080, accounted for only 3% of the radioactivity (Gal et al., 1961), and this was confirmed by Schaefer and Machleidt (1971). The major metabolite, unlike fluorocitrate, does not inhibit the activity of aconitase (Gal et al., 1961). Phillips and Langdon (1955) suggested that the unidentified metabolites include non-saponifiable lipids that probably serve as intermediates for cholesterol, and some radioactivity was found in fatty acids and cholesterol in the liver. Up to 3% of the radioactivity appeared as respiratory $CO_2$, which implied cleavage of the C-F bond (Gal et al., 1961).

Defluorination of 1080 or its metabolites, including fluorocitrate, has been demonstrated in animals and other living organisms (Egeheze and Oehme, 1979; Kirk and Goldman, 1970; Smith et al., 1977; Soifer and Kostyniak, 1983, 1984; Tecle and Casida, 1989; Twigg et al., 1986). Although fluoride is extensively excreted, primarily in urine, some deposition occurs in bone (Eason et al., 1993a; Eason et al., 1993b; Eason et al., 1994b; Rammell, 1993; Sykes et al., 1987).

The above section is from Eason and Wickstrom (2001).

Nishii et al (2012) studied the use of radio-labelled fluoroacetate in rhesus macaques as an imaging diagnostic tool for cancer tumors. Doses were tiny

(0.47ng). They observed rapid uptake into major organs followed by a rapid decline in tissue concentrations over three hours. Indicated by the radioactivity, most 1080 excreted in monkey urine during this period was unchanged (72.4%) while some had been metabolised and excreted as fluoride (27.6%). Bone deposition appeared minimal in this study.

# 2. Fate in the Environment

1080 in baits may be defluorinated in 1–2 weeks under favourable conditions. However, under less favourable conditions breakdown may take several weeks and, in extreme cold and drought, 1080 residues could persist in baits for several months. The 1080 in paste baits can still be present after >5000 mm of rain.

Degradation of 1080 is slow in soil and sediments, taking 1-4 weeks under favourable conditions. The rate of degradation will be influenced by the presence of soil or litter micro-organisms, and temperature, soil moisture and rainfall. Sodium monofluoroacetate is highly water soluble so leaching out of soil will occur.

While the concentration of 1080 in deionised (sterile) water remains relatively constant and independent of temperature, 1080 degradation occurs within 1-2 weeks in natural water. Temperature, and the presence of aquatic plants and microbes all affect 1080 degradation in aquatic environments. Water samples have been collected from streams following numerous pest control operations using 1080. 97.1% of these samples contained no residues of 1080. Where residues were found most of these had less than 1 µg $l^{-1}$ 1080. Where higher 1080 residues have been found in water, the samples were mostly from very small streams and/or associated with the presence of bait, during aerial operations.

While plants can take up 1080, it is unlikely to be in large amounts. If taken up, 1080 residues persist less than 38 days in plants.

1080 has a relatively short half-life in sub-lethally dosed animals and it is metabolised and eliminated from living animals within days. However, it can persist in carcasses for months. The rate of degradation of 1080 in carcasses will depend on moisture, temperature and the presence of micro-organisms.

## *2.1. Bait pathway*

### 2.1.1. How long do baits remain toxic?

*Under favourable conditions, e.g. 11 – 20°C and 8 – 15% moisture, 1080 may be significantly defluorinated in 1 – 2 weeks (King et al., 1994). Under less favourable conditions breakdown might take several weeks and, in extreme cold and drought, 1080 residues could persist in baits for several months.*

***Pellets***

*On land*

Booth et al. (1999a) reported that 1080 began leaching out of Wanganui #7, 6 gram, 0.15% 1080 Pellets after 20 mm of simulated rainfall and that the 1080 declined to near the limit of detection after 250 mm simulated rainfall. Bowen et al. (1995) found that both 0.08% and 0.15% 1080 6 gm RS5 cereal pellets lost 1080 more quickly than equivalent 6 gm Wanganui #7 cereal pellets under simulated rainfall. The RS5 cereal pellets were less water resistant and started to disintegrate after approximately 5 mm of rain. 1080, at both concentrations, had been completely leached out of the RS5 cereal pellets after 150 mm rain.

When 10 - 12 g 0.15% 1080 Wanganui #7 cereal pellets were exposed to a simulated rainfall of 20 mm/hour, most of the 1080 concentration was retained after exposure to 50 mm of rain. The 1080 concentration rapidly declined in the pellets over the following 50 mm of rainfall. By comparison, the 1080 concentration in 10 - 12 g 0.15% RS5 pellets declined at a steady rate. By 100 mm the 1080 had completely leached out of both types of pellets (Thomas et al., 2004). The 10 - 12 g cereal pellets in this study retained more 1080 when exposed to <100 mm of simulated rain than the 6 g cereal pellets examined by Bowen et al. (1995).

Ogilvie et al. (2004) reported that Wanganui #7 pellets lying on the ground in the field had a 99% reduction in the 1080 concentrations after 56 days. Over this time period 110 mm of rain fell.

During trials on long-life baits, Morgan (2004) found that 0.15% 1080 Pellets with a double wax coating placed in Philproof bait stations took 9 months for the toxicant concentration to decline by 30%.

Bait breakdown was monitored during the 1990 Rangitoto Island and Waipoua Forest Sanctuary possum control operations. Aerially distributed 6 g 0.08% 1080 Pellets were used in the operations, and most baits had less than 10% of their original 1080 concentration after 28 - 29 days. However, some baits only reached 10% of their original toxic loading after 41 days (Eason et al., 1991a, b).

Wright (2004) monitored the fate of 20 mm (12 g) 0.15% 1080 Wanganui #7 pellet baits at two sites during an 8600 ha aerial operation in the Hutt River upper catchment. On the day of application baits tested contained 1.43 g $kg^{-1}$ 1080. After 29 days baits from the two sites contained 0.05 g $kg^{-1}$ and 0.04 g $kg^{-1}$, and were still dyed green although damp and soft. Site one had received 30 mm of rain by this time and 70 mm for site two. After 40 days baits from both sites were pale green and had no detectable residues. Cumulative rainfall recorded by this time was 88 mm for site one and 186 mm for site two. Baits were still visible after 52 days, but by day 65 and 387 mm of rain they were not discernible at site two.

Thomas et al. (2004) analysed bait breakdown rates from data collected during 19 operations using 0.15% 1080 Wanganui #7 cereal pellets and 11 operations using 0.15% 1080 RS5 cereal pellets. Bait sizes used in the operations ranged from 3 – 12 grams. Most of the 1080 content, of both bait types, was removed following 150 – 200 mm of natural rainfall.

0.15% 1080 cereal pellets in bait bags stapled to trees four months after a possum control operation in Patterson Inlet, Stewart Island contained 188 - 475 mg $kg^{-1}$ 1080. 1080 residues in two 1080 cereal pellets in bait bags found lying on the ground were below the method detection limit (MDL) (VPRD & Pestlink 0809SIS02).

The concentration of 1080 in bait samples of 0.15% 1080 12g cereal pellets was monitored at the Marsden aerial treatment block in central westland during 2012. After 28 days with 56mm of rainfall the bait sample contained 12 mg $kg^{-1}$, therefore had lost 99.2% of the starting toxicity (van Klink 2013).

*In water*

Suren (2006) conducted laboratory experiments to examine the fate of pellet baits that fell into moving water and to quantify the rate that 1080 leached from the pellets. 0.15% 1080 Wanganui #7 pellets were placed in flow tanks that had a cobble base and water flowing through them at 20 cm $s^{-1}$. Eleven and 6 g baits were used in the experiment. Both bait sizes followed a similar pattern of breakdown. The baits remained relatively intact for the first 48 hours but lost their bright green colour. After 72 hours the baits had become swollen and started to fragment. At 84 hours the baits had disintegrated. While baits remained for up to 72 - 84 hours before they disintegrated, 1080 leached out of the baits far more rapidly. 1080 was rapidly lost from submerged baits within the first 8 - 12 hours. Fifty percent of the 1080 in the baits was lost after the baits had been submerged for 5 hours. By 24 hours, 90% of the original 1080 concentration had been lost, and no 1080 was detected in any baits after 36 hours.

*Dust*

There have been three studies that have looked at dust produced by aerial 1080 pellet operations.

Wright et al. (2002) assessed the dust produced during three 1080 pellet operations (at Rangataua Forest Park, Titirangi Reserve and Whitecliffs Forest) in 1997 and 1998. In these operations, 0.15% 1080 Whanganui #7 pellets were sown at a rate of 5 kg/ha. Dust collectors were set up within and at 200-m intervals to a distance of 1000 m downwind of the treatment area. The maximum concentration of 1080 found in the dust collectors was 25.2 µg 1080 $m^{-2}$ at one site within the Rangataua operational area 1 day after the operation. Mean 1080 dust concentrations within the operational area on day 1 ranged from 0.29 µg 1080 $m^{-2}$ at Titirangi Reserve to 3.81 µg 1080 $m^{-2}$ at Rangataua. 1000m down wind of the operational area the mean 1080 dust concentrations at day 1 ranged from 0.0 µg 1080 $m^{-2}$ at Titirangi Reserve to 0.09 µg 1080 $m^{-2}$ at Whitecliffs. By day 5 1080 dust levels within the operational area had declined to 0.05 µg 1080 $m^{-2}$ at Whitecliffs and 0.1 µg 1080 $m^{-2}$ at Rangataua Forest Park and Titirangi Reserve. On day 5, 1000m down wind of the operational area the mean concentrations of 1080 in dust were 0.0 µg 1080 $m^{-2}$ at Rangataua, 0.09 µg 1080 $m^{-2}$ at Whitecliffs and 0.13 µg 1080 $m^{-2}$ at Titirangi reserve.

1080 dust levels were monitored at loading site of the 2014 Te Maruia aerial 1080 operation (0.15% 1080 RS5 cereal pellets sown at a rate of 1 kg/ha). The concentration of 1080 dust recorded was between <0.00004 and 0.00021 mg $m^{-3}$. Based on these results, the concentration of 1080 dust at other sites around the loading zone was estimated at <0.00004 to 0.00006 mg $m^{-3}$. Using these figures, the worst case time weighted exposure to 1080 dust was estimated as 0.0048 mg $m^{-3}$, which is only 10% of the Workplace Exposure Standard (0.05 mg $m^{-3}$) (Jennings, 2014).

During an aerial 1080 operation (0.15% 1080 RS5 cereal pellets sown at a rate of 2 kg/ha) at Kumara in 2015, 1080 dust levels were monitored at 5 sites located within, at the boundary, and at 180 metres, 330 metres and 415 metres downwind of the operational area. Total suspended particulate (TSP) gauges were used to collect the dust and monitoring occurred for 1 day following the operation. 1080 was only

detected at the monitoring site 180 metres outside the operational area at a concentration of 0.0048 µg 1080 $m^{-3}$ (Wickham and Baynham, 2016).

### *Carrot*

Thomas et al. (2004) subjected 12 g carrot baits containing 1.5 g $kg^{-1}$ 1080 two different simulated rainfall treatments. The first treatment involved subjecting carrot baits to 20 mm $hr^{-1}$ simulated rainfall starting 1 hour after the 1080 was applied. The 1080 in the carrot leached out of the carrot rapidly, with the carrot losing approximately 74% of the 1080 after 10 mm of simulated rainfall. In the second treatment, which was designed to be more representative of field operations, involved starting the simulated rainfall started 48 hours after the 1080 was applied to the carrot. The carrot in this treatment retained more than 60% of its 1080 concentration after 500 mm of simulated rainfall.

Bowen et al. (1995) reported that 6 g carrot baits containing 0.8 g $kg^{-1}$ 1080 showed no decrease in 1080 concentration after 200 mm simulated rainfall.

Using data collected during five 0.8 g $kg^{-1}$ 1080 carrot operations, Thomas et al. (2004) estimated that most of the 1080 content was lost from the baits following 200 mm of natural rainfall. The authors noted the results conflicted with the simulated rainfall studies. They suggested that the difference may have been a result of the carrots being present in the field for a longer period than the 2-day duration of the simulated rainfall trials. During this period the carrots would have been subjected to decay and microbial action, which may have contributed to the more rapid 1080 loss.

### *Pastes*

There was little loss of 1080 from Pestoff Professional 0.15% 1080 paste 49 hours after it was subjected 5 mm of simulated rain. Detoxification of Pestoff Professional 0.15% 1080 paste baits left on upturned spits took 80 days, but this was reduced to 40 days when the baits were buried (Morgan, 2000). Pestoff possum paste buried in both dry and damp soil still retained significant concentrations of 1080 after 20 days (Ross and Henderson, 2003).

When 10% 1080 Gel with a carbopol carrier was applied to käpuka (NZ broadleaf), 90% of the 1080 was washed out of the baits by as little as 81 mm of rain (Batcheler and Challies, 1988). Parkes (1991) found that when 10% 1080 Gel in a carbopol carrier was applied to mahoe (*Melicytus ramiflorus*) leaves, 95.2% of the 1080 had leached from the baits after 208 mm of rain. In contrast, 10% 1080 Gel with a petrolatum carrier is highly resistant to leaching, with 78.8% of the 1080 still remaining in the baits after 64 days and 208 mm of rain. Challies and Thomson (1988) concluded that >5000 mm of rain was required to leach about 75% of the 1080 out of the baits.

Fish/meatmeal pellets (0.1% 1080 feral cat bait)

Degradation of fishmeal feral cat bait pellets containing 1g/kg 1080 was assessed on Auckland Island in winter 2019. The bait was placed directly on the ground under pest proof mesh cages in habitat including scrub, rata forest, tussock and coastal herbfield at nine separate sites. After 14 days with 38.4mm of accumulated rainfall the concentration of 1080 in sampled baits from each site had declined by

88-100%. At this point baits were intact and most were firm and free of visible mould. After 32 days with 110.4 mm of accumulated rainfall the 1080 levels had declined by 100% (to <MDL) at six sites and by >95% at the remaining three sites. By this point baits were soft and mouldly and some had become mushy. After 98 days baits were tested from four of the sites and all had 1080 <MDL (Cox et al., 2019).

Seven months after 0.10% 1080 feral cat baits were handlaid on Raoul Island in August-September 2002, baits lying in the open were observed in good condition (S. Theobald pers. comm. 2003).

*Other*

The concentration of 1080 in eggs injected with 1 mg 1080 $egg^{-1}$ did not decline after 28 days at temperatures of 15 and 30°C (Spurr et al., 1998). Note: this product is not currently registered in New Zealand.

When 12000 kg of 1080 bait (11000 kg of 0.15% 1080 Wanganui #7 Pellets and approximately 1000 kg of 0.08% 1080 apple paste) was disposed on in a landfill site at Winton, central Southland, in August 1996 the 1080 concentration in the waste material showed a 90% decrease after 10 months (Bowman, 1999).

### 2.1.2. How soluble is 1080 in natural water?

Sodium monofluoroacetate is highly water soluble and mobile (Parfitt et al., 1994). Solubility in water at 25 C is estimated at 111g/100g which is similar to table salt (O'Neil 2013 cited in PubChem Section 8.6).

Note: Solubility is the determining factor for the pesticide pathway beyond the bait.

## *2.2. Soil and sediment*

### 2.2.1. What is the range of toxic residue levels observed in soil and sediment?

*Soil*

Two soil samples were taken from the helicopter loading site on the day of the November 2014 Catlins aerial 1080 operation (0.15% 1080 RS5 pellets). Both these soil samples tested positive for 1080 (0.008 and 0.215 mg $kg^{-1}$). Four further soil samples were taken 12 days later, with 1080 being detected in one sample (0.005 mg $kg^{-1}$). Two more soil samples were taken 23 days after the operation, with 1080 being detected in one sample (0.020 mg $kg^{-1}$) (Pestlink 1415MRH01).

During the October 2014 Waitutu aerial 1080 operation (0.15% 1080 RS5 pellets), three soils samples were taken from the helicopter loading site. No 1080 was detected in these samples (Pestlink 1314TEA07).

Neither of the two soil samples taken from the loading site of the August 2014 Waikaia aerial 1080 operation (0.15% 1080 RS5 pellets) tested positive for 1080 (Pestlink 1314MRH02).

Four soil samples were taken from the helicopter loading site approximately one week after the August 2010 Waitutu aerial 1080 operation (0.15% 1080 RS5 pellets). No 1080 was detected in the samples (Pestlink 1011MRH03).

On the day 0.15% 1080 Pellets were handlaid in a field trial in the Tararua Forest Park, 0.01 mg $kg^{-1}$ 1080 was detected in one of four litter samples. Following a field trial using 0.15% carrot baits in the Tararua Forest Park, litter samples had 1080 residues of between 0.0 - 0.6 mg $kg^{-1}$ on the day the baits were laid and between 0 - 16 mg $kg^{-1}$ seven days post poisoning (Spurr et al., 2002).

During 1997-98, 118 samples of soil were taken after three different aerial applications of Wanganui #7 0.15% 1080 Pellets. There were detectable, but low (mean 0.0092 mg $kg^{-1}$) 1080 residues in 6 of the soil samples taken from two of the three operations. The mean concentrations of 1080 in soil outside the two baiting areas (0.0006mg/kg) appeared to be lower than those inside (0.024 mg/kg) (Wright et al., 2002). During the same study, samples of leaf litter were also taken. There were low, but detectable, amounts of 1080 in the litter at Days 1, 5 and 30 post-baiting. The highest concentration found in a leaf litter sample was 0.19 mg $kg^{-1}$ on Day 5 from inside one treatment area. All remaining leaf litter samples with detectable 1080 were below 0.01 mg $kg^{-1}$ and were from up to 600 m outside one of the treatment areas. It was suggested that these 'outside' results were due to baits or fragments reaching the ground close to the sampling plots (Wright et al., 2002).

Soil samples (n=10) taken from two airstrips in 1997 had 1080 residues ranged from 0 – 0.0035 mg $kg^{-1}$ (P Fisher pers. comm. 2004).

Soil from three tip/landfill sites was sampled for 1080 residues in 1996-97. The Balgownie landfill, Wanganui had 1080 residues ranged from 330 – 930 mg $kg^{-1}$ (n=2). Winton tip, central Southland had 1080 residues ranged from 50 - 1450 mg $kg^{-1}$ (n=4) and at an unspecified landfill site where 1080 residues ranged from 0.0008 - 3 mg $kg^{-1}$ (n=11) (P Fisher pers. comm. 2004).

*Sediments*

During the July 2008 Lower Arthur Valley aerial 1080 operation (0.15% 1080 RS5 pellets), three sediment samples were taken from the Arthur River. No 1080 was detected in these samples (Pestlink 0809TEA03).

On the day of the June 2007 Upper Arthur Valley aerial 1080 operation (0.15% 1080 RS5 pellets), three sediment samples were taken from a low current area in the Arthur River. No 1080 was detected in these samples (Pestlink 0708TEA08).

Three samples were taken from sediments in the West branch of the Clinton River three days after the June 2006 Clinton Valley aerial 1080 operation (0.15% 1080 RS5 pellets). No 1080 was detected in the samples (Pestlink 0607TEA01).

### 2.2.2. How long does degradation of 1080 take in soil or sediment?

Degradation of 1080 is slow in soil and sediments, taking 1-4 weeks under favourable conditions.

Laboratory studies on the biodegradation of 1080 have shown that it is defluorinated by soil micro-organisms (Gentle & Clothier 2014; Walker and Bong, 1981; Wong et al., 1992) and within soils themselves (David and Gardiner, 1966; Parfitt et al., 1994). If 1080 is not degraded by micro-organisms present in most NZ soils, it is likely to be removed from soil by leaching (Parfitt et al., 1994).

Northcott et al. (2014) examined the breakdown of 1080 in podzol (Orikaka Sandy Loam, West Coast, South Island), brown soil (Matiri, West Coast, South Island) and pumice soil (Kaingaroa, Taupo, North Island) under laboratory conditions. In all three soil types the degradation products produced and the rate at which these products were formed were similar. The major degradation pathway was through microbial degradation to the hydroxyl metabolite, hydroxyacetic acid, and microbial mineralisation to $CO_2$. The authors reported that the dominant factor affecting the rate of degradation was temperature rather than soil type or moisture content. The transformation half-life ($DT_{50}$) of 1080 increased with decreasing temperature, ranging from 6 - 8 days at 20°C, 10 - 21 days at 10°C and 22 - 43 days at 5°C.

In a soil microbial nitrogen mineralisation test conducted to OECD guidelines, O'Halloran et al. (2005) found there was no evidence that 1080 inhibited nitrate production by soil microorganisms at concentrations of up to 1 g 1080 $kg^{-1}$ of soil.

During laboratory studies, 6.1 mg of 1080 (equivalent to one possum bait) was added to 14 g samples of Kaitoke silt loam. The time taken for the 1080 in the soil to decline by 50% was 10 days at 23°C, and 80 days at 5°C (Parfitt et al., 1994). The authors also reported that when 1080 was added to Conroy sandy loam the degradation was much slower under dry conditions than wetter conditions. In Conroy sandy loam with 20% water content, it took approximately 30 days for a 50% reduction in the 1080.

### 2.2.3. Are there environmental factors that affect degradation in soil?

The presence of soil or litter micro-organisms, and temperature, soil moisture and rainfall affect the rate of 1080 degradation in soil.

Some soil micro-organisms, e.g. *Pseudomonas* and *Fusarium* species, can metabolise 1080 (King et al., 1994; Walker and Bong, 1981). However, not all micro-organisms can readily defluorinate monofluoroacetate and the rate of metabolism differs between species of soil bacteria and fungi (King et al., 1994). 1080 could be expected to persist in soil much longer in the absence of micro-organisms, however sterile soil is unlikely to occur naturally.

Temperature and soil moisture content affect the rate at which micro-organisms in soil degrade 1080. At lower temperatures/moisture content degradation is slower and 1080 will persist in the soil longer (Parfitt et al., 1994). Studies have shown that substantial defluorination of 1080 occurs in soil at temperatures of 15 - 30°C and with moisture levels above 8.3%.

Rainfall is also a major factor in removing 1080 from soil due to 1080's water solubility. 1080 has a low preference for adsorption on soil minerals, so that 1080 in soil not removed by microbial action is likely to be leached (Parfitt et al., 1994).

Note: Environmental factors will determine how widely the breakdown times reported for specific sites can be applied. For example, because breakdown is significantly affected by temperature, rainfall, leaf litter, presence or types of micro-organisms, it may occur faster or slower than the time quoted in Section 2.2.2.

## 2.3. *Fate in water*

### 2.3.1. Where available, what is the range of toxic residue levels observed in natural water?

*Water monitoring during operations*

*Between 1990 and December 2016 3527 water samples were collected from streams following aerial 1080 pest control operations throughout New Zealand. The samples were taken within 24 hours of the bait being laid and after subsequent heavy rain. 97.1% of these samples contained no residues of 1080. Residues ranging from 0.1 – 9.0 µg $l^{-1}$ were found in 101 samples but most of these had less than 1 µg $l^{-1}$ 1080. These samples were mostly from very small streams and/or associated with the presence of bait. Four of these six samples were likely to have been as a result of inadvertent contamination (Booth et al., 2007; L. Booth pers. comm. 2016; Parliamentary Commissioner for the Environment, 2011).*

*1299 of the total samples were taken from water used as human or stock drinking supplies, and 5 (0.38%) of these contained detectable 1080 residues ranging from 0.1 to 0.2 µg $l^{-1}$ (L. Booth, Landcare Research, pers. comm. 2016). All the positive samples were below the Ministry of Health maximum of 3.5 µg $l^{-1}$ for 1080 in drinking water (Ministry of Health, 2008).*

A water monitoring program following aerial 1080 (0.15% and 0.08% 1080 Wanganui #7 Pellets at 5 kg $ha^{-1}$) possum control operations on Mt Taranaki/Egmont in 1993-94, showed no detectable 1080 in 159 (1993) and 72 (1994) water samples from surface water or treated water supplies (Fowles and Williams, 1997).

Following aerial possum baiting (0.08% 1080 Wanganui #7 Pellets) in Tararua Forest Park in 1993, 66 water samples from eight sites collected over 4 months had no detectable 1080 (limit of detection 0.3 µg $l^{-1}$) (Meenken and Eason, 1995).

Following aerial rabbit baiting (pre-feed baiting and carrot baits containing 0.023% 1080, sowing rates from 16 – 60 kg $ha^{-1}$ depending on rabbit densities) in Otago during 1992, streams and rivers were monitored for 4 weeks after the operation. 2 out of 29 samples contained measurable amounts of 1080 (0.3 and 0.6 µg $l^{-1}$). These samples occurred within 48 hours of bait application, and all subsequent samples were below the limit of detection (Hamilton and Eason, 1994).

No 1080 was detected in 36 water samples taken from six streams over a 4-month period at Waipoua following aerial possum control using 0.08% 1080 Pellets sown

at 5 - 6 kg $ha^{-1}$ in 1990. After the 1990 aerial possum control operation using 0.08% 1080 Pellets at 14 kg $ha^{-1}$ on Rangitoto Island 24 water samples were collected over 6 months from 2 surface water and 2 ground water sites. No 1080 was detected in any of these samples (Eason et al., 1992).

### *Field trials*

Meenken et al. (2000) monitored water in a stream at the bottom of 14 ha catchment for the presence of 1080 after 0.15% Wanganui #7 pellets had been handlaid in a at a rate of 10.7 kg $ha^{-1}$. Monitoring occurred at regular intervals over the 17 hours after the bait was applied and during a rain event two days after the bait was laid. No 1080 was detected in any of the 52 water samples taken.

Srinivasan et al. (2012) investigated the fate of 1080 released from baits during a rainfall event immediately following an aerial 1080 operation. In this field study, stream and soilwater was sampled in a 148.8 ha headwater catchment of the Inangahua River, on the West Coast, following the application of 0.15% 1080 Wanganui #7 pellets. The pellets were applied at a rate of 2.5 kg $ha^{-1}$ within 24 hours of a rainfall event (28 mm in 8 hours, with an additional 100mm falling over the next 9 days). Water sampling occurred between 5 hours and 9 days after the 1080 was applied. The only stream sample that contained 1080 (at 0.1 µg $l^{-1}$) was collected 105 minutes after the rain started. None of the other 15 samples contained 1080 residues. Soilwater samples were taken approximately 200 mm downhill from baits after 34.4, 57.0 and 60.6 mm of rain had fallen. 1080 residues in these soilwater samples ranged from 0.5 - 61 µg $l^{-1}$.

Srinivasan and Suren (2018) investigated the transport of 1080 in surface and subsurface water flows down a a hillside in a field trial on the West Coast. In the study they handlaid 2 kg of 0.15% 1080 RS5 cereal pellets in a 0.4 $m^2$ plot (equivalent to 25,000 times a 2 kg/ha sowing rate), 6 hours prior to a forecast rainfall event. During the rainfall event (7.4 mm of rainfall) and up to 168 hours after the bait application, they collected overland water flow, subsurface soil water and ground water samples at regular time intervals within and below the plot. Water samples were also taken from a small stream below the plot. Of the 59 water samples taken, only seven returned positive 1080 residues, four of which were just above the MDL (minimum detection limit of 0.1 µg $l^{-1}$). The positive samples were all from soil water samples closest to the baits, with the highest recorded 1080 residue (1.4 µg $l^{-1}$) in a soil water sample 32 hours after the rain had commenced. No 1080 was detected in any of the groundwater, overland flow or stream samples. The researchers noted that the absence of detectable 1080 in the majority of samples clearly demonstrated the importance of dilution as a key factor when 1080 leaches out of baits during rainfall events. Given the extremely large amount of 1080 applied to such a small area immediately prior to rain, and the limited number of positive 1080 samples, they also concluded that it is unlikely detectable 1080 contamination of surface, soil and groundwater will occur at normal application rates.

### *Landfill disposal*

Concentrations of 1080 in bore groundwater surrounding a landfill site at Winton, central Southland, were measured following burial of 12000 kg of 1080 bait. 1080 was detected in 5 of 28 groundwater samples analysed (highest value 24 µg $l^{-1}$). The amount of 1080 in groundwater sampled 5 and 13 metres from the disposal site decreased until none was detected after 10 months (Bowman, 1999).

### *1080 breakdown products*

Fluoride is a principal breakdown product of 1080. In addition to the 1080 water sampling undertaken by Fowles and Williams (1997) following the aerial 1080 (0.15% and 0.08% 1080 Wanganui #7 Pellets at 5 kg $ha^{-1}$) possum control operations on Mt Taranaki/Egmont in 1993-94, they also monitored fluoride levels at the same water monitoring sites. No significant increases in fluoride concentrations above the natural background levels were recorded during or following the operations except in the Hawea public water supply. The South Taranaki District Council sporadically fluoridated this water supply, and the increased level of fluoride in the water occurred during equipment recommissioning trials.

## 2.3.2. How long does degradation of 1080 take in natural water?

*1080 degradation will occur within 1 - 2 weeks in natural water.* The overall degradation rate of 1080 in stream water, when measured in the laboratory, declined by approximately 25% in the first 24 hours. After this the rate of decline was temperature dependent (Ogilvie et al., 1995; Ogilvie et al., 1996).

Eason et al. (Eason et al., 1993b) showed that 1080 declined by approximately 70% in 1 day and dropped to below detectable limits in 4 days in aquaria containing plants and invertebrates.

In an aquarium study by Parfitt et al. (1994) 80 litre aquaria containing biologically active streamwater at 21 °C were spiked with 0.1 mg $l^{-1}$ of 1080 (the equivalent to adding 2-3 pellets per aquarium). Water samples were taken from the tanks at 2, 24, 48, 72, 79, 101 and 141 hours after the addition of the 1080. The 1080 was eliminated from the aquaria water within 48 - 141 hours.

When 40 0.15% 1080 Wanganui #7 pellets were placed in a stream simulator with a 5 litre $s^{-1}$ flow rate, 1080 concentrations at the outlet of the simulator peaked at 1.1 µg $l^{-1}$ after 2 days and no residues were detected in the water after 8 days (Suren and Bonnett, 2006).

Note: Natural/stream water implies the presence of aquatic plants, invertebrates and micro-organisms, and sediment.

### 2.3.3. Are there environmental factors that affect degradation in aquatic environments?

A number of factors affect the degradation of 1080 in aquatic environments. These include temperature, *the presence of aquatic plants and microorganisms, and flow and volume of the waterway*.

While the concentration of 1080 in deionised (sterile) water remains relatively constant and independent of temperature, the concentration of 1080 in stream water declines over time (Booth et al., 1999b). The rate at which 1080 degrades in stream water increases significantly as water temperature rises (Ogilvie et al., 1995; Ogilvie et al., 1996). The aquatic plants *Elodea canadensis* (Wright et al., 2001) and *Myriophyllum triphyllum* (Booth et al., 1999b) were found in laboratory trials to reduce the concentration of 1080 in water. In aquaria trials Parfitt et al. (1994) reported that the rate of 1080 degradation was dependent on the species of bacteria present.

Flow and volume of the waterway affect the dilution of 1080 in natural water. However, they are unlikely to significantly affect degradation at the low concentrations of 1080 that have been found in the environment.

Note: Environmental factors will determine how widely the breakdown times reported for specific sites can be applied. For example, because breakdown is significantly affected by temperature, pH, volume, still/running water, or presence or types of micro-organisms, it may occur faster or slower than the time quoted in Section 2.3.2.

## 2.4. *Fate in plants*

### 2.4.1. Is it likely that plants could take 1080 up in solution, based on molecular structure?

Many organic acids are phloem-mobile in plants, so it is likely that 1080 can be taken up by plants.

### 2.4.2. Is there evidence that plants either take up or don't take 1080 up?

*1080 uptake has been reported* in a number of plants including: käpuka (New Zealand broadleaf) (Ogilvie et al., 1998), käramuramu (Ogilvie et al., 2006), puha (Miller et al., 2009), broad beans (David and Gardiner, 1951), cabbage (David and Gardiner, 1953), *Elodia canadensis* (Ogilvie et al., 1996), *Helianthus annus* (Cooke, 1976), lettuce (Ward and Huskisson, 1972), peanut (Preuss and Weinstein, 1969), perennial ryegrass (Ogilvie et al., 1998) and sugar cane (Hilton et al., 1969).

However, not all plants appear to take up 1080. No uptake of 1080 was reported in pikopiko when single 0.15% 1080 Wanganui #7 pellets were placed at the base of pikopiko in the field, and the plants monitored for 1080 uptake (Ogilvie et al., 2006).

Where uptake occurs, it is unlikely to be in large amounts. Ogilvie et al. (1998) reported that rye grass took up only 0.015% of the available 1080 from pellets placed beside the grass. When single 0.15% 1080 Wanganui #7 pellets were placed at the base of käramuramu in the field, the maximum concentration of 1080 detected in the plants was 5 µg $kg^{-1}$ of plant material. This concentration occurred 7 days after the bait was place beside the plants, and declined to 2.5 µg 1080 $kg^{-1}$ plant material after 14 days (Ogilvie et al., 2006). In a similar field trial, Miller et al. (2009) placed a single 0.15% 1080 Wanganui #7 pellet at the base of puha plants. The highest level of 1080 detected in puha was 15 µg $kg^{-1}$ of leaf material 3 days after the pellets were placed at the bottom of the plants. Note: in this study 1080 residues were recorded in puha that had been used as controls (i.e. no 1080 pellets placed beside them). The authors could not rule out that 1080 occurs naturally in puha and are currently undertaking further research to confirm this.

To put these figures in perspective, based on the peak concentration observed in ryegrass (0.08 g $kg^{-1}$), a 50 kg sheep would need to eat (using an $LD_{50}$ of 0.4 mg $kg^{-1}$) about 250 kg of grass to have a 50% chance of dying from 1080 (Ogilvie et al., 1998). Using an $LD_{50}$ of 2 mg $kg^{-1}$ for humans, a 70 kg person would need to eat 28 tonnes of käramuramu or 9.3 tonnes of puha in one sitting to receive an $LD_{50}$ and therefore a 50% chance of dying from 1080 (Miller et al., 2009; Ogilvie et al., 2006). Even to reach the chronic toxicity NOEL of 0.05 - 0.1 mg $kg^{-1}$ $day^{-1}$ a person would need to consume 0.7 - 1.4 tonnes of 1080-containing käramuramu daily (Ogilvie et al., 2006).

A laboratory study by David and Gardiner (1951) showed that broad bean plants could take up fluoroacetate through their roots and subsequently become toxic to aphids feeding on them (i.e. 1080 acted as a systemic insecticide). However, 1080 concentrations in the plants necessary to kill the aphids were approximated 1 mg $kg^{-1}$ of plant tissue, when applied to the plant through a cut tap-root. This is a much higher concentration of 1080 than any reported in field soil samples in the context of using 1080 baits for possum control.

Where fluoroacetate is distributed in plants is likely to vary as available publications report conflicting information. For example, in *Helianthus annuus*, ammonium fluoroacetate metabolites were rapidly translocated to the shoot with little accumulation in the roots (Cooke, 1976). Conversely, sugarcane was found to strongly adsorb monofluoroacetate ion onto its roots with only minor translocation to leaves and stem (Hilton et al., 1969).

Even where 1080 uptake occurs in plants, most plants are relatively insensitive to the effects of 1080 (Bong et al., 1980). However, duckweeds have been shown to have a high sensitivity, with the growth of *Spirodela polyrrhiza* being totally inhibited by 0.5 mmol of 1080, and total growth inhibition of *S. oligorrhiza* and *Lemma minor* occurring at 1 mmol 1080 (Bong et al., 1980). Oxygen consumption in pea seedling roots was almost completely blocked when exposed to 10 mmol $l^{-1}$ monofluoroacetic acid for more than 6 hours (Polter, 1967).

Plants are capable of metabolising and degrading fluoroacetate (Dichapetalum cymosum - Meyer and Grobbelaar, 1991; peanuts - Preuss and Weinstein, 1969; lettuce - Ward and Huskisson, 1972).

### 2.4.3. Where evidence exists for plant uptake, how long do residues persist?

The maximum length of time 1080 residues persist in plants is approximately 38 days (Miller et al., 2009; Ogilvie et al., 1998).

In a laboratory experiment by Ogilvie et al. (1998), single 0.15% 1080 RS5 pellets were added to the soil of pots containing either käpuka (NZ broadleaf) or ryegrass. The 1080 residues in the plants were near the Method Detection Limit (MDL) after 38 days in käpuka (NZ broadleaf) and 7 days in ryegrass.

Ogilvie et al. (2004) reported that after käramuramu took up 1080 during field trials, the concentration of 1080 in the plants decreased to zero at 28 days. The authors recommended that a withholding period of 30 days after an aerial application of 1080 could be adopted for plants within the operational area that are used for rongoa (medicinal) purposes.

When 0.15% 1080 Wanganui #7 pellets were placed beside puha plants in the field, 1080 that had been taken up by the puha was near the MDL after 28 days and below the MDL after 38 days (Miller et al., 2009). The authors suggested a withholding period of at least 38 days could be observed on harvesting wild grown puha immediately after an aerial 1080 operation. Note: in this study 1080 residues were recorded in puha that had been used as controls (i.e. no 1080 pellets placed beside them). The authors could not rule out that 1080 occurs naturally in puha.

## 2.5. *Animal residues*

### 2.5.1. What is the range of toxic residue levels recorded for sub-lethally exposed animals?

A number of laboratory studies have measured 1080 residue levels in sub-lethally poisoned mammals, marsupials, birds and insects.

When sheep and goats were orally dosed with an aqueous 1080 solution at 0.1 mg $kg^{-1}$ b.w. (equivalent to one-quarter of the published $LD_{50}$ for sheep and less than a quarter of the $LD_{50}$ for goats) the maximum 1080 residues recorded in plasma were 0.16 - 0.33 mg $l^{-1}$ and 0.22 - 0.26 mg $l^{-1}$ respectively. In the sheep, 2.5 hours after dosing the mean 1080 concentrations of were 0.098 mg $l^{-1}$ in plasma, 0.042 mg $kg^{-1}$ in muscle, 0.052 mg $kg^{-1}$ in the heart, 0.057 mg $kg^{-1}$ in the kidney and 0.021 mg $kg^{-1}$ in the liver. The mean 1080 concentrations declined to less than 0.003 mg $kg^{-1}$ in all tissues sampled 96-hours after dosing (Eason et al., 1994a).

Rabbits orally administered a sub-lethal dose of 1080 at 0.1 mg $kg^{-1}$ b.w. (equivalent to one-quarter of the published $LD_{50}$) and sampled at intervals after dosing had maximum 1080 concentrations of 0.121 – 0.167 mg $l^{-1}$ in plasma, 0.019 – 0.025 mg $kg^{-1}$ in muscle, 0.014 - 0.08 mg $kg^{-1}$ in kidney and 0.001 – 0.002 mg $kg^{-1}$ in liver (Gooneratne et al., 1995).

During both these studies, the highest concentrations of 1080 residues were found in the blood/plasma, with moderate levels in muscle and kidneys, and lowest concentration in the liver (Eason et al., 1994a; Gooneratne et al., 1994).

A deer 'run down and killed' following a poisoning trial using 1080 carrot baits in 1958 had 1080 concentrations of 1.50 mg $kg^{-1}$ in its meat, 0.47 mg $kg^{-1}$ in the heart and 0.92 mg $kg^{-1}$ in the liver (McIntosh and Staples, 1959).

When possums were orally dosed with an aqueous 1080 solution at 0.1 mg $kg^{-1}$ b.w. the maximum 1080 residues recorded in plasma were 0.11 - 0.31 mg $l^{-1}$ (Eason et al., 1993b).

In sub-lethally poisoned mallard ducks, a maximum concentration of 1080 was 12.95 mg $ml^{-1}$ in serum and 8.01 mg $g^{-1}$ in heart two hours after dosing with 8 mg $kg^{-1}$ 1080 (Ataria et al., 2000).

Lyver et al. (2005) reported that five out of 8 captive long-finned eels fed 1080 contaminated possum muscle had sub-lethal residues of 0.0174 ± 0.0104 mg $kg^{-1}$, while three out of nine eels fed gut tissue containing 1080 had residues of 0.0306 ± 0.0220 mg 1080 $kg^{-1}$ b.w..

Suren and Bonnett (2006) exposed caged koura to single 6 g 0.15% 1080 Wanganui #7 baits for up to 8 days. The maximum recorded 1080 residue level in the viscera was 3.3 µg $g^{-1}$ in an animal collected 1 day after being exposed to bait. The maximum recorded 1080 residue in tail muscle was 5 µg $g^{-1}$ in an individual collected after 4 days exposure. The highest recorded total 1080 residue (viscera + muscle tissue) was 7.7 µg $g^{-1}$ from an individual sampled 1 day after the bait was placed in its cage.

In trout dosed with a very high sub-lethal dose of 1080 (~6.4 mg $kg^{-1}$) the maximum concentrations measured in the tissue (up to 4.7 mg $kg^{-1}$) were recorded at 24 hours and 48 hours after ingestion. The concentration of 1080 in the tissue decreased to ~2 mg $kg^{-1}$ after 48 hours (Champeau et al., 2014)

Two laboratory studies have looked at 1080 residues in sub-lethally poisoned terrestrial invertebrates. Booth and Wickstrom (1999) recorded a mean 1080 concentration of 5.51 mg $kg^{-1}$ in ants (*Huberia striata*) one day after sub-lethally dosing them with 0.3 g 1080 $kg^{-1}$. Tree weta dosed with 15 g 1080 $kg^{-1}$ had residues of between 0.033 and 5.8 mg $kg^{-1}$ (Eason et al., 1993b).

Animals have also been sampled during pest control operations to test for sub-lethal 1080 residues. These results are presented in Table 1.

24 hours after an aerial rabbit control operation (0.4 g $kg^{-1}$ aerial carrot at 25 kg $ha^{-1}$) on Motuihe Island, Auckland in July 2002, 5 live cockles and 6 live marine mussels were tested for 1080 residues. None contained 1080 residues (VPRD 4928 - 4938).

During the February 2010 Egmont National Park aerial 1080 operation (0.15% 1080 Wanganui #7 pellets, 2.3 kg $ha^{-1}$) freshwater and marine mussels were monitored for 1080 residues. Freshwater mussels were sampled from 11 sites within the operational area. Marine mussels were sampled at 2 sites approximately 20 km from the operational area. No 1080 was detected in any of the samples (VPRD).

Note: The information in this section is derived from direct analyses for 1080 in animal tissues, from animals known to have received a sub-lethal dose of 1080. Analyses of associated metabolites (e.g. citrate, fluorine) in tissues are difficult to compare directly with analysis of 1080 concentrations, so this information is not included.

**Table 1.** 1080 residue levels recorded in sub-lethally exposed animals during pest control operations.

| Species | Sample Type | Residues (mg $kg^{-1}$) | Reference |
|---|---|---|---|
| *Arthropods* | | | |
| Beetles | Mixed samples | <0.1 | 1 |
| Invertebrates (various) | 7 mixed samples | 0.0-0.75 | 2,3 |
| Weta | Whole body | 2.7 | 1 |

1 Spurr et al. (2002); 2 Eason et al. (1991b); 3 VPRD.

## 2.5.2. How long do toxic residues of the pesticide persist in sub-lethally exposed animals?

### *Mammals*

Rabbits given sub-lethal doses of 1080 showed rapid elevation of plasma 1080 in the first hour post dose. Plasma 1080 concentration then declined rapidly at first and slowly thereafter, with very little 1080 being detected in plasma at 6 hours. The sub-lethal dose was cleared from tissues within 3 hours (Gooneratne et al., 1995). Sub-lethally dosed goats and sheep rapidly eliminated 1080, with only traces detected after 18 hours in goat plasma, and after 96-hours in sheep plasma and tissue (Eason et al., 1994a). Gooneratne et al. (2008) reported serum 1080 concentrations in ewes dosed with 0.30 mg $kg^{-1}$ were undetectable 3 days after dosing and no 1080 was detected in the skeletal muscle, kidneys of liver of animals that survived for 14 days after dosing. In possums only traces of 1080 were detected possum plasma 24 hours after receiving a 1 mg $kg^{-1}$ sub-lethal dose. All traces of 1080 were eliminated from the tissues of the rabbits, possums, goats and sheep within one week (Eason and Gooneratne, 1993). A withholding period of 5 days has been suggested as adequate for animals suspected to have received a sub-lethal dose of 1080 (Gooneratne et al., 2008).

### *Birds*

Mallard ducks dosed with a 8 mg 1080 $kg^{-1}$ sub-lethal dose substantially eliminated the 1080 from heart muscle and blood within 24 hours (Ataria et al., 2000).

*Invertebrates*

Tree weta orally dosed with 15 µg 1080 $g^{-1}$ eliminated >90% of the 1080 within 4 - 6 days (Eason et al., 1993b). Ants dosed with 0.3 g 1080 $kg^{-1}$ still had detectable levels of 1080 (0.27 mg $kg^{-1}$) seven days after dosing (Booth and Wickstrom, 1999).

*Aquatic organisms*

When koura were sub-lethally poisoned from eating 1080 baits, the concentration of 1080 in the tail muscle and viscera initially increased, and then declined between days 4 - 8. After eight days the mean residue levels in the tail muscle were less than 0.5 µg/g, a decrease by a factor of five, presumably as a result of the animals metabolising or excreting the compound (Suren and Bonnett, 2006).

One long-finned eel fed a bolus of fed gut tissue containing 8.3 mg 1080 $kg^{-1}$ still had 1080 residues (0.02 mg 1080 $kg^{-1}$) in its tissue 9 days later (Lyver et al., 2005).

1080 could still be detected in the tissue of trout 5 days after they were dosed with a very high sub-lethal dose of 1080 (~6.4 mg $kg^{-1}$) (Champeau et al., 2014).

Note: This information is derived from direct analyses for 1080 in tissues from animals known to have received a sub-lethal dose of 1080. Analyses of associated metabolites e.g. citrate, fluorine in tissues are difficult to compare directly with analysis of 1080 concentrations, so this information is not included.

### 2.5.3. What is the half-life of 1080 in sub-lethally exposed animals?

Data on the half-life of 1080 in plasma and tissues is presented in Table 2.

**Table 2.** Half-life of 1080 in plasma and tissue.

| Species | Sample Type | T ½ (hours) | Reference |
|---|---|---|---|
| Sheep | Plasma | 10.8 | 1 |
| | Muscle | 12.0 | 2 |
| | Liver | 3.0 | 2 |
| Goat | Plasma | 5.5 | 1 |
| Possum | Plasma | 9.1 | 3 |
| Rabbit | Plasma | 1.1 | 4 |
| | Muscle | 0.4 | 4 |
| | Kidney | 0.8 | 4 |
| Mouse | Plasma | 2.0 | 5 |

| | | | |
|---|---|---|---|
| | Muscle | 1.7 | 5 |

1 Eason et al. (1994a); 2 Rammell (1993); 3 Eason et al. (1993b); 4 Gooneratne et al. (1994); 5 Sykes et al. (1987).

### 2.5.4. What is the range of residue levels recorded in carcasses of animals killed by 1080?

In sheep dosed with a lethal amount of 1080 (200 µg $kg^{-1}$), the concentration of 1080 in the muscle of sheep sacrificed post-dosing reached a maximum of 111 µg $kg^{-1}$ in 4 hours and declined exponentially thereafter. In the liver a maximum concentration of 38 µg $kg^{-1}$ was recorded at 2 hours with exponential decline thereafter (Rammell, 1993). Sheep that died 22 – 25 hours after receiving a 0.30 mg $kg^{-1}$ dose of 1080 had 1080 concentrations of 0.06 1- 0.75 µg $g^{-1}$ in the heart, 0.058 - 0.72 µg $g^{-1}$ in the skeletal muscle and 0.047 - 0.051 µg $g^{-1}$ in the liver. In sheep that died 43 - 52 hours after dosing (0.30 mg $kg^{-1}$) the 1080 residues in skeletal muscle was 0.023 - 0.031 µg $g^{-1}$, but was undetectable in the heart and liver. The concentration of 1080 in the rumen contents of sheep that died within 24 hours of dosing was 0.15 - 0.27 µg $g^{-1}$ (Gooneratne et al., 2008).

Residues in rabbits given lethal doses of 1080 (0.8 mg $kg^{-1}$) were measured in the liver, kidney and muscle at the time of death and at one, two and three weeks after death. The residue concentrations were highly variable, but concentrations measured at 3 weeks were generally lower than other sample times. The maximum residue concentrations were not specified (Gooneratne et al., 1995).

Burns and Connolly (1992) reported that residues of 1080 in the breast muscle of Eurasian magpies were dose depended, with higher doses resulting in higher 1080 residues. Additionally, within dose levels, birds that survived longer had lower residues. For birds that died within 24 hours of dosing, the mean concentration of 1080 in the breast muscle was 0.73 µg $g^{-1}$ at a 1080 dose of 1.59 mg $kg^{-1}$ b.w., 0.70 µg $g^{-1}$ at a dose of 2.00 mg $kg^{-1}$ b.w., 0.84 µg $g^{-1}$ at a dose of 2.52 mg $kg^{-1}$ b.w. and 1.16 µg $g^{-1}$ at a dose of 2.52 mg $kg^{-1}$ b.w. In birds that died the day after being dosed the concentrations in the breast muscle were: 0.23 µg $g^{-1}$ (1.59 mg $kg^{-1}$ b.w. dose), 0.39 µg $g^{-1}$ (2.00 mg $kg^{-1}$ b.w. dose), 0.50 µg $g^{-1}$ (2.52 mg $kg^{-1}$ b.w. dose) and 0.64 µg $g^{-1}$ (3.17 mg $kg^{-1}$ b.w. dose).

Ants (*Huberia striata*) lethally poisoned with sugar water containing 1.5 g 1080 $L^{-1}$ had 1080 residues of 56 mg $kg^{-1}$, while ants lethally poisoned with 0.15% 1080 Wanganui #7 pellets had residues of 4.78 mg $kg^{-1}$ (Booth and Wickstrom, 1999).

1080 residues have also been recorded in animal tissues sampled from field situations (Table 3).

**Table 3.** 1080 residue levels recorded in carcasses in New Zealand during pest control operations.

| Species | Sample Type | Residues (mg $kg^{-1}$) | Reference |
|---|---|---|---|
| ***Birds*** | | | |
| Blackbird | Muscle | 0.01–32.0 | 1; 2; 3; 4 |
| Chaffinch | Muscle | 0.14–5.80 | 1; 4 |
| Dunnock | Muscle | 0.28–1.75 | 4 |
| Hedge Sparrow | Muscle | 0.03 | 1 |
| Kea | Muscle | 0.036 – 19.2 | 1 |
| | Stomach | 0.018-0.107 | 1 |
| Keruru/Kukupa | Muscle | 0.01 | 1 |
| Kiwi (Rowi) | Muscle [a] | 0.008-0.012 | 1 |
| Morepork/ruru | Muscle | 0.01 | 1 |
| California Quail | Crop | 18 - 76 | 5 |
| Rifleman | Abdominal cavity | 0.016–0.863 | 1 |
| NI Robin | Muscle | 0.37–3.80 | 6 |
| Silvereye | Muscle | 0.68 | 1 |
| Thrush | Muscle | 2.01 | 4 |
| Tomtit | Abdominal cavity | 0.298–0.406 | 1; 2; 4 |
| | Muscle | 0.23–4.2 | |
| Tui | Muscle | 0.012 | 1 |
| Weka | Muscle | 0.012–4.3 | 1; 19; 20 |
| Whio | Muscle | 0.0012 | 1 |
| Fernbird | Muscle | 0.14 – 0.75 | 7 |
| ***Marsupials*** | | | |
| Possum | Bone | 0–0.01 | 1; 8; 9 |
| | Liver | 1.5–8.4 | |
| | Muscle | 0.003–4.74 | |
| | Stomach | 0.05–~70 | |

| Species | Sample Type | Residues (mg $kg^{-1}$) | Reference |
|---|---|---|---|
| *Mammals* | | | |
| Short-tailed bat | Muscle | 0.013 | 10 |
| Cat | Muscle | 0.06–1.24 | 1 |
| | Stomach | 0.36 | |
| Cattle | Muscle | 0.003–0.46 | 1 |
| | Stomach | 0.04–9.1 | |
| Deer | Muscle | 0.012–7.37 | 1; 2; 3; 11; 21 |
| | Stomach | 0.33–51 | |
| | Heart | 0. 85-8.12 | |
| | Liver | 0. 75-4.05 | |
| Dog | Muscle | 0.014–0.41 | 1 |
| | Stomach | 0.028–0.7 | |
| | Intestine | 0.44 | |
| | Vomit | 1.07 | |
| Ferret | Muscle | 0.004–13 | 1; 12; 13; 14 |
| Rat - kiore | Muscle | 69 | 1 |
| Mouse | Whole body | 0.001–55 | 1 |
| | Muscle | 9.1–10.3 | |
| | Liver | 7.8–17.6 | |
| Pig | Muscle | 0.03–0.21 | 1 |
| | Stomach | 56 | |
| Sheep | Muscle | 0.021–0.3 | 1 |
| | Liver | 0.04 | |
| | Plasma | 0.35 | |
| | Stomach | 0.001–1.3 | |
| Stoat | Muscle | 0.002–1.07 | 1; 11; 15; 16 |
| | Stomach | 0–0.146 | |

| Species | Sample Type | Residues (mg $kg^{-1}$) | Reference |
|---|---|---|---|
| Goat | Muscle | 0.36 | 21 |
| Chamois | Muscle | 0.23 | 21 |
| ***Invertebrates*** | | | |
| Honeybee | 2 whole animals | 0–10.8 | 1 |
| Honeybee | Pooled samples of bees | 0.059-1.43 | 18 |
| Honeybee | Corbicula ('pollen sac') | 1050.85 | 1 |
| Honeybee | Honey (27 samples extracted from 73 hives) | 0 | 18 |
| Wasp | wasps | 5–38 | 17 |
| | larvae | 66–255 | |
| | Nest debris | 17–96 | |

Variation in these residue concentrations will be due to: amount of 1080 ingested over what time, time taken to death variation between species and within individuals of that species.

a. Two kiwi (Okarito Rowi) found dead had 1080 dectected in muscle samples, but in both cases there was evidence for other potential causes of death (predation, starvation) and it is not known if 1080 poisoning was a cause or contributing factor to either death.

1 VPRD; 2 Speedy (2003); 3 Nugent et al. (2004); 4 Morriss et al. (2016); 5 Evans and Soulsby (1993); 6 Powlesland et al. (1999b); 7 van Klink et al. (2013); 8 Eason et al. (1991a); 9 Meenken and Booth (1997); 10 Edmonds et al. (2017); 11 McIntosh and Staples (1959); 12 Gillies and Pierce (1999); 13 Heyward and Norbury (1999); 14 Parliamentary Commissioner for the Environment (1994);15 Murphy et al. (1999); 16 Dilks and Lawrence (2000); 17 Eason et al. (1991b); 18 Pattemore and Fale (2022); 19 van Klink 2013; 20 Tinnemans et al. (2019); 21 Morriss et al 2019.

### 2.5.5. How long do residues of 1080 persist in carcasses of animals killed by the pesticide?

*While 1080 is metabolised and eliminated from living animals it can persist in carcasses for months where it will degrade more slowly than indicated by the half-life in living mammalian metabolism. The rate of degradation of 1080 in carcasses will depend on moisture, temperature and the presence of micro-organisms.*

The retention of 1080 in tissue was greater in rabbits dosed with a lethal dose than in those that received a sub-lethal dose. In this study 1080 was detectable (~0.03 mg $kg^{-1}$) in rabbit muscle 3 weeks after death following a lethal dose of 1080 (Gooneratne et al., 1995).

Tissue from possum carcasses monitored following possum and wallaby control on Rangitoto Island in 1990 still contained high 1080 residues 13 days after the operation. By day 28 the carcasses had significantly decomposed and consisted of pelts and bone so no further samples were taken (Eason et al., 1991a).

The mean concentrations of 1080 in possum stomachs and contents collected 75 days after the estimated date of death from 0.08% 1080 paste in May - June 1994 was 4.90 mg $kg^{-1}$. This was significantly less than the mean of 30.06 mg $kg^{-1}$ in possum stomachs and contents samples taken on day 25 (Meenken and Booth, 1997).

Wright (2004) monitored the fate of possum carcasses at two sites after an 8600 ha aerial 1080 operation in the Hutt River upper catchment in 2003. At site one the carcasses had lost most of their fur and were described as "very putrid" 52 days after the bait was applied, 156mm of rain had fallen by this time. By day 65 bones were exposed on carcasses at site two. The stomach remains of carcasses from both sites were tested at day 73 and found to contain 6 mg $kg^{-1}$ and 13 mg $kg^{-1}$ at sites one and two respectively. Cumulative rainfall recorded by this time was 231 mm for site one and 458 mm at site two. Three possum carcasses found downstream at about this time were contained 1080 residues of 6 mg $kg^{-1}$, 7 mg $kg^{-1}$ and <MDL. A red deer carcass also found on the river bank contained 0.5 mg $kg^{-1}$. The last carcass tested for residues 178 days following the bait application was found to contain green dyed bait in its stomach, but residue tests were <MDL.

Note: This information is derived from direct analyses for 1080 in tissues from animals known to have died from 1080 poisoning. Analyses of associated metabolites e.g. citrate, fluorine in tissues are difficult to compare directly with analysis of 1080 concentrations, so this information is not included.

Persistence of 1080 in the carcasses of poisoned sika deer was studied by Ross and McCoskery (2012). Bone marrow had comparitively low levels of 1080 for at least 213 days. Using this data in a review of secondary poisoning risks, Eason et al (2013) calculated that a 20kg dog would have to eat 2.4 kg of deer bone marrow at the concentration seen at day 30 to be seriously at risk. However the authors cautioned that 1080 residues in possum bone marrow had not been studied and given that possum stomach residues are often higher that those measured in deer, could pose a risk to dogs.

# 3. Effects on Non-Target Native Species

Based on the few studies of native species available, and the large number of non-native species studied (Part 4) suggests 1080 is likely to be toxic to most native animals. There is wide variation in sensitivity between taxonomic groups with mammals more sensitive than birds and invertebrates (on a weight for weight basis). Sub-lethal effects have been demonstrated for native invertebrates in the laboratory. The small size of many native species (relative to the target pests) means that toxic baits used for pest control are capable of causing harm to almost any animal that eats the bait. Therefore, the level of exposure to the bait becomes important in determining the effects on non-target native species in the field.

Most information on non-target exposure to 1080 bait relates to aerial poisoning as this is thought to be the "worst case scenario" for studying non-target effects. Hand laid baits are sometimes used to approximate aerial poisoning in studies. Bait station studies are scarce. It could be assumed that native species are not more at risk using bait stations than distributing the same bait type aerially.

There are records of a range of native bird species found dead after aerial poisoning operations and many of these individuals have contained residues of 1080. However, when records are discounted from:

- operations which did not meet current bait quality standards (e.g. using unscreened, un-dyed carrot bait with berry fruit lures) or
- those animals which did not have detectable 1080 residues,

the Vertebrate Pesticide Residue Database (VPRD) between 1994-2018 recorded only 44 poisoned individuals representing 11 native species across all bait types used in aerial and handlaid operations. No conclusions about population effects can be drawn from this information but it is useful to focus further studies. Some native species (mainly invertebrates) have contained 1080 residues when sampled, an indication of potential risk to insectivores from secondary poisoning.

Loss of individuals in a population of native species as a consequence of 1080 poisoning can have variable significance to the long-term viability of the population depending on the context. Those animals with a large population and/or a high rate of increase can compensate for small loses. Poison-related mortality may be replacing deaths from predation or winter starvation. Threatened species usually have a poor ability to recover from additional mortality, making the consequences theoretically more concerning.

There have been numerous studies examining the effects of aerial poisoning on native non-target populations over the last 20 years. 24 species of native birds, particularly threatened species, have been monitored. None of the studies have identified population level mortality which threatened the viability of the species, although the only reliably calculated mortality rates are for kokako, kiwi, kaka and fernbirds. The upper 95% mortality rates for kokako, kiwi and kaka are all less than 3.5%. The mean mortality rate for fernbirds is 9.4%.

Limited monitoring of short tailed bats and native frogs has not indicated detectable mortality due to aerial 1080 poisoning.

Invertebrate populations have been monitored in nine aerial poisoning operations and none have shown significant population effects on any species studied, nor is there evidence to suggest poisoned invertebrates are a significant factor in secondary poisoning of other animals. Long term monitoring of native land snails indicates substantial benefits to threatened populations in sites treated with aerial poisoning.

The risks 1080 operations pose to aquatic species is considered very low. Fish are very tolerant to 1080. Additionally, 1080 contamination of water is rarely found during 1080 operations and is at an extremely low level when it has occurred. No mortality of longfin eels, köaro or upland bullies was observed during experiments where high densities of cereal 1080 pellets were placed in water just upstream of them. Eels and koura have survived experimental feeding of cereal 1080 pellets, and eels have survived feeding on possum tissue containing 1080. There have also been no detectable effects on aquatic invertebrate communities in field studies when 1080 baits were placed at high densities in streams.

## *3.1. Toxicity*

### 3.1.1. What is the lethal dose ($LD_{50}$) range for each taxon?

The $LD_{50}$ values available for native mammals, birds and arthropods are presented in Table 4. While there is no information for any native reptiles, amphibians, fish or molluscs, Section 4 has information on overseas species in these taxa which is useful.

**Table 4.** Acute oral toxicity of 1080 for native taxa.

| Species | $LD_{50}$ (mg $kg^{-1}$) | References |
|---|---|---|
| ***Birds*** | Range: 8.00 - 9.25 | |
| Grey duck | 10.0 | 1 |
| Silvereye | ~ 9.25 | 1 |
| Weka | ~ 8.1 | 2 |
| ***Mammals*** | | |
| Short tailed bat | 0.15 ('Worst case' LD value) | 3 |
| ***Invertebrates*** | Range: 42.00 - 91.00 | |
| NZ ant | 72.00 (24 hr $LD_{50}$) | 4 |
| | 42.00 (48 hr $LD_{50}$) | 4 |
| Wellington tree weta | 91.00 | 4 |
| Earthworms (Eisenia fetida) | No mortality from soil exposures up to 865 mg/kg | 5 |

1 McIlroy (1984); 2 McIntosh et al. (1966); 3 Lloyd and McQueen (2000); 4 Booth and Wickstrom (1999); 5 O'Halloran at el 2005.

### *Aquatic Invertebrates*

Based on sub-lethal exposure trials, Suren and Bonnett (2006) suggest that the 1080 $LC_{50}$ for koura is relatively high.

## 3.1.2. Based on the mode of action, are there any taxa that are unlikely to be affected by 1080?

*1080 is considered a broad-spectrum toxicant* although variation in $LD_{50}$'s and body size of animals suggests that some native species could survive low exposure to 1080. The susceptibility of a specific animal is linked to its metabolic rate (McIlroy, 1994), so cold-blooded animals may be more tolerant to 1080 as their metabolic rate is likely to be much lower. Fish have been found to be highly tolerant of 1080 in overseas studies (Fagerstone et al., 1994).

### 3.1.3. Have sub-lethal effects on birds, mammals, reptiles/amphibians, fish, arthropods, or molluscs been described for 1080?

*Birds*

There was a significant difference in the activity of Western weka for 3 days after an aerially applied 1080 cereal pellet operation block compared with birds over the same period in a non-treatment block. In the 3 days following the 1080 operation, the average daily activity of weka with diagnostic transmitters dropped by 31.2% ± 4.6% (standard error of the mean) (N = 10) and 8.0% ± 4.3% (N = 6) in the treatment and non-treatment blocks respectively. All individuals in the treatment block had a pronounced drop in activity during the 3 days following the poison operation compared to 7 days immediately prior to the operation, but seemed to revert to normal daily activity levels within approximately 7 days (Tinnemans et al. 2019).

*Reptiles/amphibians*

An Australian study of shingleback lizards found a decrease in testosterone levels in the plasma in study animals and a degeneration of seminiferous tubules in some individuals when high sublethal doses of 1080 were administered intraperitoneally (Twigg et al., 1988).

*Invertebrates*

A laboratory study of **Auckland tree weta** by Hutcheson (1990) found poisoned animals, including those sub-lethally poisoned, became active during the day rather than sheltering as is their normal behaviour demonstrated by a control group and a group which fed on non-toxic baits.

**Cockroaches** that had eaten 1080 baits in a laboratory study appeared drugged and their normal response to predators was suppressed (McIntyre, 1987).

Smith and Grosch (1976) studied the sub-lethal effects of 1080 on *Bracon hebetor*, a **parasitoid wasp** found in North America. They found egg production decreased after a single sub-lethal dose. There was also low hatchability of eggs laid in the first few days post dosing.

In **compost worms**, used as an surrogate for native earth worms, cocoon production and the number of live juveniles decreased progressively as 1080 concentrations increased, particularly at 1080 concentrations in the soil of ≥100 mg $kg^{-1}$. These soil concentrations were well above those that normally occur following the field use of 1080 (up to 0.08 mg/kg) (O'Halloran et al., 2005).

The presence of up to 1g/kg 1080 in soil did not affect the ability of soil **microorganisms** to mineralize nitrogen (O'Halloran et al 2005). This is an absurd amount, the equivalnet of mixing over 600kg of 1080 pellets into 1 kg of soil.

### 3.1.4. How much bait needs to be ingested for poisoning, based on pen trials with native species?

Based on the information given in section 3.1.1, the amount of bait native species need to ingest to be poisoned is given in Table 5.

**Table 5.** Amount of bait needed to be ingested to result in death based on $LD_{50}$ for native species.

| Species | $LD_{50}$ (mg $kg^{-1}$) | Av. Weight Female (g) | Amount of 0.4g $kg^{-1}$ Bait (g) for $LD_{50}$ | Amount of 0.8g $kg^{-1}$ Bait (g) for $LD_{50}$ | Amount of 1.0g $kg^{-1}$ Bait (g) for $LD_{50}$ | Amount of 1.5g $kg^{-1}$ Bait (g) for $LD_{50}$ | Amount of 2.0g $kg^{-1}$ Bait (g) for $LD_{50}$ | Amount of 50g $kg^{-1}$ Bait (g) for $LD_{50}$ | Amount of 100g $kg^{-1}$ Bait (g) for $LD_{50}$ |
|---|---|---|---|---|---|---|---|---|---|
| ***Birds*** | | | | | | | | | |
| Silvereye | 9.25 | 13 | 0.30 | 0.15 | 0.12 | 0.08 | 0.06 | 0.002 | 0.001 |
| Weka | 8 | 700 | 14.00 | 7.00 | 5.60 | 3.73 | 2.80 | 0.11 | 0.06 |
| ***Mammals*** | | | | | | | | | |
| Short-tailed bat | 0.15 | 14 | 0.005 | 0.006 | 0.002 | 0.001 | 0.001 | 0.00004 | 0.00002 |
| ***Arthropods*** | | | | | | | | | |
| NZ ant | 42 | 0.002 | 0.00021 | 0.00011 | 0.00008 | 0.00006[b] | 0.00004 | 0.000002 | 0.0000008 |
| Tree weta | 91 | 1 | 0.228 | 0.114 | 0.091 | 0.061 | 0.046 | 0.002 | 0.001 |

[a] Weights for birds from Heather and Robertson (1996) & weights of bats from Lloyd and McQueen (2000); [b] A single 6 g 0.15% 1080 pellet has enough toxin to deliver an $LD_{50}$ dose to >100 000 ants with a mean bodyweight of 2 mg each (Booth and Wickstrom, 1999).

Note: The $LD_{50}$ values given in section 3.1.1 have been used in the calculations. The body weights used to calculate the amount of bait required for an $LD_{50}$ are average weights of females, which are generally more susceptible to poisoning because of smaller body weight and physiological factors therefore a 'worst case scenario' for poisoning.

## 3.2. *Exposure*

### 3.2.1. What species (individual animals) have been reported as non-target deaths in field operations with 1080 use?

*Aerial and Handlaid Operations*

Individual animals have been found dead after aerial and handlaying operations using 1080 carrot and cereal pellet baits (Table 6, Table 7). The information presented in the tables includes animals found dead or assumed to have been lethally poisoned from the presence of 1080 residues. The information has been restricted to those operations where the basic performance standards could be verified.

Deaths of 4 kea and eight southern black-backed gulls were reported from a trial where 1080 carrot bait was aerially applied for tahr control (Douglas 1967). The baits used (chopped carrot pieces up to 200g, 0.14-0.36% 1080, green dyed) did not met current standards for registered 1080 products.

**Table 6.** Non-target native species deaths reported during aerial operations using 0.08% or 0.15% carrot baits (0.08% 1080 unless stated).

| Species | No. Found Dead | No. of Operations | Cases Where Residues Confirmed | Sowing Rate (kg ha$^{-1}$) | | Ref. |
|---|---|---|---|---|---|---|
| | | | | Prefeed | Toxic | |
| ***Birds*** | | | | | | |
| Morepork | 2 | 2[a] | 2 | | 15 | 1 |
| Tomtit | 8 | 4 [a] | 8 | | 10 - 15 | 1; 2 |
| | 3 | 1[b] | 3 | | 5 | 3 |
| NI Robin | 3 | 1 [a] | 3 | 5 | 15 | 4 |
| Kereru | 6 | 3 | 1 | | 15 | 1; 5; 6 |
| Rifleman | 5 | 1 | 5 | | 15 | 1 |
| Grey warbler | 1 | 1 | 0 | | 15 | 5 |
| Tui | 1 | 1 | 1 | ? | ? | 7 |
| Weka[c] | 1 | 1 | 1 | | 5 | 8 |
| | 1 | 1 | 1 | 3 | 5 | 9 |

[a] 1 of these operations was at Tahae (Pureora) where there is some evidence that the carrot was not screened adequately to meet bait specifications (Powlesland et al.,

1999a); [b] In this operation the carrot bait was coated with EDR deer repellent; [c] 0.15% 1080 carrot

Records of 1 tui and 1 whitehead from Kapiti island 1984 are not included above as there is some evidence that the carrot was below specs and the birds were not residue tested (Sherley, 1992). Records of robin, grey warbler, fantail, morepork/ruru, and Tomtit from 1978/79 not included above because carrot bait not to current quality standards.

1 Spurr and Powlesland (1997); 2 VPRD: T0171 & T1195; 3 Speedy (2003); 4 Powlesland et al. (1999a); 5 Greene (1998); 6 VPRD: T1223; 7 VPRD: T1809; 8 VPRD: 10210; 9 VPRD.

**Table 7.** Non-target native species deaths reported during aerial & handlaid operations using 0.15% or 0.08% 1080 pellets.

| Species | No. Found Dead | No. of Operations | Cases Where Residues Confirmed | Sowing Rate (kg $ha^{-1}$) | | Ref. |
|---|---|---|---|---|---|---|
| | | | | Prefeed | toxic | |
| ***Birds*** | | | | | | |
| Silvereye | 1 | 1[a] | 1 | | 2 | 1 |
| | 1 | 1[a] | 0[i] | ? | 1.5 – 2.5 | 16 |
| Morepork | 2 | 1[b] | 1[c] | | 5 | 3; 4 |
| | 2 | 2 | 0[i] | 1 | 2 | 5 |
| Tomtit | 5+[d] | 3[a] | 0[e] | | 5 - 7 | 3; 6 |
| | 2 | 1[a] | 2 | Yes | 3 | 7 |
| | 1 | 1 | 1 | 2 + 2 | 4 | 32 |
| Weka | 2 | 2[a] | 2 | | 3 - 5 | 8; 9 |
| | 2 | 2[a,f] | 1[g,h] | | 1 | 10; 11 |
| | 2 | 2 | 2 | 1 | 2 | 27 |
| | 1 | 1 | 1 | 1 | 1 | 28 |
| Kakariki | 2 | 1[a] | 2 | 3 | 3 | 12 |
| | 1 | 1 | 0[i] | 2 | 2 | 13 |
| Kereru | 4 | 3[a] | 1[j] | | 2 - 3 | 14 |
| Kiwi | 1 | 1[a,f] | 0[i] | | 1 | 15 |
| Kiwi (Rowi) | 2[k] | 1 | 2 | 2 | 2 | 29 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Kea | 52 | 14[a] | 36 | 1 - 3 | 1 - 4 | 16; 24; 30 |
| Tui | 1 | 1 | 0[i] | 2 | 2 | 17 |
| | 1 | 1 | 0[i] | ? | 2 | 18 |
| | 1 | 1 | 0[i] | 1 | 1 | 19 |
| Fernbird | 3 | 1[a] | 3 | 2 | 1 | 20 |
| Grey warbler | 3 | 1[a] | 0[i] | ? | 1.5 – 2.5 | 2 |
| Takahe | 3 | 1 | 3 | 1.5 | 1.5 | 25 |
| Whio | 2 | 1 | 1 | 2 | 2 | 23 |
| Southern black-backed gull | 120 | 1 | 2 | 1.5 | 1.5 | 31 |
| Southern black-backed gull | 556 | 1 | 4 | 2 + 2 | 4 | 26 |
| ***Mammals*** | | | | | | |
| Short-tailed bat | 1 | 1 | 1 | 1 | 1 | 21 |
| ***Frogs*** | | | | | | |
| Hochstetter's | 1 | 1[a] | 0[i] | | 7 | 22 |

[a] toxic loading of baits 0.15%; [b] toxic loading of baits 0.08%; [c] the second bird was not tested; [d] number found in second operation unspecified, assumed at least 1; [e] none of these birds were tested for residues; [f] baits handlaid; [g] this bird also had cyanide residues which is thought to be the cause of death; [h] the second bird tested negative, assumed to have come from handlaid treatment block – see Pestlink report 0203SND28; [i] tested negative; [j] two other kereru tested negative; [k] for each of these Rowi there was evidence for other potential causes of death (predation, starvation) and it is not known if 1080 poisoning was a cause or contributing factor for either death.

Note: 1 kokako record (Rotoehu 1994) omitted as baits were experimental (Flux and Innes, 2001; Spurr and Powlesland, 1997).

1 VPRD: T1534; 2 VPRD T3567; 3 Spurr and Powlesland (1997); 4 VPRD: T0283; 5 VPRD T5712; 6 Calder and Deuss (1985); 7 Morriss et al. (2016); 8 Walker (1997); 9 VPRD: T0169 & T2061; 10 VPRD: T1370 & T1467; 11 Pestlink: 0203SND12 & 0203SND28; 12 Rhodes et al. (2008); 13 VPRD 13305; 14 VPRD: T2061; 10206 & 1427; 15 VPRD: T1283; 16 VPRD: L23934, L23949, L35852, L41021, L41026, L23948, T5227 T5245, T7093, T7416, T7418, T7479, T8343, T7869; 17 VPRD 13306; 18 VPRD; 19 VPRD T4372; 20 van Klink et al. (2013); 21 Edmonds et al. (2017); 22 McNaughton and Greene (1994); 23 VPRD: T7287 & N. Lightbourne pers comm.; 24 Kemp et al. (2019); 25 VPRD T7505; 26 VPRD T7821; 27 van Klink (2013); 28 Tinnemans et al. (2019); 29 VPRD: T8093 & T8078; 30 Young et al. (2023); 31 P. Eschenmoser pers. comm.; 32 VPRD 28890.

*Bait stations*

Individual animals have been found dead after bait station operations using 1080 carrot and cereal pellet baits (Table 8). The information presented in the table includes animals found dead or assumed to have been lethally poisoned from the presence of 1080 residues. The information has been restricted to those operations where the basic performance standards could be verified.

**Table 8.** Non-target native species deaths reported during operations using 0.15% 1080 pellets in bait stations.

| Species | No. Found Dead | No. Of Operations | No. Of Cases Where Residues Confirmed | Sowing Rate (kg ha$^{-1}$) | | Ref. |
|---|---|---|---|---|---|---|
| | | | | Prefeed | Toxic | |
| *Birds* | | | | | | |
| Kea | 1 | 1 | 1 | | 1 | 1 |
| Tui | 1 | 1 | 0[a] | | ? | 2 |

[a] tested negative

1 VPRD: T0597; 2 VPRD: 8692.

*Other methods*

No information on deaths after the use of other methods and bait types could be located.

### 3.2.2. In which species have residues of 1080 been detected following operations?

*Aerial and Handlaying Operations*

1080 residues have been detected in a number of living animals following aerial and handlaying operations using 1080 cereal pellets (Table 9).

24 hours after an aerial rabbit control operation (0.4 g kg$^{-1}$ aerial carrot at 25 kg ha$^{-1}$) on Motuihe Island, Auckland in July 2002, 5 live cockles and 6 live marine mussels were tested for 1080 residues. None contained 1080 residues (VPRD 4928 - 4938).

During the February 2010 Egmont National Park aerial 1080 operation (0.15% 1080 Wanganui #7 pellets, 2.3 kg ha$^{-1}$) freshwater and marine mussels were monitored for 1080 residues. Freshwater mussels were sampled from 11 sites within the operational area. Marine mussels were sampled at 2 sites approximately 20 km from the operational area. No 1080 was detected in any of the samples (VPRD).

The information in this section includes the results of laboratory analysis from live animals captured or killed for sampling from treatment areas. Residues from

animals found dead are presented in section 3.2.1 above. The information has been restricted to those operations where the basic performance standards could be verified.

During a field trial in Egmont National Park in 2016, RS5 pellets were prefeed on four occasions (4 kg/ha; 2 kg/ha; 1 kg/ha and 1 kg/ha 21-48 days apart) followed by 0.15% 1080 RS5 pellets at a sowing rate of 4 kg/ha over 1,600 ha. The surrounding area was prefed once at a sowing rate of 1 kg/ha, followed by 0.15% 1080 RS5 pellets at a sowing rate of 2 kg/ha. 11 green coloured whio scats were found following the toxic drop, attributed to 5 individual birds, with the majority of the scats (9) found within the trial area. Nine of the scats were tested for 1080 residues with 3 testing positive. The whio present at the site where the positive samples were collected disappeared. (D Worthy & J Scrimgeour pers. comm.).

Following a 1080 operation (aerially applied 2kg/ha prefeed, 2kg/ha 0.15% 1080 6g RS5 bait) on Mt Taranaki in June 2019, 19 green coloured whio scats were were found and all tested positive for 1080 residues (VPRD). The locations of 1080-positive whio scats indicated they were likely to be from a number of different individual birds. The proportion of whio that consumed 1080 bait is unknown as is the identity and fate the birds that did eat bait. Of 19 radio tagged birds from the same area 17 were alive and 2 were found dead after the operation (see section 3.2.3). Seven of the radio tagged birds were present on sections of river where 1080-positive scats were found and none of the birds died of poisoning. (N. Lightbourne pers. comm.).

A green whio scat collected from the Waingaro River in Kahurangi National Park following an aerial 1080 pellet operation (1.5 kg/ha prefeed, 1.5 kg/ha 0.15% 1080 6g RS5 bait) tested positive for 1080 (VPRD).

**Table 9.** Residues detected in live non-target native species during aerial and handlaid pest control operations using 0.15% and 0.08% 1080 pellets.

| Species | Residues (mg $kg^{-1}$) | No. Of Samples | Sowing Rate (kg $ha^{-1}$) | | Ref. |
|---|---|---|---|---|---|
| | | | Prefeed | Toxic | |
| ***Birds*** | | | | | |
| Kiwi | 0.011 | 1[d] | | 3[a] | 1 |
| Weka | 4.35 | 1 [d] | | 5 [a] | 2 |
| Whio | 0.06-1.51 | 3 [d] | 2x at 4 & 2 | 4 | 10 |
| | 0.003-0.198 | 19 [d] | 2 | 2 | 11 |
| | 0.081 | 1 [d] | 1.5 | 1.5 | 12 |
| ***Mammals*** | | | | | |

| | | | | | |
|---|---|---|---|---|---|
| Short-tailed bat | 0.013 | 1 | 1 | 1 | 3 |
| ***Invertebrates*** | | | | | |
| Bush weta | 2.7 | 1 | 1.5 | 1.5[a] | 4 |
| Tree weta | 66 | 1[e] | | 5[a] | 5 |
| | 8.6 | 1 | | 5[a] | 6 |
| Cave weta | 32–130 | 4[f] | | 5[a] | 5 |
| | 4 | 1 | | 5[a] | 6 |
| Weevil | 10 | 1 | | | 6 |
| Kauri snails | 0 | 4 | | 5[b,c] | 7; 8 |
| Arthropods (mixed) | 0.05–0.75 | 4 | | 5[b,c] | 7; 8 |
| Spiders (mixed) | 14 | 1[g] | | 5[a] | 5 |
| Arthropods (mixed) | 14-46 | 3[h] | | 5[a] | 5 |
| | 0-0.006 | 3 | | 5[b] | 9 |

[a] toxic loading of baits 0.15%; [b] toxic loading of baits 0.08%; [c] baits were handlaid; [d] faecal dropping sample selected for testing because green colour suggested toxic bait consumption; [e] 1 sample totalling 26 individuals collected from pitfall traps in treatment area; [f] four samples totalling 9 individuals; [g] 1 samples of 4 spiders, 2 collected from baits and 2 from pitfall traps; [h] 3 samples totalling 58 individuals collected off 1080 baits.

1 VPRD: T0819; 2 VPRD: T0169; 3 Edmonds et al. (2017); 4 VPRD: T6452; 5 Lloyd and McQueen (2000); 6 Spurr and Berben (2004); 7 Pierce and Montgomery (1992); 8 VPRD: R004; 9 VPRD: 139 & 146; 10 VPRD: T6388,T6403 & T6405; 11 VPRD: T7183, T7184, T7197; 12 VPRD: T7198

### 3.2.3. What evidence is there to suggest that use of 1080 causes, or doesn't cause, a population decline of native species at sites where it is used?

***Aerial and hand laying operations using 0.15% or 0.08% 1080 Pellets***

*Birds*

44 radio-tagged **great spotted kiwi** have been monitored through four 0.15% 1080 Pellet aerial operations and none died from 1080 poisoning (Table 10).

**Table 10.** Great spotted kiwi monitored during aerial 1080 operations using 0.15% 1080 pellets.

| Operation | No. of Birds Exposed | No. killed by Poison | Sowing Rate (kg ha$^{-1}$) | | Ref. |
|---|---|---|---|---|---|
| | | | Prefeed | Toxic | |
| 1994 (Aug) Saxon River | 9 | 0 | | 5 | 1 |
| 1994 (Dec) Karamea | 7 | 0 | | 5 | 2 |
| 2009 (Sept) Gouland Downs | 8 | 0 | 1 | 2 | 3 |
| 2009 (Sept) Hawdon | 20 | 0 | 1 | 2 | 4 |

1 Walker (1997); 2 Robertson et al. (1999); 3 S. Forder pers. comm. Pestlink: 0809GDB08; 4 Veltman and Westbrooke (2011)

A total of 243 **NI brown kiwi** have been monitored during aerial and handlaid 1080 pellet operations during 8 operations and none have died from poisoning (.Table 11). Kiwi call count monitoring during the Waipoua operation did not indicate significant 1080 related mortality (Pierce and Montgomery, 1992).Table 11. NI brown kiwi monitored during aerial and handlaid 1080 operations using 0.15% or 0.08% 1080 pellets.

| Operation | No. of Birds Exposed | No. Killed by Poison | Sowing Rate (kg ha$^{-1}$) | | Ref. |
|---|---|---|---|---|---|
| | | | Prefeed | Toxic | |
| 1990 (June) Waipoua | 5 | 0 | | 5[a] | 1 |
| 1990 (Sept) Waipoua | 6 | 0 | | 5 | 1 |
| 1995 Rewarewa | 22 | 0 | | 3[b,c] | 2 |
| 2001 (Sept) Tongariro Forest | 27 | 0 | 2 | 3[b] | 3 |
| 2006 (Sept) Tongariro Forest | 68 | 0 | 2 | 4[b] | 3 |
| 2011 (Sept) Tongariro Forest | 44 | 0 | 1.5 | 2[b] | 3 |
| 2014 (Aug) Tongariro Forest | 39 | 0 | 0.75 | 0.75[b] (strip sowing) | 3 |
| 2017 (Aug) Tongariro Forest | 32 | 0 | 1.5 | 1.5[b] | 3 |

[a] toxic loading of baits 0.8 g $kg^{-1}$; [b] toxic loading of baits 1.5 g $kg^{-1}$; [c] baits were handlaid.

1 Pierce and Montgomery (1992); 2 Robertson et al. (1999); 3 H. Robertson & J. Guillotel pers. comms.

46 **Rowi** were monitored during an aerial 0.15% 1080 Wanganui #7 pellet operation at Okarito in November 1998 with no deaths being reported (Veltman and Westbrooke, 2011). 19 **Haast tokoeka** were monitored during an aerial 0.15% 1080 Wanganui #7 pellet operation (2 kg $ha^{-1}$ prefeed, 3 kg $ha^{-1}$ toxic) in the Haast Kiwi Sanctuary in May 2001, with no deaths being recorded (H Robertson pers. comm.).

Based on a meta-analysis of 199 kiwi (all species) from 10 surveys between 1994 and 2009, Veltman and Westbrooke (2011) calculated the upper bound of the 95% confidence interval for an estimate of zero mortality at 1.5%.

A total of 302 NI **kokako** has been exposed to this method and bait type over 13 operations and 2 have disappeared after poisoning (Table 12). Between 1986 and March 1998, 366 kokako (including 6 juveniles) have been monitored through 31 aerial poisoning operations (of all bait types and toxins combined), although the number exposed and known to have survived is greater. Of the monitored birds, 4 have disappeared after poisoning, leading to a maximum estimate for kokako mortality of 1.4% per operation with a 5% chance that it will exceed 4% (Flux and Innes, 1999). Based on a meta-analysis of 129 radio tagged and banded kokako that were monitored through 8 aerial 1080 operations between 1986 and 2001, Veltman and Westbrooke (2011) calculated the upper bound of the 95% confidence interval for an estimate of zero mortality at 2.3%.

**Table 12.** NI kokako monitored during aerial and handlaid 1080 operations using 0.15% or 0.08% 1080 pellets.

| Operation | No. of Birds Exposed | No. Killed by Poison | Sowing Rate (kg $ha^{-1}$) | | Ref. |
|---|---|---|---|---|---|
| | | | Prefeed | Toxic | |
| 1986 Pureora Nth Block | 16 | 0 | | 10-12[b,d] | 1 |
| 1986 Okahukura Forest | 11 | 1 | | 10-12[b,d] | 1 |
| 1986 Meyers Farm (Pureora) | 5 | 0 | | 8-10[c] | 1 |
| 1987 Pureora Nth Block | 23 | 0 | | 8[c,d] | 1 |
| 1988 Mapara | 3 | 0 | | 10[c] | 1 |
| 1988 Cowan WR/ Okahukura Forest | 24 | 0 | | 8-10[c] | 1 |
| 1990 Waipoua | 6 | 1e | | 5[c] | 2 |

| | | | | | |
|---|---|---|---|---|---|
| 1990 Mapara | 52 | 0 | | 8[c] | 3 |
| 1989 Moki Forest | 12 | 0 | | 9[c] | 4 |
| 1990 Kaharoa Forest | 24 | 0 | | [b] | 5 |
| 1991 Mapara | 48 | 0 | | 8[c] | 3 |
| 1992 Mapara | 50 | 0 | | 8[c] | 3 |
| 1992 Kaharoa Forest | 28 | 0 | | 6[b] | 6 |
| 1994 Rotoehu | 26 | 0 | | 2 [b] | 7 |
| 2001 Mapara | 16 | 0 | yes | 2 [b] | 7 |

[a] monitoring method assumes birds which disappear have died from poisoning; [b] toxic loading of baits 0.15%; [c] toxic loading of baits 0.08%; [d] These operations used 'Mapua' surface coated cereal pellets which are no longer used; [e] this bird least fitted the basic assumptions of the monitoring method and probably should not have been included in the assessment- according to the authors.

1 Innes and Williams (1990); 2 Pierce and Montgomery (1992); 3 Bradfield (1993); 4 Spurr (1994b); 5 Speed (1992); 6 Speed (1993); 7 Veltman and Westbrooke (2011).

A total of 132 **weka** have been exposed to this method and bait type over 8 operations and 4 have died from poisoning (Table 13). The pooled mortality rate from monitoring 90 Western weka across four pre-fed aerially applied 1080 cereal pellet operations is 3.3% (0.7–9.4% CI) (Tinnemans et al. 2019).

**Table 13.** Weka monitored during aerial and handlaid 1080 operations using 0.15% 1080 pellets.

| Operation | No. of Birds Exposed | No. Killed by Poison | Sowing Rate (kg ha$^{-1}$) | | Ref. |
|---|---|---|---|---|---|
| | | | Prefeed | Toxic | |
| 1994 Saxon River | 7 | 0 | | 5 | 1 |
| 1994 Tennyson inlet | 17 | 1 | | 5 | 1 |
| 1994 Rotumanu | 8 | 0 | | 5 | 2 |
| 2000 Copland | 10 | 0 | | 3 | 3; 4 |
| 2012 Pukaki block (Central Westland) | 12 | 1 | 1 | 2 | 5 |
| 2012 Marsden block (Central Westland) | 20 | 1 | 1 | 1 | 5 |
| 2013 Tennyson | 26 | 1 | 1 | 1 | 6 |

| | | | | | |
|---|---|---|---|---|---|
| 2014 Tennyson | 32 | 0 | 1 | 1 | 6 |

1 Walker (1997); 2 Spurr and Powlesland (1997); 3 van Klink and Tansell (2003); 4 Pestlink: 02/03SWS22; 5 van Klink (2013); 6 Tinnemans et al. (2019).

A total of 47 radio tagged **morepork/ruru** has been exposed to this method and bait type over 6 operations and none have died from poisoning (Table 14). Call count monitoring at Waipoua did not indicate any significant 1080 related mortality (Pierce and Montgomery, 1992).

**Table 14.** Morepork/ruru monitored during aerial and handlaid 1080 operations using 0.15% or 0.08% 1080 pellets.

| Operation | No. of Birds Exposed | No. Killed by Poison | Sowing Rate (kg $ha^{-1}$) | | Ref. |
|---|---|---|---|---|---|
| | | | Prefeed | Toxic | |
| 1990 Waipoua | 2 | 0 | | 5[a] | 1 |
| 1994 Saxon River | 6 | 0 | | 5[b] | 2 |
| 1994 Tennyson Inlet[c] | 1 | 0 | | 5[b] | 2 |
| 1998 Pureora | 3[d] | 0 | | 5[a] | 3 |
| 2010 Waitutu | 11 | 0 | 1 | 2[b] | 4 |
| 2014 Hokonui | 24 | 0 | Yes | Unknown | 5 |

[a] toxic loading of baits 0.08%; [b] toxic loading of baits 0.15%; [c] six of the birds monitored were at Gouland Downs; [d] This study followed 28 radio tagged birds over 3 years. Significant natural mortality (18%) was observed over hard winters.

1 Pierce and Montgomery (1992); 2 Walker (1997); 3 Powlesland et al. (1999b); 4 Greene et al. (2013); 5 Dilks (2015).

A total of 59 **fernbirds** has been exposed to this method and bait type over 3 operations and 7 have disappeared after poisoning (Table 15).

In the 2010 study in Ianthe Forest, 36 radio-tagged **South Island fernbirds** were monitored during an aerially applied 1080 cereal pellet operation. 5 birds dropped their transmitters, 1 was killed by a predator and 3 died from 1080 poisoning. Based on this, the mortality of fernbirds due to 1080 poisoning was estimated at 9.4% (2.4-22.6% 95% CI). The authors concluded that the impact of aerial 1080 operations on fernbird numbers is small, and the survival and improved breeding success that would have resulted from introduced predators being reduced during the 1080 operation would have outweighed the losses (van Klink et al., 2013).

**Table 15.** Fernbirds monitored during aerial and handlaid 1080 operations using 0.15% or 0.08% 1080 pellets.

| Operation | No. of Birds Exposed | No. Killed by Poison | Sowing Rate (kg ha$^{-1}$) | | Ref. |
|---|---|---|---|---|---|
| | | | Prefeed | Toxic | |
| 1990 Waipoua | 14d | 0 | | 5[a] | 1 |
| 1994 Gouland Downs | 9 | 4c | | 5[b] | 2 |
| 2010 Ianthe Forest | 36 | 3 | 1 | 2[b] | 3 |

[a] toxic loading of baits 0.8 g kg$^{-1}$; [b] toxic loading of baits 1.5 g kg$^{-1}$; [c] due to the banded birds not being roll called immediately prior to the poisoning this study was inconclusive about cause of disappearance; [d] includes 2 banded birds.

1 Pierce and Montgomery (1992); 2 Walker (1997); van Klink et al. (2013)

A total of 55 colour banded **NI robins** have been exposed to this method over 2 operations and 10 have disappeared after poisoning (Table 16).

Twenty-one colour banded and 5 unbanded **SI robins** monitored during 2 aerial 1080 pellet operations all survived (Table 16)

**Table 16.** Robins monitored during aerial and handlaid 1080 operations using 0.15% 1080 pellets.

| Operation | No. of Birds Exposed | No. Killed by Poison | Sowing Rate (kg ha$^{-1}$) | | Ref. |
|---|---|---|---|---|---|
| | | | Prefeed | Toxic | |
| 1994 Saxon River | 2 | 0 | | 5 | 1 |
| 1998 Waitotara | 38 | 10 | | 4 | 2 |
| 1998 Long Ridge, Pureora | 17 | 0 | | 5 | 2 |
| 2011 Silver Peaks, Dunedin | 24 | 0 | 1.5 | 2 | 3 |

[a] monitoring method assumes birds which disappear have died from poisoning.

Not included here is monitoring of robins using the 5-minute count method which can only reliably detect very large population changes (Powlesland et al. 1999).

1 Walker (1997); 2 Powlesland et al. (1999b); 3 Schadewinkel et al. (2014).

A total of 29 colour banded **NI tomtit** have been monitored during two non-prefed aerial 1080 cereal pellet operations, with 1 bird disappearing (Table 17).

A monitoring study in Tongariro Forest (2001) using distance sampling found no significant difference in the mortality of **tomtits** between the treatment (2 kg ha$^{-1}$

prefeed followed by 3 kg ha$^{-1}$ 0.15% 1080 pellets) and non-treatment sites (Westbrooke et al., 2003). Distance sampling of tomtits also occurred during an aerial 1080 operation (2 kg ha$^{-1}$ prefeed followed by 2 kg ha$^{-1}$ 0.08% 1080 pellets) on Mt Pureora in 2003. There was no decline in male tomtits counts in this operation (Westbrooke and Powlesland, 2005). These results led the Westbrooke and Powlesland (2005) to conclude that aerial poisoning operations using cereal pellets at low sowing rates causes "…little, if any…" short term impacts on tomtit populations.

Monitoring of **tomtits** using distance sampling has also been undertaken during two operations using cereal pellets coated with ***EDR*** deer repellent. Oates (2008b) monitored **North Island tomtits** at three sites during an aerial 1080 pellet operation in Rotoaira Forest in 2007. The three sites were: a block where deer repellent coated 1080 pellets were used; a block where standard, uncoated pellets were used; and a non-treatment site where no possum control occurred. Tomtit numbers declined by between 20 – 36% at all sites. This led the author to conclude some factor (possibly too long a time period between the pre and post control surveys) other than the use of the deer repellent or 1080 caused the decline. In 2008, **South Island tomtits** were monitored during an aerial operation using ***EDR*** deer repellent coated pellets (2 kg ha$^{-1}$ prefeed followed by 2 kg ha$^{-1}$ 0.15% 1080 pellets) in the Waianakarua Scenic Reserve southwest of Oamaru and at a nearby non-treatment site when no possum control occurred. At both these sites tomtits increased by similar amounts (~13%) during the post control monitoring (Oates, 2008a).

**Table 17.** Tomtits monitored during aerial and handlaid 1080 operations using 0.15% or 0.08% 1080 pellets.

| Operation | No. of Birds Exposed | No. Killed by Poison | Sowing Rate (kg ha$^{-1}$) | | Ref. |
|---|---|---|---|---|---|
| | | | Prefeed | Toxic | |
| 1998 Pureora | 14 | 0 | | 5[a] | 1 |
| 2001 Tongariro | 15 | 1 | | 3[b] | 2 |

[a] toxic loading of baits 0.08%; [b] toxic loading of baits 0.15%. 12 g baits used; [c] monitoring method assumes birds which disappear have died from poisoning.

Not included here is monitoring of tomtit using the 5-minute count method which can only reliably detect very large population changes (Powlesland et al. 1999).

1 Powlesland et al. (2000); 2 Westbrooke et al. (2003).

Transect counts of **SI tomtits, grey warbler, SI robins and riflemen** were conducted before and after the 2010 Waitutu aerial 1080 operation (1 kg ha$^{-1}$ prefeed followed by 2 kg ha$^{-1}$ 0.15% 1080 pellets). The transects were located at five sites, three within the operational area and two in a non-treatment area. While the numbers of tomtits and grey warblers detected on the transects changed following the application of the 1080, the scale and direction of the changes (decreases for

tomtits and increases for grey warbler) was similar at all five sites. The pre- and post-control counts of riflemen and SI robins were similar between the operational area and non-treatment sites. The authors therefore concluded there was no evidence for population level impacts from 1080 on any of these species (Greene et al., 2013).

Van Vianen et al. (2018) monitored **bellbird**, **silvereye**, **SI tomtit**, **rifleman**, **brown creeper**, **grey warbler** and **fantail** using five minute bird counts pre- and post-aerial 1080 operations (1 kg $ha^{-1}$ prefeed followed by 2 kg $ha^{-1}$ 0.15% 1080 pellets) in the Rolleston Range and Alexander Range in 2012. The five-minute bird count monitoring occurred in the operational areas and at nearby non-treatment areas. None of the monitoried species declined significantly more within the operational areas compared to the non-treatment sites, indicating 1080 did not have an impact on the populations.

Sixty-four **whio** have been monitored through aerial 1080 pellet operations where bait was sown over the river habitat where the monitored birds were present. Two of these birds died (Table 18). The two birds that died were from a sample of 19 radio tagged birds from an operation on Mt Taranaki in June 2019. Only one of the 2 dead whio could be tested, and was found to have 1080 residue at 0.0012 µg/g in a muscle tissue sample (VPRD, N. Lightbourne pers. comm.).

Another 62 **whio** have been monitored through 1080 pellet operations that had bait exclusion areas on the main rivers so if monitored birds foraged only in the main river bed they may not have been exposed to toxic bait. None of these birds died of poisoning (Table 18).

There was no reduction in visual counts of whio in the Otira valley after application of 0.15% 1080 Pellets at 6 kg $ha^{-1}$ in 1989 (Spurr and Powlesland, 1997).

**Table 18.** Whio monitored during aerial 1080 operations using 0.15% or 0.08% 1080 pellets.

| Operation | No. of Birds Exposed | No. Killed by Poison | Sowing Rate (kg $ha^{-1}$) | | Ref. |
|---|---|---|---|---|---|
| | | | Prefeed | Toxic | |
| Tongariro Forest (2006) [a] | 28 | 0 | 2 | 4 | 1 |
| Pukepoto-Mangatepopo (2007) [a] | 34 | 0 | 2 | 3 & 5 | 1 |
| Oparara (2008) [b] | 15 | 0 | 2 | 3 | 1 |
| Wangapeka/Fyfe (2011) [b] | 12 | 0 | Yes | 2 | 3 |
| Wangapeka (2016) [b] | 18 | 0 | 1.5 | 1.5 | 4 |
| Mt Taranaki (2019) [b] | 19 | 2 [c] | 2 | 2 | 5 |

a These operations included bait application exclusions of ≥20m from main rivers.

[b] These operations did not have bait application exclusions over the rivers where monitored whio were present.

[c] One of these birds was tested and positive for 1080, the other was too decayed to allow for testing and is acknowledged as potentially killed by poisoning based on timing of death.

1 Veltman and Westbrooke (2011); 2 Veltman et al. (2014); 3 Steffans pers. comm.; 4 Malham pers. comm.; 5 Lightbourne pers. comm.

A total of 60 radio tagged **Kaka** have been exposed to this method and bait type over 4 operations and none have died from poisoning (Table 19). Additionally, 38 radio tagged birds have been exposed to 0.08% carrot baits over 2 operations and none have died from poisoning (Greene, 1998; Powlesland et al., 2003). Based on a meta-analysis of the kaka monitored through the 5 pellet and carrot operations between 1994 and 2008, Veltman and Westbrooke (2011) calculated the upper bound of the 95% confidence interval for an estimate of zero mortality at 3.5%.

**Table 19.** Kaka monitored during aerial 1080 operations using 0.15% 1080 pellets.

| Operation | No. of Birds Exposed | No. Killed by Poison | Sowing Rate (kg $ha^{-1}$) | | Ref. |
|---|---|---|---|---|---|
| | | | Prefeed | Toxic | |
| Windbag (1998) | 15 | 0 | | 5 | 1 |
| Waipapa (2001) | 20 | 0 | | 5 | 1 |
| Waipapa (2008) | 10 | 0 | 1 | 1.5 | 2 |
| Waitutu (2010) | 15 | 0 | 1 | 2 | 3 |

1 Powlesland et al. (2003); 2 Veltman and Westbrooke (2011); 3 Greene et al. (2013)

**Kereru (NZ pigeon/kukupa)** have not been monitored individually when exposed to this method and bait type. However none of six birds ate non-toxic cereal pellets offered in a trial on Kapiti island (Spurr and Powlesland, 1997). Monitoring of kereru during 5 aerial 1080 operations using cereal pellets did not detect population changes using the five minute count method (Spurr and Powlesland, 1997). Additionally, all 15 radio tagged birds exposed to an aerial 1080 operation using carrot bait survived (Powlesland et al., 2003).

21 marked (8 radio-tagged and 13 banded) adult **NZ falcon** were monitored through three 0.15% 1080 cereal pellet operations undertaken in Kaingaroa Forest during 2013-2014 by Horikoshi et al. (2018). All the marked falcon survived the operations. Using the live-recaptures model in Program MARK 8.1, the researchers estimated of the 95% C.I. survival of adult falcon through the operations at 84-100%.

Seaton et al. (2009) collected productivity data from 87 **falcon** nests in Kaingaroa pine plantation during three breeding seasons, 2003 - 2006. During this time 1080 pellets and carrots were ground laid or aerially applied in forest compartments where falcon bred. The numbers of chicks successfully fledged was not related to time since 1080 application (1 month to >3 years), application method or bait type. During the study the breeding falcon population increased from 20 to 36 pairs, leading to the authors concluding that 1080 did not have a negative impact on falcon, and probably had a positive impact by reducing predation pressure on the falcon.

**Falcon** territories remained occupied, presumably by the resident birds, during four aerial 1080 operations using cereal pellets (Pureora 1984, Mapara 1990-92) and one using carrot bait (Waihaha 1994) (Spurr and Powlesland, 1997). The total number of falcon involved in this monitoring was about 13, although the Mapara birds (3 pair) were exposed in three consecutive years (Bradfield, 1993; Calder and Deuss, 1985; Greene, 1998).

**Kakariki (parakeet)** nests have been monitored during two aerial cereal 1080 operations. Fifteen nests were monitored during the October 2007 Hurunui Valley operation and a further seven nests were monitored during a 1080 operation in the Dart Valley. Dead chicks in a failed nest in the Hurunui Valley operation contained 1080 residues and the female was not seen after the nest failed. All the monitored nests in the Dart Valley operation were successful, however two unmonitored Kakariki were found dead with 1080 residues in their tissues. The combined estimate of mortality of nesting parakeets from these operations was 2.27% (0.1-12 % 0.95 CI) (Rhodes et al., 2008). The authors concluded that while some Kakariki were killed during the 1080 operations, given the rate of nest predation observed in areas where no predator control was carried out, the net benefit from the 1080 operations was positive. No detectable impact could be determined through five minute bird count monitoring before and after four aerial 1080 operations using carrot or cereal pellet baits (Spurr and Powlesland, 1997). Additionally following an intensively monitored aerial 1080 operation in Waihaha in 1994 using carrot bait, Greene (1998) observed "...kakariki remained common within the study area...".

**Australasian harrier** have not been monitored individually when exposed to this method and bait type. However no detectable impact could be determined through five minute bird count monitoring before and after an aerial 1080 operation using cereal pellets on Rangitoto island and "the small resident population was still seen...throughout the year following the poisoning" (Miller and Anderson, 1992). Additionally, Pierce and Maloney (1989) found no evidence of dead harriers after aerial 1080 poisoning of rabbits in the McKenzie basin.

**Kea** survivorship with this method was analysed using information from 29 operations where radio-tagged kea were monitored (Table 20). A total of 271 indvidual radio tagged kea were exposed across these operations. Because some tagged kea were exposed to more than one operation there were 318 kea to operation records. Forty-nine kea were killed across 13 of the 29 operations, an overall mean mortality rate of 15.4%. Mortality rate and sample sizes varied greatly between operations and the average operation-level mortality rate was 13.4% (Cieraad 2024).

**Table 20.** Kea monitored during aerial 1080 operations using 0.15% 1080 pellets. Data from Cieraad (2024).

| Operation | No. of kea observed | No. of observed kea killed | No. of prefeeds | Toxic pellet size (g) | Toxic pellets per hectare |
|---|---|---|---|---|---|
| Abby Rocks 2011 | 8 | 0 | 1 | 12 | 167 |
| Abby Rocks 2014 | 20 | 1 | 1 | 6 | 167 |
| Anatoki 2014 | 2 | 0 | 1 | 6 | 167 |
| Arawhata 2008 | 4 | 0 | 1 | 12 | 333 |
| Arthurs Pass East 2022 | 26 | 4 | 1 | 6 | 250 |
| Arthurs Pass West 2022 | 22 | 4 | 1 | 6 | 250 |
| Copland 2012 | 2 | 0 | 1 | 12 | 167 |
| Fox-Franz 2008 | 17 | 6 | 1 | 12 | 208 |
| Hawdon 2009 | 10 | 0 | 1 | 6 | 333 |
| Hawdon 2012 | 6 | 0 | 1 | 12 | 167 |
| Hawdon 2014 | 4 | 0 | 1 | 6 | 167 |
| Hawdon 2017 | 4 | 0 | 1 | 6 | 333 |
| Hawdon 2019 | 6 | 0 | 1 | 6 | 500 |
| Hawdon 2019_2 | 6 | 1 | 1 | 6 | 250 |
| Matukituki 2020 | 10 | 6 | 2 | 6 | 250 |
| Mt Arthur 2009 | 12 | 0 | 1 | 12 | 167 |
| Mt Arthur 2014 | 5 | 0 | 1 | 12 | 167 |
| Okarito 2011 | 36 | 8 | 1 | 12 | 167 |
| Oparara 2014 | 5 | 2 | 1 | 12 | 167 |
| Oparara 2016 | 3 | 0 | 1 | 6 | 250 |
| Otira-Taipo 2022 | 28 | 7 | 1 | 6 | 167 |
| Ortira 2013 | 11 | 4 | 1 | 12 | 167 |
| Perth Phase 1 2019 | 14 | 2 | 2 | 6 | 667 |

| | | | | | |
|---|---|---|---|---|---|
| Perth Phase 2 2019 | 13 | 0 | 2 | 6 | 333 |
| Rotoiti 2014 | 2 | 1 | 1 | 6 | 167 |
| Wangapeka 2011 | 13 | 0 | 1 | 12 | 167 |
| Wangapeka 2014 | 8 | 0 | 1 | 6 | 167 |
| Wangapeka 2016 | 15 | 0 | 1 | 6 | 250 |
| Wet Jacket 2020 | 6 | 3 | 1 | 6 | 250 |

Thirteen radio tagged **rock wren** were monitored through an operation with aerially applied 0.15% 1080 6g pellets applied at 1.5 kg/ha in the Oparara-Grange area of Kahurangi National Park in November 2019. All birds were alive 10 days after the bait application. Twenty days after the bait application 12 of the birds could still be tracked. Ten of these were still alive, one was found dead on its nest and tested negative for 1080 residue, and another bird had been predated (likely by a falcon) (T. Rawlence pers. comm.).

Eighteen **takahe** in the Gouland Downs area of Kahurangi National Park (where Takahe were released in 2018) were monitored during an aerial 1080 operation in August 2020. The operation (Aorere block of Kahurangi NP) had a 587-hectare 1080 bait exclusion zone over the area where most of the takahe were present. Six monitored birds were present in the 1080 bait application area (0.15% 1080 6g pellets at 1.5kg/ha) during the operation and three of these died of poisoning (Kiss et al., 2020).

Five-hundred and fifty-six **southern black-backed gulls (*Larus dominicanus*)** were killed in an aerial 1080 operation (0.15% 1080 6g pellets at 4kg/ha following 2 prefeed applications of 6g pellets at 2kg/ha) at South Okarito in November 2021. A high proportion of the dead gulls were found at a nesting colony that was included in the treatment area, though carcasses were also found on the riverbed and coastal strip boundary of the treatment area (ZIP 2021). There was no monitoring of before and after gull abundance and the local population size was not known. Although southern black-backed gulls are highly abundant in New Zealand, the number of recorded deaths from this operation indicate there was likely to have been some reduction in the local population.

*Reptiles/amphibians*

Lizards and frogs were not monitored in any 1080 poisoning operations prior to 1994; however, none have been reported killed by 1080. Captive **McCann's skinks** ate non-toxic cereal pellets (RS5 and Agtech), especially when the baits were wet, but the level of consumption (0.01 - 0.02 g over 2 days) was probably insufficient for the animals to have received a lethal dose had the baits been toxic (Freeman et al., 1997).

The attractiveness of non-toxic RS5 cereal pellets (dyed green and lured with cinnamon) to wild **grand** and **Otago skinks** were tested by Marshall and Jewell (2007). The baits were offered in two sizes – small pieces no larger than 6 mm and large baits (whole pellets). The baits were offered dry or wet. All bait types were

sampled (licked, nudged or bitten) by both species of skink, with small pieces sampled more often than large baits. No animals tried to consume large pieces of cereal bait. However, 1/10 grand skinks and 3/20 Otago skinks consumed small, wet pellet fragments.

Monitoring of a population of **Archeys frog** in the Coromandel Ranges before and following application of 0.15% 1080 Pellets at 5 kg $ha^{-1}$ in 1995, showed no decline in Archeys frog (Perfect, 1996). Ongoing monitoring of **Archeys frogs** has occurred in Whareorino Forest, King Country, since 2005. This includes monitoring before and after an aerial 1080 operation (2kg ha prefeed, 2 kg ha 0.15% 1080 Whanganui #7 pellets) in May 2012. The frog population size and survival was not affected by the 1080 operation (Bridgeman, 2015).

**Hochstetters frogs** were counted at 3 sites pre- and post- application at 7 kg $ha^{-1}$, 1994 Hunua Ranges. One frog found dead immediately following poison operation tested negative for 1080. Fluctuations in frog numbers counts were influenced so strongly by short term environmental effects that any effect of the poison drop could not be detected (McNaughton and Greene, 1994).

*Bats*

Edmonds et al. (2017) monitored individually marked **Short-tailed bats** before, during and after an aerial 1080 operation in the Eglinton Valley in December 2014. In this 10 939 ha operation, RS5 pellets were prefed at a 1 kg/ha followed by 1 kg/ha 0.15% 1080 RS5 pellets approximately 6 weeks later. 764 out of 771 marked bats (99.1%) were alive one week after the operation. One bat pup found dead under a roost tree tested positive for 1080 residues. However, any immediate impact of 1080 was assessed as minimal because the calculated annual survival rates of female bats was high (91.5%).

Lloyd (1994) offered non-toxic cereal pellets to captive **Short-tailed bats** and hand broadcast baits containing a fluorescent marker throughout an area known to be inhabited by bats and concluded "…short-tailed bats are unlikely to eat carrot or grain-based baits…". However short-tailed bats are possibly vulnerable to secondary poisoning because they are known to feed on arthropods that have been recorded feeding on 1080 baits and residues in these prey can in theory be enough to kill a bat (Lloyd and McQueen, 2000).

In a study in Rangataua forest where 0.15% 1080 Pellets were aerially broadcast (3 – 5 kg $ha^{-1}$) over "…almost the entire winter range…" of the study animals, a total of 269 **short-tailed bats** were caught at their roost following poisoning and held for 48 hours to determine mortality or signs of poisoning. All animals survived and showed no signs of 1080 poisoning (Lloyd and McQueen, 2000).

*Fish*

Native fish have not been monitored during 1080 operations. However, a field experiment has been conducted to study the impact of 1080 on **longfin eels, kōaro** and **upland bullies**. Four headwater streams were selected in the Mawhera Forest in the Grey Valley, West Coast. In each stream four sites were selected – 10 m and 100 m downstream, and 10 m and 100 m upstream from where 1080 baits were to be placed in the stream. At each site 8 fish of each species were placed in individual

cages. Fish mortality was recorded after 1 and 4 days. Baits (6.5 g, 0.15% 1080 Wanganui #7 pellets) were then placed in the streams at a density equivalent to a sowing rate of 25 – 30 kg $ha^{-1}$ (this represented an extreme scenario of 10 x normal sowing rates). Fish survival was monitored 1 and 4 days after the bait was placed in the water. No fish died after the baits were added to the water, suggesting all three species were tolerant to 1080 in water at the concentrations used in the study (Suren and Lambert, 2006).

*Terrestrial invertebrates*

Invertebrate populations have been monitored during eight 1080 aerial poisoning operations using cereal pellets. None of these studies suggest significant population effects on any species studied nor is there evidence to suggest poisoned invertebrates are a significant factor in secondary poisoning of other animals.

An extensive study of forest invertebrates found on 1080 baits by Sherley et al. (1999) found that at any time only a small proportion of baits had invertebrates on them, and the few individuals per bait represented a small section of the fauna present in the litter. The number of invertebrates recorded on baits in treatment grids declined when 0.15% 1080 Pellets were laid at 18 kg $ha^{-1}$, but started to return to original levels (relative to control grids) within 6 days of removal of the toxic baits. The reduction in invertebrate numbers did not extend further than 20 cm around each bait.

Another study by Spurr and Berben (2004) hand laid 0.15% 1080 Pellets at 5 kg $ha^{-1}$ to simulate aerial poisoning in Tararua Forest Park in 1999 and monitored the occupancy of artificial refuges by **tree weta** and **cave weta** (*Isoplectron sp.*). No significant impact of bait application was found for these species nor was there any effect observed on numbers of **slugs, spiders** and **cockroaches** which also commonly used the same refuges.

No impact was detected on populations of **weta** in Waipoua Forest and all **cockroaches, centipedes, millipedes, kauri snails** and all but one **beetle** survived in enclosures with 0.08% 1080 Pellets (Pierce and Montgomery, 1992).

Spurr (1994a) found no impacts on populations **of amphipods, ants, beetles, collembolans, millipedes, mites, slugs, snails, spiders** and **cave weta** at Puketi Forest or Titirangi Scenic Reserve where 0.08% 1080 Pellets were aerially applied at 5 kg $ha^{-1}$.

In Mapara where 0.08% 1080 Pellets were aerially applied in three consecutive years 1990-92, a comparison of invertebrate fauna showed a greater number of predatory insects in the treatment site, characteristic of a healthy forest, and more fungal eating insects in the non-treatment site, characteristic of unhealthy forest (Bradfield, 1993).

A range of invertebrate species on Rangitoto Island were sampled using a range of collection techniques, before and after aerial poisoning with 0.08% 1080 Pellets at 12 kg $ha^{-1}$. No population effects were observed (Anon., 1990).

*Aquatic invertebrates*

In the early 1990's, the Taranaki Regional Council monitored aquatic invertebrates in streams before and after two aerial 1080 operations. No effect of the aerial 1080 operations on the invertebrate communities could be demonstrated. However, the post control samples were collected between 32 and 42 days after the aerial operation, and the sampling protocol could have resulted in any short-term reductions in invertebrate numbers being missed (Suren and Lambert, 2006).

Suren and Lambert (2006) therefore conducted an experiment to assess the ecological impact of 1080 leaching from baits on aquatic invertebrate communities. The experiment was conducted in four streams in the Mawhera Forest in the Grey Valley, West Coast. In each stream four sites were selected – 10 m and 100 m downstream, and 10 m and 100 m upstream from where 1080 baits were to be placed in the stream. At each site invertebrate communities on 10 replicate rocks were quantified 4 days and 1 day prior to baits being placed in the stream. The invertebrate communities were dominated by **Caddisflies** (*Helicopyche, Pycnocentrodes, and Pycnocentria*), **orthoclad midges**, and the **mayfly** *Deleatidum*. Baits (6.5 g 0.15% 1080 Wanganui #7 pellets) were then placed in the streams at a density equivalent to a sowing rate of 25 – 30 kg $ha^{-1}$ (this represented an extreme scenario of 10 x normal sowing rates). The invertebrate communities were re-sampled 1 day and 4 days after the bait was placed in the stream. No biologically significant effects on the invertebrate communities as a result of the 1080 were observed.

### *Aerial and hand laying operations using 0.08% and 0.15% carrot baits*

*Birds*

Two **NI brown kiwi** followed in a 0.08% 1080 carrot operation did not die from poisoning (Table 21). Following a non-toxic bait trial on Kapiti Island in May 1993, when carrot containing the biomarker pyranine was aerially sown at 10 kg $ha^{-1}$, none of five **little spotted kiwi** droppings examined fluoresced (Lloyd and Hackwell, 1993). Other kiwi species have not been monitored during carrot operations.

**Table 21.** NI brown kiwi monitored during aerial 1080 operations using 0.08% carrot baits.

| Operation | No. of Birds Exposed | No. Killed by Poison | Sowing Rate (kg $ha^{-1}$) | | Ref. |
|---|---|---|---|---|---|
| | | | Prefeed | Toxic | |
| 1995 Tongariro Forest | 2 | 0 | | ? | 1 |

1 Robertson et al. (1999).

A total of 44 **NI kokako** has been exposed to 0.08% 1080 carrot baits over 2 operations and none have disappeared after poisoning Table 22). Between 1986 and March 1998, 366 kokako (including 6 juveniles) have been monitored through 31 aerial poisoning operations (of all bait types and toxins combined), although the

number exposed and known to have survived is greater. Of the monitored birds, 4 have disappeared after poisoning, leading to a maximum estimate for kokako mortality of 1.4% per operation with a 5% chance that it will exceed 4% (Flux and Innes, 2001).

**Table 22.** Kokako monitored during aerial 1080 operations using 0.08% carrot baits.

| Operation | No. of Birds Exposed | No. Killed by Poison | Sowing Rate (kg ha$^{-1}$) | | Ref. |
|---|---|---|---|---|---|
| | | | Prefeed | Toxic | |
| 1993 Pureora Nth Block | 10 | 0 | 5 | 10 | 1 |
| 1996 Pureora Nth Block | 34 | 0 | 7 | 15 | 2 |

[a] monitoring method assumes birds which disappear have died from poisoning.

1 Speed et al. (1993); 2 Marsh (1996)

Twenty-eight **Weka** were monitored during an aerial 1080 carrot operation at Turiwhate in Central Westland in August 2008. Non-toxic pre-feed carrot (12 g) were sown at a rate of 3 kg ha$^{-1}$. Ten days later toxic carrot (1.5 g kg$^{-1}$ 1080) lured with orange was sown at 5 kg ha$^{-1}$. One bird died for 1080 poisoning (confirmed by residue testing). All the other birds survived for at least two months after the operation. The estimated mortality rate of weka during the operation was 0.2 - 17.8% (95% confidence intervals) (van Klink, 2008). 5 minute counts of weka in the Copland valley operation in 1986 (20 kg ha$^{-1}$ 0.2% screened carrot bait) found no detectable effect (Spurr, 1988). During a non-toxic carrot bait trial on Kapiti Island in May 1993, carrot containing the biomarker pyranine was aerially sown at 10 kg ha$^{-1}$. 10 of 87 weka droppings examined following the drop fluoresced from the pyranine. Weka were observed feeding on the baits on several occasions (Lloyd and Hackwell, 1993).

A total of 6 **morepork/ruru** has been exposed to this method and bait type over 1 operation and one has died from poisoning (Table 23).

**Table 23.** Morepork/ruru monitored during aerial 1080 operations using 0.08% carrot baits.

| Operation | No. of Birds Exposed | No. Killed by Poison | Sowing Rate (kg ha$^{-1}$) | | Ref. |
|---|---|---|---|---|---|
| | | | Prefeed | Toxic | |
| 1996 Tahae (Pureora) | 6 | 1[a] | 7 | 15 | 1 |

[a] there is some evidence that the carrot was not screened adequately to meet bait specifications

1 Powlesland et al. (1998).

16 marked (15 radio-tagged and 1 banded) adult **NZ falcon** were monitored through two 0.08% 1080 carrot operations undertaken in Kaingaroa Forest during 2013-2014 by Horikoshi et al. (2018). One of the falcon was found dead following an operation but no 1080 residues were detected in its tissues. Using the live-recaptures model in Program MARK 8.1, the researchers estimated of the 95% C.I. survival of adult falcon through the operations at 68-100%.

Seaton et al. (2009) collected productivity data from 87 **NZ falcon** nests in Kaingaroa pine plantation over three breeding seasons, 2003-06. During this time 1080 carrots and pellets were aerially applied or ground laid in forest compartments where falcon bred. The numbers of chicks successfully fledged was not related to time since 1080 application (1 month to >3 years), application method or bait type. During the study the breeding falcon population increased from 20 to 36 pairs, leading to the authors concluding that 1080 did not have a negative impact on falcon, and probably had a positive impact by reducing predation pressure on the falcon.

**Falcon** territories remained occupied, presumably by the resident birds, during an aerial 1080 operation using carrot bait in Waihaha in 1994 (Spurr and Powlesland, 1997).

A 53 colour banded **robins** have been exposed to this method and bait type over 2 operations and 15 have disappeared after poisoning (Table 24).

**Table 24.** Robins monitored during aerial 1080 operations using 0.08% carrot baits.

| Operation | No. of Birds Exposed | No. Killed by Poison | Sowing Rate (kg ha$^{-1}$) | | Ref. |
|---|---|---|---|---|---|
| | | | Prefeed | Toxic | |
| 1996 Tahae (Pureora) | 22 | 12[b] | 7 | 15 | 1 |
| 1997 Waimanoa (Pureora) | 31 | 3[c] | 5 | 10 | 2 |

[a] monitoring method assumes birds which disappear have died from poisoning.

[b] there is some evidence that the carrot was not screened adequately to meet bait specifications (Powlesland et al., 1999b).

[c] 1 bird also disappeared form the non-treatment site during the study period

Not included is monitoring of robins using the 5 minute count method which can only reliably detect very large population changes (Powlesland et al., 1999b).

1 Powlesland et al. (1998); 2 Powlesland et al. (1999a).

A total of 19 colour banded **tomtit** has been exposed to this method and bait type over two operations and 16 have disappeared after poisoning (Table 25). During the 1997/98 nesting season, tomtit pairs in the 1997 treatment area had high nesting success (80% of nests fledged chicks, mean of four fledglings per nest). Even so, by the following spring it seemed that the population had not recovered to its pre-poison level. (Powlesland et al., 2000).

**Table 25.** Tomtit monitored during aerial 1080 operations using 0.08% carrot baits.

| Operation | No. of Birds Exposed | No. Killed by Poison | Sowing Rate (kg ha$^{-1}$) | | Ref. |
|---|---|---|---|---|---|
| | | | Prefeed | Toxic | |
| 1996 Tahae (Pureora) | 5[c] | 5[b] | 7 | 15 | 1 |
| 1997 Waimanoa (Pureora) | 14 | 11 | 5 | 10 | 1 |

[a] monitoring method assumes birds which disappear have died from poisoning; [b] there is some evidence that the carrot was not screened adequately to meet bait specifications (Powlesland et al., 1999b);

[c] tomtit data in this study was opportunistically collected as part of a robin study. Only 2 of the birds were banded, no non-treatment area was used.

1 Powlesland et al. (2000)

A distance sampling study of an aerial operation in 2002 using carrot bait at 2 kg ha$^{-1}$ found the **tomtit** population increased by over 60% between pre-poison (winter 2002) and post poison (winter 2003) (Hamilton, 2004).

Westbrooke and Powlesland (2005) reported the results of distance sampling of **tomtits** carried out during three 2003 aerial carrot operations (Kokmoka Forest, Mohaka Forest and Waimanoa). In these operations prefeed carrots were sown at 3-5 kg ha$^{-1}$ followed by 0.8% 1080 carrots sown at 3-5 kg ha$^{-1}$. Tomtit numbers declined by between 15 -47% during each of these operations.

During August-September 2006 transect counts of male **North Island tomtits** were carried out during an aerial 1080 carrot operation in Aorangi Forest Park, to examine whether carrots with ***EDR deer-repellent*** applied to them posed a risk to tomtits. The operation was divided into two blocks: a 1200 ha block where the toxic carrot was applied without deer-repellent, and a 9,800 ha block where the toxic carrot contained deer-repellent. Following pre-operation monitoring of the tomtits, both blocks were prefed at a rate of 3 kg ha$^{-1}$. 13 days later the toxic bait (0.8% 1080) was applied at a rate of 5 kg ha$^{-1}$. Post control, there was no decline in the number of tomtits recorded in either block. It was concluded that the addition of the deer-repellent to carrot baits did not pose an increased risk to tomtits (Ross, 2007).

**Whio** are unlikely to eat carrot baits and their aquatic invertebrate prey is unlikely to be contaminated by 1080. All 19 radio tagged whio survived for at least four weeks following a pre-fed aerial application of carrot bait (0.08%) at 15 kg ha$^{-1}$ (Greene, 1998).

A total of 38 radio tagged **Kaka** has been exposed to this method and bait type over 2 operations and none have died from poisoning (Table 26).

Non-toxic carrot containing the biomarker pyranine was aerially sown at 10 kg ha$^{-1}$ on Kapiti Island in May 1993. Over the 11 days following the drop, 20 **kaka** were caught a total of 25 times and inspected for fluorescence due to the pyranine. Only

one juvenile kaka showed traces of pyranine. A large number of **kaka** droppings were also inspected, but no fluorescence was observed (Lloyd and Hackwell, 1993).

**Table 26.** Kaka monitored during aerial 1080 operations using 0.08% carrot baits.

| Operation | No. of Birds Exposed | No. Killed by Poison | Sowing Rate (kg ha$^{-1}$) | | Ref. |
|---|---|---|---|---|---|
| | | | Prefeed | Toxic | |
| 1994 Waihaha (Pureora) | 21 | 0 | 10 | 15 | 1 |
| 2000 Whirinaki | 17 | 0 | 5 | 10 | 2 |

Kaka monitored using 5 minute count method are not reported here because this technique cannot reliably detect population changes for kaka (Powlesland et al., 2003).

1 Greene (1998); 2 Powlesland et al. (2003).

**Kakariki (parakeet)** have not been monitored individually when exposed to this method and bait type. However no detectable impact could be determined through five minute bird count monitoring before and after four aerial 1080 operations using carrot and cereal pellet baits (Spurr and Powlesland, 1997). Additionally following an intensively monitored aerial 1080 operation in Waihaha in 1994 using carrot bait, Greene (1998) observed "...kakariki remained common within the study area...".

**Kea** have been monitored using 2 radio tagged individuals in one aerial operation using carrot bait (0.08%) at 5 kg ha$^{-1}$ in Hohonu Range. Both birds survived (Kemp and van Klink, 2008).

**Kereru (NZ pigeon/kukupa)** have been monitored using radio tagged individuals in one aerial operation using carrot bait (0.08%) at 10 kg ha$^{-1}$ in Whirinaki. All 15 birds survived (Powlesland et al., 2003). Monitoring of kereru during 9 aerial 1080 operations using screened carrot bait did not detect population changes using the five minute count method (Spurr and Powlesland, 1997).

During a non-toxic carrot bait trial on Kapiti Island in May 1993, carrot containing the biomarker pyranine was aerially sown at 10 kg ha$^{-1}$. Two kereru caught were examined for traces of pyranine, but none was observed. However, fluorescence due to pyranine was observed in one kereru dropping (Lloyd and Hackwell, 1993).

None of the three **tui** and two **bellbirds** examined fluoresced, after non-toxic carrot containing the biomarker pyranine was sown at 10 kg ha$^{-1}$ on Kapiti Island in May 1993 (Lloyd and Hackwell, 1993).

Call counts of **Australasian bittern/Makutu** were conducted pre- and post- aerial 1080 (3 kg ha-1 pre-feed, 3 kg ha-1 0.8 g 1080/kg orange lured carrot) control of possums in the South Taupo wetlands in 2004. Of the 10 birds present in the treatment area pre-control, 90% were located post-control. In the non-treatment area, 5/9 birds were located post-control. The change in call counts in the non-treatment area were attributed to nightly variation in booming by the birds and not an actual decline in numbers. The researchers considered that the poison operation

had little to no impact on bittern in the wetland (Oates and Beath, 2005). As bitterns in the study were neither colour-banded nor fitted with transmitters their individual fates could not be reliably linked to the distribution of poisonous baits (Veltman et al., 2014).

*Reptiles/amphibians*

Lizards and frogs were not monitored in any 1080 poisoning operations prior to 1994; however, none have been reported killed by 1080. There has been limited population monitoring of aerial poisoning operations using cereal pellets but none using carrot baits.

The attractiveness of non-toxic carrot baits (dyed green and lured with cinnamon) to wild **grand** and **Otago skinks** were tested by Marshall and Jewell (2007). The baits were offered in two sizes – small pieces no larger than 6mm and large baits (whole rounds of sliced carrot). Both bait sizes were sampled (licked, nudged or bitten) by both species of skink, with small pieces sampled more often than large baits. While the carrot baits were sampled, none were consumed.

*Bats*

**Short-tailed bat** have not been individually monitored when exposed to this method and bait type. Lloyd (1994) offered non-toxic carrot baits to captive bats and hand broadcast baits containing a fluorescent marker throughout an area known to be inhabited by bats and concluded "…short-tailed bats are unlikely to eat carrot or grain-based baits…". However short-tailed bats are possibly vulnerable to secondary poisoning because they are known to feed on arthropods that have been recorded feeding on 1080 baits and residues in these prey can, in theory, be enough to kill a bat (Lloyd and McQueen, 2002).

In a study in Rangataua forest where 0.15% 1080 Pellets were aerially broadcast (3 – 5 kg $ha^{-1}$) over "…almost the entire winter range…" of the study animals, a total of 269 short-tailed bats were caught at their roost following poisoning and held for 48 hours to determine mortality or signs of poisoning. All animals survived and showed no signs of 1080 poisoning (Lloyd and McQueen, 2000).

*Invertebrates*

Invertebrate populations have been monitored in two 1080 aerial poisoning operations using carrot baits. None of these studies suggest significant population effects on any species studied nor is there evidence to suggest poisoned invertebrates are a significant factor in secondary poisoning of other animals.

No impacts on the numbers of **ground-dwelling invertebrates** caught in pitfall traps up to 1 year following aerial application of carrot bait at 15 kg $ha^{-1}$ at Waihaha Forest in 1994 (Spurr, 2000a).

Powlesland et al. (2005) monitored invertebrate numbers every second or third month for a year before a 5 kg $ha^{-1}$ 1080 carrot operation, and for two years afterwards. Numbers of **tree weta**, **cave weta**, **cockroaches**, **spiders** and **harvestmen**, and **leaf-veined slugs** did not decline substantially in refuges in the treatment area relative to those in the non-treatment area immediately after the poison operation. From the results, the authors concluded that aerial 1080 carrot

operations are unlikely to have a detrimental effect on invertebrates that occupy cavities above ground.

An extensive study of **forest invertebrates** found on 1080 baits by Sherley et al. (1999) found that at any time only a small proportion of baits had invertebrates on them, and the few individuals per bait represented a small section of the fauna present in the litter. Each month between June to October 1995 and from April to October 1996, non-toxic carrot baits were sown at 18 kg $ha^{-1}$ and observed for 7-10 days. Fewer invertebrates were found on non-toxic (green dyed, cinnamon lured) carrot baits than non-toxic cereal pellets. The number of invertebrates visiting the carrot baits increased as time progressed, from a low of 7% usage on day one to 17% on day three. There was no evidence that invertebrates found on baits were drawn from further than 20cm around a bait.

### *1080 pellets or carrot baits in bait stations*

*Birds*

11 **NI brown kiwi** were monitored during a 1080 cereal bait station operation in September 2009 in Northland with no deaths being reported (P Graham pers. comm.).

Captive birds were offered bait on plastic dishes and wild birds were observed interacting with bait placed in bowls on tree mounted platforms and on the ground. None of three **kaka**, 4 **kereru** and 5 **kakariki** in captivity ate any bait. Two **brown kiwi** and 3 **weka** in captivity ate tiny amounts. A total of 87g of bait was eaten by 6 kea over the 2 days of the captive trial. **Bellbird, fantail, kereru, silvereye** and **tui** observed within 3m of the bait in the field study showed no interest while South Island **robin** investigated the bait briefly. Three **weka** were observed feeding on the bait placed on the ground during the field trial for a total of 16.9 minutes (Morgan, 1999).

*Reptiles*

Of the 10 **Common skinks** offered non-toxic bait in captivity, 2 investigated the bait but none was eaten (Morgan, 1999).

*Bats*

Of the 6 **short-tailed bats** offered non-toxic bait in captivity, none fed on it (Morgan, 1999).

*Invertebrates*

Of the 8 **Wellington tree weta** offered non-toxic bait in captivity, one fed on it briefly. Of the 8 **large land snails** (*Powelliphanta hochstetteri hochstetteri*) offered non-toxic bait in captivity, 3 fed on it. Of the 6 **ground beetles** (*Megadromus bullatus*) offered non-toxic bait in captivity, none fed on it (Morgan, 1999).

### *Pestoff Professional Possum Paste (0.08% and 0.15%)*

*Birds*

In pen trials at Orana park, Christchurch, **kaka**, **brown kiwi**, **weka**, **kea**, **kereru** and **kakariki** were offered BB13 and BB16 paste for two days. Kaka, brown kiwi, weka and kea all ate appreciable quantities (greater than 5.1 g of at least one of the paste types) (Morgan, 1999).

All 14 monitored **NI brown kiwi** survived exposure to 0.08% paste baits laid in Northland forest in 1995 (Robertson et al., 1999).

*Bats*

Captive **short-tailed bats** fed on non-toxic paste bait on all three nights that this food was presented. On average 5.73 g of paste was eaten (Morgan, 1999).

*Reptiles*

Two out of 8 **common skinks** fed on non-toxic paste over two nights during laboratory trials. The total time spent feeding on the paste was 2.8 minutes (Morgan, 1999).

*Invertebrates*

One out of 8 **giant land snails** (*Powelliphanta hochstetteri hochstetteri*) spent a total of 21.5 minutes feeding on non-toxic paste over two nights during laboratory trials. Two out of 10 **Wellington tree weta** fed on non-toxic paste for a total of 5.9 minutes (Morgan, 1999).

**Bark beetles** were observed feeding on 1080 paste in bait bags during a possum control operation at Mount Stanley, Nelson Marlborough Conservancy in April 2002. None were found dead (B. Mehrtens pers. comm.)

### *10% 1080 Gel*

No information could be found

### *Cut apple bait*

No information could be found on population effects. However some testing of non-toxic bait has been done with native species (Thomas et al., 2003). Note that this study presented bait in open dishes rather than bait stations and the behaviour of captive animals is not always typical of those in the wild.

*Birds*

Of 8 **kereru** offered non-toxic cut apple bait (green dyed, orange lured), none fed on it. The one **kaka** tested spent over 11 minutes per day on average feeding on the bait. **Kakariki**, **silvereye** and **weka** spent a similar time feeding on the bait. Four **kea** spent over an hour feeding on the bait. The authors concluded that this bait presented a risk to native birds and should only be used in bait stations (Thomas et al., 2003).

### 3.2.4. What evidence is there to suggest that 1080 use causes or doesn't cause a population decline of native species in aquatic ecosystems?

The effects of 1080 in aquatic ecosystems have not been well studied in New Zealand because the concentrations of 1080 observed in waterways have been negligible (see Section 2.3). Studies of 1080 toxicity to fish (non-native species see Section 4), suggest fish can tolerate concentrations many thousands of times higher than the highest ever recorded in water sampling after aerial poisoning operations.

Lyver et al. (2005) reported that there was no evidence captive **longfinned eels** would eat 1080 cereal pellets added to their water, nor was there any 1080 detected in eel tissue from water contaminated by baits. In the same study, eels did eat 1080 contaminated possum tissue but none died.

During trials by Suren and Bonnett (2006),1080 was not detected in any **koura** exposed to water containing 1080. While koura did eat Wanganui #7 baits, none died.

# 4. Effects on Domestic and Feral Animals

There is wide variation between species in their susceptibility to 1080 poisoning. Dogs are especially vulnerable and highly likely to die if they eat 1080 baits or scavenge animals killed by 1080. Larger animals such as cattle need several possum baits to receive a lethal dose but deaths have been reported where animals have access to baits, including those contained in bait stations.

Sub-lethal effects at realistic dose rates have been recorded in sheep and other species, typically affecting the heart. Exposure to prolonged high doses resulted in mild foetal abnormalities in pregnant rats and damaged sperm in male rats but no mutagenic properties were found. No antidote is currently available for 1080 poisoning although veterinary treatment can be successful.

Feral deer population mortality from aerial poisoning operations targeting possums and rats has been highly variable. Across a number of 1080 cereal pellet operations deer mortality estimates were more often classed as low (0-33%) when sowing rates were at or below 1.5kg/ha and potentially at those sites that had been previously treated within 5 years. Field trials have indicated that deer-repellent baits can reduce the level of deer mortality relative to when non-repellent baits are used.

Birds are generally less susceptible to 1080 than mammals but introduced birds such as blackbirds and chaffinches are found dead after aerial poisoning operations. Lizards and fish appear quite tolerant of 1080, according to research on overseas species.

Although 1080 is toxic to honeybees, baits used in pest control are generally not attractive to honeybees. However this may not be the case if honeybees are particularly hungry and food resources are scarce. On occasion and under these conditions honeybees have been observed collecting and storing cereal pellet bait material in hive frames as a substitute for pollen. Tests of honey from affected hives found no trace of 1080. Paste baits containing 1080 were reformulated in the 1990s to reduce their attractiveness to bees.

## *4.1. Toxicity*

### 4.1.1. What is the lethal dose range for each taxon?

The $LD_{50}$ values for a range of domestic and feral animals are presented in Table 27. For completeness, it includes information on species not present in New Zealand.

While no $LD_{50}$ data is available, mortality rates of pregnant ewes exposed to 1080 are higher compared to non-pregnant ewes (O'Connor et al., 1999)

**Table 27.** Acute oral toxicity ($LD_{50}$ mg $kg^{-1}$) of 1080 for non target domestic and feral animals.

| Species | $LD_{50}$ (mg $kg^{-1}$) | Ref. |
|---|---|---|
| ***Birds*** | Range: 2.1 - 12.6 | |
| Mallard duck | 4.8 | 1 |
| Maned duck | 12.6 | 2 |
| Common pigeon | 4.25 | 3 |
| Leghorn hens | 10.0 | 4 |
| White leghorn chicken[a] | 7.5 | 5 |
| Rhode Island red chicken | 6.5 | 6 |
| Plymouth rock chicken | 5.5 | 7 |
| Eurasian magpie | 2.12 | 8 |
| Chukar partridge | 3.51 | 3 |
| Ring-necked pheasant | 6.46 | 3 |
| California quail | 4.6 | 9 |
| European goldfinch | 3.5 (approx.) | 2 |
| Australian magpie | 9.9 | 2 |
| House sparrow | 2.5 | 10 |
| ***Marsupials*** | Range: 0.210 - 0.79 | |
| Bennett's wallaby | 0.21 | 11 |
| Brush-tailed possum | 0.79 | 12 |
| Dama wallaby | 0.27 | 11 |
| ***Mammals*** | Range: 0.06 - 8.3 | |
| Dog | 0.06 | 7 |
| | 0.07 ($LD_{100}$: 0.1) | 14 |
| Cat | 0.28 | 14 |

| | | |
|---|---|---|
| Ferret | 1.41 | 3 |
| Rabbit | 0.35 | 15 |
| House mouse | 8.3 | 16 |
| Norway rat | 0.22-3.0 | 7 |
| Cattle | 0.393 | 17 |
| Deer (not specified) | 0.5 | 14 |
| Horse | 0.32-1.00 | 18 |
| Pig | 0.4 | 18 |
| Sheep | 0.25-0.64 | 18 |
| Goat | 0.3-0.7 | 18 |
| ***Reptiles/Amphibians*** | Range: 43.6 - >500 | |
| Spotted grass frog | c. 60 | 19 |
| American Bullfrog | 54.4 | 3 |
| Leopard frog | 150 | 7 |
| South African clawed frog | >500 | 20 |
| Blotched blue-tongued lizard | 336.4 | 19 |
| Shingle-back lizard | 205.9[b] | 19 |
| Gould's monitor | 43.6 | 19 |
| ***Fish*** | Range: 54 - 3500 mg $l^{-1}$ | |
| Bream & bass | > 370[c] | 21 |
| Rainbow trout | 54 | 22 |
| Fingerling trout | >1000[d] | 14 |
| Harlequin fish | 3500[e] | 23 |
| Bluegill sunfish | >970[f] | 22 |
| ***Aquatic arthropods*** | Range: 0.05 - 3500 mg $l^{-1}$ | |
| *Daphnia magna* | 350[g] | 22 |

| | | |
|---|---|---|
| Mosquito larvae (*Anopheles quadrimaculatus*) | 0.05-0.1 (approx.) | 24 |
| ***Terrestrial arthropods*** | Range: 8 - 21 | |
| Honeybee | 8 | 25 |
| Housefly | 21 | 26 |

[a] laying hens appeared to be more susceptible to 1080 poisoning than hens that were not laying; [b] non-tolerant populations from South Australia, Western Australian populations $LD_{50}$ reported as 524 mg $kg^{-1}$; [c] survived indefinitely at this concentration; [d] survived this concentration; [e] substance tested was Fluoroacetamide (a compound related to 1080); [f] no effects observed at this level; [g] 48-hour $EC_{50}$

1 Hudson et al. (1972); 2 McIlroy (1984); 3 Tucker and Crabtree (1970); 4 Kalmbach (1945); 5 Cottral et al. (1947); 6 Ward and Spencer (1947); 7 Chenoweth (1949); 8 Burns and Connolly (1992); 9 Hudson et al. (1984); 10 Peacock (1964); 11 Munday (1978); 12 Bell (1972); 13 Rammell and Fleming (1978); 14 Eason and Frampton (1991); 15 McIlroy (1982a); 16 McIlroy (1982b); 17 Robison (1970); 18 Atzert (1971); 19 McIlroy et al. (1985) ; 20 Quin and Clark (1947); 21 King and Penfound (1946); 22 Fagerstone et al. (1994); 23 Bauermeister et al. (1977); 24 Deonier et al. (1946); 25 Booth and Wickstrom (1999); 26 Matsumura and O'Brien (1963).

### 4.1.2. How much bait needs to be ingested for poisoning, based on pen-trials with non-target feral and domestic species?

The amount of bait needed to be ingested by non-target domestic animals for poisoning is presented in Table 28 and for feral animals in Table 29.

*Fish*

No information relating to bait intake (oral $LD_{50}$ values) could be found. Force-feeding cereal pellets containing approximately 4 mg of 1080 to two fingerling trout and five adult **trout**, and about 8 mg of 1080 to two adult trout had no visible effect (Rammell and Fleming, 1978).

All toxicity values for fish reflect concentration of 1080 in water ($LC_{50}$ values) which is more relevant when assessing likely risks to fish from possum baits. To achieve the 96-hour $LC_{50}$ of 54 mg $l^{-1}$ for rainbow trout, all the 1080 in 3.6kgs of 1.5 g 1080 $kg^{-1}$ bait would have to leach out of the bait, and then remain in 100 litres of still water, without breaking down, for 96-hours. This is highly unlikely to occur in under pest control conditions in New Zealand.

**Table 28.** Amount of bait needed to be ingested to result in death based on $LD_{50}$ for non target domestic animals.

| Species | $LD_{50}$ (mg $kg^{-1}$) | Av. Weight Female (g) | Amount of 0.4g $kg^{-1}$ Bait (g) for $LD_{50}$ | Amount of 0.8g $kg^{-1}$ Bait (g) for $LD_{50}$ | Amount of 1.0g $kg^{-1}$ Bait (g) for $LD_{50}$ | Amount of 1.5g $kg^{-1}$ Bait (g) for $LD_{50}$ | Amount of 2.0g $kg^{-1}$ Bait (g) for $LD_{50}$ | Amount of 50g $kg^{-1}$ Bait (g) for $LD_{50}$ | Amount of 100g $kg^{-1}$ Bait (g) for $LD_{50}$ |
|---|---|---|---|---|---|---|---|---|---|
| ***Birds*** | | | | | | | | | |
| Chicken | 7.5 | 900 | 16.88 | 8.44 | 6.75 | 4.50 | 3.38 | 0.13 | 0.08 |
| ***Mammals*** | | | | | | | | | |
| Cat | 0.28 | 2500 | 1.75 | 0.88 | 0.70 | 0.47 | 0.35 | 0.01 | 0.001 |
| Cattle | 0.393 | 170000 | 167.03 | 83.51 | 66.81 | 44.54 | 33.41 | 1.34 | 0.67 |
| Red Deer | 0.5 | 80000 | 100.00 | 50.00 | 40.00 | 26.67 | 20.00 | 0.80 | 0.40 |
| Dog | 0.06 | 8000 | 1.20 | 0.60 | 0.48 | 0.32 | 0.24 | 0.01 | 0.005 |
| Goat | 0.3 | 35000 | 26.25 | 13.13 | 10.5 | 7.00 | 5.25 | 0.21 | 0.11 |
| Horse | 0.32 | 190000 | 152.00 | 76.00 | 60.80 | 40.53 | 30.40 | 1.22 | 0.61 |
| Pig | 0.4 | 120000 | 120.00 | 60.00 | 48.00 | 32.00 | 24.00 | 0.92 | 0.48 |
| Sheep | 0.25 | 50000 | 31.25 | 15.63 | 12.50 | 8.33 | 6.25 | 0.25 | 0.13 |
| ***Invertebrates*** | | | | | | | | | |
| Honeybee | 8 | 0.1 | 0.002 | 0.001 | 0.0008 | 0.0005 | 0.0004 | 0.00002 | 0.000008 |

The $LD_{50}$ values given in section 4.1.1 have been used in the calculations and the average weights of females have been used, as females are generally smaller and therefore a 'worst case scenario' for poisoning. Where LD values were cited as greater (>) or less (<) than a value, this value was used to make the calculations.

**Table 29.** Amount of bait needed to be ingested to result in death based on $LD_{50}$ for non target feral animals.

| Species | $LD_{50}$ (mg $kg^{-1}$) | Av. Weight Female (g) | Amount of 0.4g $kg^{-1}$ Bait (g) for $LD_{50}$ | Amount of 0.8g $kg^{-1}$ Bait (g) for $LD_{50}$ | Amount of 1.0g $kg^{-1}$ Bait (g) for $LD_{50}$ | Amount of 1.5g $kg^{-1}$ Bait (g) for $LD_{50}$ | Amount of 2.0g $kg^{-1}$ Bait (g) for $LD_{50}$ | Amount of 50g $kg^{-1}$ Bait (g) for $LD_{50}$ | Amount of 100g $kg^{-1}$ Bait (g) for $LD_{50}$ |
|---|---|---|---|---|---|---|---|---|---|
| ***Birds*** | | | | | | | | | |
| Mallard duck | 4.8 | 1100 | 13.20 | 6.60 | 5.28 | 3.52 | 2.64 | 0.11 | 0.05 |
| Goldfinch | 3.5 | 15 | 0.13 | 0.07 | 0.05 | 0.04 | 0.03 | 0.001 | 0.0005 |
| Australian magpie | 9.9 | 350 | 8.66 | 4.33 | 3.47 | 2.31 | 1.73 | 0.07 | 0.03 |
| Chukar partridge | 3.51 | 500 | 4.39 | 2.19 | 1.76 | 1.17 | 0.88 | 0.04 | 0.02 |
| Common pigeon | 4.25 | 400 | 4.25 | 2.13 | 1.70 | 1.13 | 0.85 | 0.03 | 0.02 |
| Pheasant | 6.46 | 1200 | 19.38 | 9.69 | 7.75 | 5.17 | 3.88 | 0.16 | 0.08 |
| California quail | 4.6 | 180 | 2.07 | 1.04 | 0.83 | 0.55 | 0.41 | 0.02 | 0.01 |
| House sparrow | 2.5 | 30 | 0.19 | 0.09 | 0.08 | 0.05 | 0.04 | 0.002 | 0.0008 |
| ***Mammals*** | | | | | | | | | |
| Red Deer | 0.5 | 80000 | 100.00 | 50.00 | 40.00 | 26.67 | 20.00 | 0.80 | 0.40 |
| Goat | 0.3 | 35,000 | 26.25 | 13.13 | 10.50 | 7.00 | 5.25 | 0.21 | 0.11 |
| Pig | 0.4 | 120,000 | 120.00 | 60.00 | 48.00 | 32.00 | 24.00 | 0.92 | 0.48 |
| Rabbit | 0.35 | 800 | 0.70 | 0.35 | 0.28 | 0.19 | 0.14 | 0.01 | 0.003 |

The $LD_{50}$ values given in section 4.1.1 have been used in the calculations and the average weights of females have been used, as females are generally smaller and therefore a 'worst case scenario' for poisoning. Where LD values were cited as greater (>) or less (<) than a value, this value was used to make the calculations.

### 4.1.3. Based on the mode of action, are there any taxa that are unlikely to be affected by 1080?

No, all species appear to be susceptible to the mode of action of 1080. However, there is a wide variance in dose rates required to produce observable effects. This means the degree of exposure is important in assessing risk.

### 4.1.4. Have sub-lethal effects on birds, mammals, marsupials, reptiles/amphibians, fish, arthropods, or molluscs been described for 1080?

*Domestic animals*

Even small doses of monofluoroacetate result in myocardial damage in **sheep**, and this damage is cumulative with subsequent exposure (Annison et al., 1960). In sheep that received multiple sub-lethal doses of 1080, myocardial degeneration has been reported as well as necrosis of individual or small groups of myocardial fibres (Schultz et al., 1982). Researchers in Australia noted macroscopic lesions in the heart of sheep, described as acute multifocal injury to the myocardium, after doses as low as 0.11 mg $kg^{-1}$ $day^{-1}$ for 3–7 days. A dose of 0.1 mg $kg^{-1}$ is approximately equivalent to a 30-kg sheep eating one 4 g 0.08% 1080 possum bait. Mild cardiac histopathology at doses of 0.055 mg $kg^{-1}$ $day^{-1}$ has been reported, but the duration of treatment was not specified (Whittem and Murray, 1963).

O'Connor et al. (1999) orally administered groups of pregnant **ewes** with either single (0.25 mg $kg^{-1}$), or multiple (0.05 mg $kg^{-1}$ over 3 consecutive days) doses of 1080 approximately two weeks prior to lambing as part of a trial on the toxicity of 1080 to pregnant ewes. The surviving ewes and their lambs were followed through to weaning. There were no differences in the ewe health, lambing percentages, lamb survival, or lamb growth rates between either of the 1080-dosed groups and a control (0 mg 1080 $kg^{-1}$) group.

In a study of the long-term effects of 1080 in **sheep**, 21 ewes that survived acute 1080 poison and a control group of 23 animals were monitored for two years (Gooneratne et al., 2008). No adverse effects on general health or condition were observed in any of the animals. There was no increase in the incidence of infectious or metabolic diseases in the 1080-exposed animals compared to the control group. The ewes were mated in both years. There was no difference in lambing percentage, lamb survival or mean lamb birth mass between the groups in either year. At the end of the study 10 ewes from each group were euthanised and necropsied. Tissue samples of the heart, brain, kidney, liver, lung, skeletal muscle rumen, abomasums, duodenum and ovaries were collected for histopathology. There were no grossly visible pathological lesions in the 1080-exposed ewes. Histopathological lesions were restricted to the heart and brain. There were scattered foci of fibrous tissue in the muscle of the heart. One animal had small, focal lesions in several regions of the brain, indicating chronic neuronal degeneration. The significance of the heart and brain lesions is uncertain in light of the lack of apparent adverse effects on general health and reproductive performance.

Glial cells in the brain are particularly sensitive to fluorocitrate (Erlichman et al., 1998; Hulsmann et al., 2000).

### *Feral animals*

The results from three different, complementary tests (using laboratory rats and mice) indicate that 1080 is not mutagenic, and therefore unlikely to cause cancer. A developmental toxicity study in rats indicated that 1080 causes developmental defects in rats when pregnant females are exposed to relatively high doses (0.33 and 0.75 mg $kg^{-1}$) on a daily basis during the period of organogenesis (from days 6 through to 17 of gestation). The developmental abnormalities observed were mild skeletal effects: slightly curved forelimbs, and bent or 'wavy' ribs (Eason et al., 1999).

Spielmann et al. (1973) reported that 1080 at a dose just below the maternal $LD_{50}$ was not teratogenic to **rats**. The embryos in this study showed no macroscopic or skeletal abnormalities. This work involved only a single dose and the results contrast with the investigation by Eason et al. (1999) which followed current international guidelines that require dosing rats from day 6–17 of gestation at three dose levels. Eason et al. (1999) found the NOEL derived from their multi-dose study (0.1 mg $kg^{-1}$ $day^{-1}$) was 10-fold less than the single dose NOEL (1 mg $kg^{-1}$) reported by Spielmann et al. (1973).

Reduced testes weight, atrophy of seminferous tubules and damaged spermatids has been reported in **rats** (Shinoda et al., 2000; Smith et al., 1977; Sullivan et al., 1979). Wolfe (1998) reported an increased heart weight in rats of both sexes, and decreased weight of testes/epididymides and abnormal sperm formation in male rats.

In the most recent exposure study in rats (Eason and Turck, 2002), the NOEL for rats administered 1080 via oral gavage for 90 days was 0.075 mg $kg^{-1}$ $day^{-1}$. This study confirmed that the epididymides, testes and heart are the target organs for 1080 sub-lethal effects, with severe hypospermia, severe degeneration of the seminiferous tubulies and cardiomyopathy seen at doses of 0.25 mg $kg^{-1}$ $day^{-1}$.

Decreased body weight and food consumption in **mink** and **ferrets**, and impaired reproduction in mink has been reported following sub-lethal 1080 poisoning (Hornshaw et al., 1986).

In pen trials 1080 caused damage to the wing muscle in **mallard ducks** (Ataria et al., 2000) and reduced testes weight in **starlings** (Balcomb et al., 1983).

An Australian study of the sub-lethal effects of 1080 on the **shingleback lizard**, a decrease in plasma testosterone concentration in the study animals was reported and there was a suggestion of degeneration of seminiferous tubules in some individuals (Twigg et al., 1988).

Smith and Grosch (1976) studied the effects of 1080 on *Bracon hebetor*, a **parasitoid wasp** found in North America. They found egg production was disrupted after a sub-lethal dose. Inhibition of reproduction in a **nematode** species (Middendorf and Dusenbery, 1993) Metabolism and movement inhibited in *Haemonchus* **worms** (Ward and Huskisson, 1978).

Note: The information in this section includes studies with species not extant in New Zealand

## 4.2. *Exposure*

### 4.2.1. What species (individual animals) have been reported as non-target deaths in field operations with 1080?

*Aerial and hand laid operations*

*Pets*

Based on the EPA NZ annual 1080 reports, between 2007 and 2016, 34 **dogs** and 1 **cat** were reported to have died during aerial 1080 operations (Table 30).

This compares to 72 **dogs** and 1 **cat** confirmed as being killed during 1080 operations in the 7 years between 1986 and 1992 (Orr and Bentley, 1994), and the 254 **dogs** and 9 **cats** confirmed as being poisoned by 1080 in the 17 years between 1960 and 1976 (Rammell and Fleming, 1978).

*Livestock*

Based on the EPA NZ annual 1080 reports, between 2007 and 2016, 10+ **cattle**, 7+ **sheep**, 4 **horses**, 4 **pigs** and 1+ **farmed deer** were reported to have died during aerial 1080 operations (Table 29).

In the 7 years between 1986 and 1992 the following livestock were confirmed as being poisoned by 1080: 24 **cattle**, 37 **sheep**, 10 **deer**, 4 **pigs** and 1 **goat** (Orr and Bentley, 1994).

Rammell and Fleming (1978) reported 125 **cattle**, 2101 **sheep**, and 25 **fowl** were confirmed to have died during 1080 operations between 1960 and 1976.

**Table 30.** Pet and livestock deaths reported during aerial 1080 operations between 2007 and 2016 (Based on EPA NZ annual reports).

| Species | Total Found Dead | No. of Operations |
|---|---|---|
| ***Domestic animals*** | | |
| Dog | 34 | 21 |
| Cat | 1 | 1 |
| ***Livestock*** | | |
| Cattle | 10+ | 5 |
| Sheep | 7+ | 5 |
| Horse | 4 | 1 |
| Pig | 4 | 2 |
| Farmed deer | 1+ | 1 |

**Honeybees** from hives near the loading zone of an operation in Golden Bay in August 2002 were observed gathering the green dust from toxic RS5 cereal baits. This loading zone had been used on previous occasions for aerial 1080 operations using the same bait type and no similar observations were made (Pestlink 0203GDB13).

Honeybees were observed collecting bait material (0.15% 1080 RS5 cereal pellets) at a bait loading zone near Arthurs Pass in February 2022. The bees accessed the bait over a period of about 1 ½ hrs. Soon after the incident the beekeeper found dead bees outside the entrances of three hives. He estimated about 200 bees outside one hive and 20-30 outside the other two. Green material was observed in pollen cells in the brood frames in two of these hives in one further hive (Pattemore and Fale 2022).

A sample of green material from the corbicula ('pollen sac') of a bee captured at the loading site contained 1050.85 mg $kg^{-1}$ 1080 (Table 32), indicating it was predominantly the 1080 bait material. Two samples of the dead bees from the hives tested positive for 1080 (0.059 and 1.43 mg $kg^{-1}$). Two samples of the green material from hive brood frames tested positive for 1080 (76.7 and 195 mg $kg^{-1}$).

Based on the observations and information from the incident it was considered most likely the bees were foraging on the bait as a substitute for pollen, to use as a protein source. Bee ecologists consider this was due to the scarce floral resources in the area during the period leading up to the operation meaning the bees were highly motivated to find new sources of food. They concluded it highly unlikely that the bees were collecting bait material as a nectar substitute for honey making because pollen foraging bees (as the observations consisted of) do not bring nectar back to the colony or interact directly with honey cells, the bait material was dry, and conditions at the time suggest bees were pressured to seek alternative pollen sources rather than nectar sources.

To confirm this conclusion tests of honey from 27 samples extracted from 73 hives in the apriary found no traces of 1080 (MDL 0.002 mg $kg^{-1}$). This included a sample from the honey extracted from one of the affected hives (where 1080 was detected in material from brood frame cells) three days after the incident (Pattemore and Fale 2022).

AHB (2012) conducted trials to investigate the attractiveness of RS5 and Wanganui #7 pellets to honeybees. The bees were trained to visit wet and dry cereal baits coated with a sugar-syrup attractant. The attractiveness of the baits was determined by switching the sugar-coated bait with standard non-toxic baits. Within 10 minutes, the bees lost interest in the standard baits. When EDR coated pellets were used, bees continued to visit the baits for approximately 30 minutes after the sugar-coated baits had been switched with the EDR coated pellets. When 1080 cereal pellets were placed within 80 metres of hives, no bees were observed visiting or landing on the baits.

To test the risk of dust to honey bees, six hives were put out during an actual 1080 operation at Buller South. 1080 was not detected in honeybees, wax, nectar or pollen samples collected within 24 hours of the operation or when the monitoring

was repeated after 15 – 16 days. Additionally, there was no evidence of 1080 dust on flowers on which honeybees were observed foraging (AHB, 2012).

*Feral animals*

A review of **deer** (various species) mortality observed in 26 aerial 1080 operations which used **cereal pellets** without deer repellent between 1999 and 2019 found a wide range of mortality estimates. Operations were classified as having low (0 to 33% mortality), moderate (34 to 66%) or high (67 to 100%) impacts on deer populations with 42%, 38% and 20% in each respective class. Sowing rates at or below 1.5kg/ha more often resulted in low deer by-kill. Bait size (6 or 12 gram) did not explain variation. Deer mortality was suggested to be lower for operations at sites that had been treated within the previous five years (Morriss et al., 2020).

A **red deer** kill of 43% was reported following application of ***cereal pellets*** at 10 kg $ha^{-1}$, July 1988 at North Pureora. Simultaneous carcass searches over the poisoned area confirmed the pellet-count result (Nugent et al., 2001). A red deer kill of 54% was reported following application at 3 kg $ha^{-1}$ June 1999 in the Orongorongo Valley (Nugent et al., 2001). A red deer kill of 5% was reported following application at 3 kg $ha^{-1}$ overall but sown in strips of 25 kg $ha^{-1}$, with pre-feeding June 1999 at Wainuiomata Valley (Nugent et al., 2001).

**Fallow deer** were monitored during an aerial 1080 operation in the Blue Mountains using ***0.15% 1080 pellets*** at 2 kg $ha^{-1}$ 12 days after prefeeding with non-toxic bait. All three radio tagged deer were killed and estimates using a range of data available (carcass searches, deer sightings and hunter kill records) led the authors to conclude a best guess kill of 67-75% (Nugent and Yockney, 2001).

By-kill of **white-tailed deer** was estimated for an August 2014 aerial 1080 operation covering 15,215ha of the Dart and Routeburn catchments using 1kg/ha 6 gram RS5 **0.15% cereal pellets** pre-fed 4 days earlier. Four 100 ha areas within the treatment block were searched over four days with a total of 190km of search effort. The search success rate was estimated at 78% using simulated carcasses (paper sacks) placed in the search areas beforehand and used to adjust the number of deer found dead. Overall the estimated mortality was 0.96 deer/$km^2$ but this method did not allow a population estimate to be determined (Pinney et al 2021).

A study of **red deer** mortality during ***1080 carrot*** operations (0.15%) in Pureora in 1994 resulted in kills of 30% and 31% following application at 15 kg $ha^{-1}$, with non-toxic pre-feeding, and 42% where no prefeed was used (Fraser et al., 1995). Deer faecal pellet densities in this study area declined by about 40% 15 months after poisoning but returned to pre-control levels a year later, and then apparently doubled over the ensuing two years (Coleman et al., 2000).

A **red deer** kill of 57% was reported following application of 0.09% ***carrot baits***, with pre-feeding at 15 kg $ha^{-1}$, May 1996 at North Pureora (Sweetapple and Fraser, 1997). A red deer kill of 93% was reported following application in August 1997 of 0.08% ***carrot bait*** and at 15 kg $ha^{-1}$, with pre-feeding at Titiraupenga. In the same study using 0.15% bait at 15 kg $ha^{-1}$ (prefed) the reported kill was 92% (Fraser and Sweetapple, 2000).

During the 2017 TBfree aerial 1080 operation at Paemahi (Kaimanawa Forest Park), the impact of ***EDR*** deer repellent coated cereal pellets on **sika deer** was studied.The study involved pre- and post monitoring using camera traps in four 600 ha blocks, two within and two outside the operational area. 730 deer were sighted during the pre-monitoring and the deer density was estimated at 20 deer $km^{-1}$. There was a decline in deer sighted post control, however, the decline was highest in the two blocks outside the operational area. The reduction in deer sightings was attributed to a decline in deer activity in winter rather than as a result of the 1080 operation. 11 deer were found dead by searchers, giving a by-kill of 1.6 deer $km^{-1}$ . This is equivalent to <10% of the deer population that was present (TBfree, 2017).

A trial comparing mortality rates of red deer between Pestex® DR (deer-repellent) and Pestex® (non deer-repellent) 1080 cereal pellet baits was conducted during possum control operations in the Clarence and Awatere valleys in winter 2019. Each block was treated with 1kg/ha of non-toxic bait (16mm, cinnamon lured) followed 17-20 days later by 2kg/ha toxic bait (16mm, cinnamon lured, 0.15% 1080) with one block of 13,280 hectares having the deer repellent Pestex® DR bait and the other block of 9,447 hectares the non deer repellent Pestex® bait for both prefeed and toxic phases. All of 11 radio collared deer that were present in the non deer repellent Pestex® treatment block at the time of 1080 bait application died (estimated kill rate 100%, 95% CI 74.1-100%). Nineteen of 30 radio collared deer that were present in the deer repellent Pestex® DR block died (63.3% kill; 95% CI = 43.9–79.5%). The estimated reduction in deer by-kill with Pestex® DR compared to standard Pestex® 1080 bait was 36% (95% CI = 13–60%)(Morriss et al 2019). The average weight of the deer killed in the deer repellent block was signficantly lower than in the non repellent block reflecting that the population of deer there were more nutritionally limited, smaller, and potentially more vulnerable to poisoining through aerial 1080 operations than those in the standard bait block.

In the trial reported by Morriss et al (2019) there were incidental observations of dead **goats** (n=3) and **chamois** (n=1) in the block sown with Pestex (non-repellent) bait. The chamois and one goat were tested and found to contain 1080 residues in muscle tissue sampled. In the block sown with Pestex DR (repellent) bait three live chamois were seen and no dead chamois or goats were reported.

The effect of Prodeer Possum & Rat bait (deer-repellent 1080 cereal pellet manufactured by Orillion) on incidental red deer mortality was studied during a 54,188 hectare possum control operation at Molesworth and Muller stations in May and June 2021. Prefeed bait (Prodeer, cinnamon-lured, 6g pellets) was applied at 1.0kg/ha and toxic bait (Prodeer, cinnamon-lured, 0.15% 1080, 6g pellets) at 2kg/ha 19-21 days later. Of 39 radio-collared deer that were alive and present in the treatment area just before 1080 baiting, two died, indicating a deer kill of 5.1% (95% CI 0.9-18.7%) (Morriss et al 2021).

The impact of Prodeer 1080 bait on red deer and feral pigs was studied during a 5,395 hectare possum control operation at Willowflat Forest, Hawke's Bay, in October 2021. Prefeed (Prodeer non-toxic 6g pellets) was applied at 1.5kg/ha followed 13 days later by toxic bait (Prodeer, 0.15% 1080, 12g pellets) at 2kg/ha. Trail cameras were used to monitor deer and pig activity over 4 months before and 2 months after the poison operation at the poison treatment site and a nearby

unpoisoned block at Maungataniwha Forest. Deer visit rates per camera day increased by a similar amount in both the poisoned and unpoisoned blocks throughout the study period, probably in response to seasonal changes such as increased grass growth. There was no effect of poisoning on deer count per camera after accounting for the time+site effects, with an estimated increase in activity of 2% (95% CI = -5.5–10%) in the poisoned area. A few live deer were seen during deployment servicing and removal of cameras but no dead deer. A small number (1%) of deer observations on camera were of fallow deer. For pigs in the poisoned area there was a estimated decrease of 47% (95% CI=39-54%) in pig count per camera after accounting for time+site effects, however camera visitation rate of feral pigs progressively declined through the monitoring period (including over each 7 day period in the 4 months before the control) and it was not clear if the poison operation caused any bykill of pigs. No pig carcasses were observed incidientally during fieldwork in the poisoned area (Morriss and Gormley 2022).

The survival of tahr was assessed during two aerial applications of 1080 cereal pellets within a 8,659 ha treatment area in the Perth River valley in late autumn and winter of 2020. A first phase of bait applications took place in March-April with two applications of prefeed (each with 6g baits at 2kg/ha) applied 15 days apart before toxic bait (6g baits, 0.15% 1080 at 4kg/ha) was applied 10 and 11 days later. All baits in the intial phase were green-dyed Wanganui #7 with 0.3% orange lure. The second phase of applications took place in June with prefeed (6g baits at 1kg/ha) being applied 7 days apart before toxic bait (6g baits at 2kg/ha) was applied 27 and 28 days later. All baits in the second phase were green-dyed RS5 with 0.3% cinnamon lure. Tahr fitted with radio collars, a mix of female adults and juveniles of both sexes, were monitored before and after the bait applications. Based on locations of animals during searches, 11-15 were exposed to the first baiting phase and 8-14 were also exposed to the second baiting phase. All of these animals survived the poison baiting operations (Kerr 2020). In a trial of aerially applied 1080 carrot bait for tahr control, estimated tahr kill rates were 11%, 30% and 51% in blocks that received no prefeed, 1 prefeed, and 2 prefeed applications repectively (Douglas 1967). The baits used (chopped carrot pieces up to 200g, 0.14-0.36% 1080, green dyed) did not met current standards for registered 1080 products.

*Game birds*

During an aerial 1080 operation in Rotoehu Forest in October 2004 (type of bait not stated), Fish and Game staff monitored **pheasant** crowing rates using five-minute counts in treated and untreated blocks. There was a healthy population throughout the forest and there was no discernible difference in the crowing rates between the blocks following the 1080 operation (McDougall, 2005).

Evans and Soulsby (1993) reported 27 **California Quail** died during three 1080 ***carrot*** (0.2 g 1080 $kg^{-1}$) rabbit control operations between 1985 and 1991. In all three operations, the deaths could be attributed to 1080 either through residue testing or observing carrot in the crop. The authors also reported **Chukar** being found dead following two other rabbit control operations using carrot (0.2 g 1080 $kg^{-1}$).

During an aerial 1080 rabbit control operation on Dovedale Station, Central Otago in August 1993, five **California quail** coveys were monitored inside (treatment coveys) and a further two outside (non-treatment coveys) the operational area. The operational area received two prefeeds of unscreened carrot bait 7 days apart. Seven days later unscreened green dyed toxic ***carrot*** (0.2 g 1080 $kg^{-1}$) was applied at a rate of 25 kg $ha^{-1}$. California quail survived inside the operational area in significant numbers. Following the operation, of the coveys inside the operational area, quail numbers remaining the same in two and dropped in one. The other two coveys in the treatment are could not be located. One non-treatment covey's numbers remained the same and the other one appeared to break up for breeding. Insufficient information was obtained to determine whether the change in covey sizes were as a result of non-location, breeding dispersal, emigration or poisoning (Evans and Soulsby, 1993).

Four **California quail** deaths were reported during two rabbit control operations using 1080 ***oat*** (0.2 g 1080 $kg^{-1}$) baits in the 1980-90's (Evans and Soulsby, 1993).

During a 1976 rabbit control operation near Lake Benmore using 1080 ***oat*** (0.2 g 1080 $kg^{-1}$) baits, **Canada geese** died after eating the bait. The birds contained up to 70g of the bait in their crops and gizzards (Anonymous, 1986).

*Other birds*

A number of other introduced bird species have been found dead during aerial 1080 operations (using carrot and cereal pellet baits). These include **blackbirds**, **thrush**, **chaffinch**, **dunnock**, **goldfinch**, **redpoll**, **yellow hammer** and **hedge sparrows** (Morriss et al., 2016; VPRD; Pestlink: 0304RAN08 ; Nugent et al., 2004; Rammell and Fleming, 1978).

Morriss et al. (2016) reported that **blackbirds** comprised 80% of the introduced dead birds found during 15 aerial 1080 operations (cereal pellet and carrot) between 2003 and 2014. Furthermore, they reported that in two detailed studies conducted in the Hauhungaroa Ranges in 2011 and 2013, while blackbirds represented 3.2% and 1.9% of the overall live bird counts, they comprised 54% and 73% respectively of the dead birds found.

### *Bait station operations using 0.15% or 0.08% 1080 Pellets*

Domestic and feral non-target deaths reported after the use of 1080 cereal pellets in bait stations are reported in Table 31**Error! Reference source not found.**.

**Table 31.** Feral and domestic non-target animal deaths reported during bait station operations using 0.15% 1080 pellets.

| Species | Total Found Dead | No. of Operations Involved | No. of Cases Where Residues Confirmed | Sowing Rate (kg $ha^{-1}$) | Ref. |
|---|---|---|---|---|---|

| | | | | | |
|---|---|---|---|---|---|
| Dog | 2 | 1 | 1 | | 1; 2 |
| Cattle | 16 | 1 | 2 | | 3 |
| Australasian magpie | 1 | 1 | 0 | | 1 |

1 VPRD: 6461-1; 2 Pestlink: 0405WNG12; 3 VPRD: T2109.

### *Pestoff Professional 1080 Possum Paste (0.08 & 0.15%)*

Honey bees were known to be attracted to 1080 paste baits (sometimes referred to as jam baits) used in pest control prior to 1995. In an operation using this formulation of bait, honey was sampled from hives within the estimated forage zone of the bait application. Samples from 3 honeycombs that were uncapped/semi capped 12 days after the operation had residues of 1080 at 0.003-0.015 mg $kg^{-1}$ (Lowe 1994). Changes in formulation of 'Pestoff Professional' possum paste since then have been found to be unattractive to bees (Morgan, 2000).

### *Cut apple bait*

Honey bees offered this bait near their hive were seldom observed on the bait compared with control baits offered (Thomas et al., 2003).

## 4.2.2. For which species have residues of this pesticide been detected following 1080 operations?

### *Aerial and hand laid operations*

1080 residue levels in domestic and feral animals found dead after 1080 operations are presented in Table 32.

**Table 32.** 1080 residue levels recorded in domestic and feral animals during pest control operations in New Zealand.

| Species | Sample Type | Residues (mg $kg^{-1}$) | Ref. |
|---|---|---|---|
| *Mammals* | | | |
| Cat | Muscle | 0.06–1.24 | 1 |
| | Stomach | 0.36 | |
| Dog | Muscle | 0.014–0.41 | 1 |
| | Stomach | 0.028–0.7 | |
| | Intestine | 0.44 | |

| Species | Sample Type | Residues (mg $kg^{-1}$) | Ref. |
|---|---|---|---|
| | Vomit | 1.07 | |
| Cattle | Muscle | 0.003–0.46 | 1 |
| | Stomach | 0.04–9.1 | |
| Sheep | Muscle | 0.021-0.3 | 1; 2 |
| | Stomach | 0.001-1.3 | |
| Deer | Muscle | 0.012–7.37 | 1; 3; 4; 5 |
| | Stomach | 8.7–35.9 | |
| | Heart | 0. 85-8.12 | |
| | Liver | 0. 75-4.05 | |
| Deer - whitetail | Muscle | 0.27-3.08 | 1 |
| | Stomach | 0.33-51 | |
| Goat | Muscle | 0.36 | 19 |
| Chamois | Muscle | 0.23 | 19 |
| Pig | Muscle | 0.03–0.21 | 1 |
| | Stomach | 56 | |
| ***Birds*** | | | |
| Blackbird | Muscle | 0.01–32.0 | 1; 3; 4; 6 |
| Chaffinch | Muscle | 0.14–5.80 | 1; 6 |
| Dunnock | Muscle | 0.28–1.75 | 6 |
| Hedge Sparrow | Muscle | 0.03 | 1 |
| Thrush | Muscle | 2.01 | 6 |
| California Quail | Crop | 18 - 76 | 7 |
| ***Invertebrates*** | | | |
| Honeybee | 2 whole animals | 0–10.8 | 1 |
| Honeybee | Pooled samples of bees | 0.059-1.43 | 18 |
| Honeybee | Corbicula ('pollen sac') | 1050.85 | 1 |

| Species | Sample Type | Residues (mg $kg^{-1}$) | Ref. |
|---|---|---|---|

1 VPRD; 2 Parliamentary Commissioner for the Environment (1994); 3 Speedy (2003); 4 Nugent et al. (2004); 5 McIntosh and Staples (1959); 6 Morriss et al. (2016); 7 Evans and Soulsby (1993); 18 Pattemore and Fale (2022); 19 Morriss et al. (2019)

#### 0.15% 1080 Pellets in bait stations

Muscle samples from 8 trout had no detectable 1080 following application in bait stations at 100g/station, approximately 1 station/ha, October 1997, Lake Rotoiti (VPRD T0543, T0642).

## *4.3. Treatment*

### 4.3.1. Is there an effective treatment of 1080 poisoning that is practical to administer?

No antidotes for 1080 poisoning are currently available but research is continuing (Ataria et al., 1995; Cook et al., 2001; Diaz, 2018).

# 5. Human Health

The estimated lethal dose of 1080 in humans lies in the range of 0.7 and 10.0 mg $kg^{-1}$. Sodium monofluoroacetate (1080) is absorbed through the gastrointestinal tract or via the lungs if inhaled. Monofluoroacetate is not readily absorbed through intact skin, but it can be absorbed more readily through cuts and abrasions. The onset clinical signs usually range from 30 minutes to about 2-3 hours. Signs of poisoning include nausea, vomiting, and abdominal pain initially, followed by respiratory distress, anxiety, agitation, muscle spasms, stupor, seizures, and coma.

1080 is not a mutagen and is unlikely to be a carcinogen. It has sub-lethal effects on reproduction and is classified as a teratogen.

There is no effective antidote for 1080 poisoning in humans and any treatment given is largely symptomatic and supportive.

## *5.1. Toxicity*

### 5.1.1. What is the oral MDL (mg $kg^{-1}$ b.w.)?

The oral MDL (Minimum Lethal Dose) for humans has been estimated at 0.6 mg $kg^{-1}$ (TERA 2006). The oral $LD_{50}$ is estimated at being between 0.7 and 10.0 mg $kg^{-1}$ (Chenoweth, 1949; Eisler, 1995; Kaye, 1970). Other authors cite lethal dose estimates lying between 2 and 10 mg/kg (Reyes 2020, Nishii et al 2012). Some suggest differences in LD50 figures depending on how it is administered with intravenous injection yeilding much lower figures than oral in monkeys (Nishii et al 2012).

However, from a public health perspective, it is more appropriate to use the minimum lethal dose (MLD) as the estimate of the acute toxicity in humans. In this review the lowest estimated MLD of 0.7 mg $kg^{-1}$ is used in the acute toxicity calculations.

### 5.1.2. How much bait would children and adults need to ingest for poisoning?

The information on bait consumption required for poisoning is presented in Table 33.

**Table 33.** Amount of 1080 bait needed to be ingested by a human to result in death based on the $LD_{50}$.

| | MLD (mg $kg^{-1}$) | Av. Weight (kg) | Amount of 0.8 g $kg^{-1}$ 1080 Bait (g) for MDL | Amount of 1.5 g $kg^{-1}$ 1080 Bait (g) for MDL |
|---|---|---|---|---|
| Child | 0.6 | 15 | 11.25 | 6 |
| Adolescent | 0.6 | 30 | 22.5 | 12 |

| | | | | |
|---|---|---|---|---|
| Small adult | 0.6 | 60 | 45 | 24 |
| Large adult | 0.6 | 90 | 67.5 | 36 |

### 5.1.3. What is the dermal MDL (mg $kg^{-1}$ b.w.)?

Monofluoroacetate is not readily absorbed through intact skin, but it can be absorbed more readily through cuts and abrasions. An MDL has not been estimated, but Fagerstone et al. (1994) estimated the dermal $LD_{50}$ at 300 mg $kg^{-1}$. Exposure guidelines (Threshold Limit Values, TLV) for 1080 have been set in USA, with a Time-weighted average (TLV-TWA) of 0.05 $mg/m^3$ for skin exposure (Anon., 1991).

In New Zealand the Occupational Health and Safety Service (OSH) has set a Biological Exposure Index (BEI) of 15 µg $l^{-1}$ (0.015 ppm) for 1080 in human urine (Occupational Safety and Health Service, 2002).

### 5.1.4. Where the pesticide involves a gaseous form, what is the gaseous MDL (ppm in air)?

This is not applicable for 1080.

### 5.1.5. Where there is dust or mist associated 1080 use, what is the dust and mist MDL (ppm in air)?

There is no published information on the $LC_{50}$ for 1080 in dust or mist. A Biological Exposure Index (BEI) of 15 µg $l^{-1}$ (0.015 ppm) for 1080 has been set by Occupational Health and Safety Service (OSH) New Zealand (Occupational Safety and Health Service, 2002).

### 5.1.6. Is there evidence that 1080 may have mutagenic and/or carcinogenic properties? If known, what are the LOEL or NOEL values?

Three different complementary tests (Ames assay; mouse lymphona assay; mouse micronucleus assay) indicate that 1080 is not a mutagen and is therefore unlikely to be a carcinogen (Eason et al., 1999). The latter test dosed mice with 0.75, 1.5, 3.0, 6.0 and 7.5 mg/kg cf the published LD50 dose for mice being 8.3 mg/kg (McIlroy 1982b) .

### 5.1.7. Is there evidence that 1080 may have sub-lethal effects on reproduction or lactation, or is classified as a teratogen? If known, what are the LOEL or NOEL values for these reproductive and developmental effects?

1080 has sub-lethal effects on reproduction and is classified as a teratogen (de Meyer and de Plaen, 1964; Spielmann et al., 1973).

It is a male reproductive toxicant with effects on testes of mammals (Eason and Turck, 2002; Shinoda et al., 2000; Wolfe, 1998). In a 90 day study, Wolfe (1998) reported a decreased weight of testes and epididymides, and abnormal sperm formation in male rats. In a 90 day toxicology study of 1080, Eason and Turck (2002) reported hypospermia in the epididymides and degeneration of the seminiferous tubules of the testes of male rats dosed with 1080 at 0.25 mg $kg^{-1}$ $day^{-1}$. The NOEL for rats administered 1080 via oral gavage for 90 days was 0.075 mg $kg^{-1}$ $day^{-1}$.

Neither 1080 nor its active metabolite fluorocitrate bound to human androgen or alpha oestrogen receptors during in vitro assays (Tremblay et al., 2005). 1080 and fluorocitrate did not bind to sheep oestrogen receptors either (Tremblay et al., 2004). Therefore, while 1080 is a male reproductive toxicant, it is not considered an endocrine disruptor.

Sub-lethal doses of 1080 to pregnant rats alters skeletal development of rat foetuses (Eason et al., 1997; 1999). Teratogenic effects have been reported at 0.75 mg $kg^{-1}$ $day^{-1}$ (Eason et al., 1999) and the developmental NOEL is 0.1 mg $kg^{-1}$ $day^{-1}$.

### 5.1.8. Is there evidence that 1080 may have sub-lethal effects on target organs? If known, what are the LOEL or NOEL values for these effects?

Sub-lethal effects on target organs have been reported. Small testes and epididymis in male rats were observed following doses of 1080 at 0.25 mg $kg^{-1}$ $day^{-1}$, and these observations were corroborated by a reduction in the weight of the testes. 1080-related increases in heart weight were noted in both males and females at 0.25 mg $kg^{-1}$ $day^{-1}$ when compared with controls. The NOEL for rats administered 1080 via oral gavage for 90 days was 0.075 mg $kg^{-1}$ $day^{-1}$ (Eason and Turck, 2002).

Changes in testes in male rats and in heart weights in both sexes of rats were reported by Wolfe (1998). Based on these findings the NOEL for sodium fluoroacetate, when given orally to Sprague-Dawley rats for 13 weeks, was 0.05 mg $kg^{-1}$ $day^{-1}$ (Wolfe, 1998).

Rhesus monkeys given trace doses of 1080 were monitored for three months afterwards. No statistically significant changes in blood chemistry, liver enzymes or renal function were observed (Nishii et al 2012).

### 5.1.9. How rapid is the onset of toxicity for 1080 in humans?

The onset clinical signs usually ranges from 30 minutes to about 2-3 hours (Eason and Wickstrom, 2001), however, in one case of acute poisoning, onset of symptoms was described as within minutes (Williams, 1948). Relatively few cases of human poisoning (accidental or deliberate) have been reported in the literature. Liu et al (2020) provide information for 68 cases in China, of which 6 were fatal. A further 23 cases, 16 of which were fatal are reported in (Reyes et al 2020; Anon., 1992; Brockmann et al., 1955; Ellenhorn and Barceloux, 1988; Harrison et al., 1952; Trabes et al., 1983).

Poisoning symptoms experienced include nausea, vomiting, and abdominal pain initially, followed by respiratory distress, anxiety, agitation, muscle spasms, stupor, seizures, and coma. Hypotension (low blood pressure) is thought to be one of the more important predictors of mortality in 1080 intoxication (Chi et al., 1999; Chi et al., 1996). Liu et al (2020) identified a number of other blood parameters indicative of 1080 poisoning and/or patient survival.

## 5.2. *Treatment*

### 5.2.1. Is there an effective treatment or antidote for 1080 poisoning in humans?

There is no effective antidote for 1080 poisoning in humans. Treatment is largely symptomatic and supportive, with special attention focused on stabilising cardiac and central nervous system functions (Goncharov et al., 2006). Renal replacement therapy has also been used successfully (Reyes et al 2020) The success of the treatment is likely to depend on whether the dose was acute or sub-lethal.

There is ongoing research into antidotes for 1080 (e.g. Goncharov et al., 2006; Hoyos et al., 2018). Ethanol has been found to be useful antidotal therapy but could not be considered totally effective (Goncharov et al 2006; Liu et al 2020).

# 6. Operational

1080 is considered to have medium humaneness for possums, however there has been little formal research into the humaneness of 1080 on other target species. Most deaths of pest species occur 8 – 48 hours after ingestion of a lethal dose.

All the registered target species have relatively high susceptibility to 1080. The short latent period means that bait shyness can develop in animals receiving a sub-lethal dose. Mice exhibit a marked avoidance of 1080 which is likely to result in control operation failures.

The majority of pest control operations using 1080 have target pest kills of greater than 80%.

## *6.1. Animal Welfare*

### 6.1.1. What are the animal welfare impacts of 1080 on the target pest?

1080 toxicosis generally has a characteristic 'lag time' in mammalian species, where following intake of a lethal dose, the animal will show no visible signs of poisoning for up to a number of hours, before beginning to display symptoms (Eason and Wickstrom, 2001). The onset clinical signs usually ranges from 30 minutes to about 2 - 3 hours with most deaths in mammals generally occurring 8 – 48 hours after ingestion of a lethal dose (Eason and Wickstrom, 2001). The severity of symptoms observed are difficult to evaluate (Littin et al 2009 ; Beausoleil & Mellor 2015) However an insight may be gained from testimony from people who have ingested 1080. They describe abdominal pain, agitation and vomiting (Chi et al 1996; Liu et al 2020)

***Possums***

Littin et al. (2009) reported that the onset of symptoms in eight unhandled lethally dosed possums occurred at 1 hour 50 minutes (±0:09 s.e.m) with animals exhibiting abnormal appearances and postures. Seven of the animals showed retching, and three vomited starting at 2 hours 53 minutes. Lack of coordination began at 3 hours 37 minutes, after which possums spent most of the time until death lying, showing spasms and tremors. Five of the possums had seizures while lying prostrate. The mean time to death was 11 hours 26 minute (±1:55 s.e.m).

In possums the animal welfare impacts of 1080 is described as intermediate when compared to other vertebrate toxic agents used to kill possums in New Zealand (Littin et al., 2009; MAFBNZ, 2010).

***Rodents***

Cook (1998) reported laboratory rats orally dosed with 1080 exhibited hypersensitivity to light and sound, an increased incidence of grooming or scratching of the abdomen, increased cage pacing and increased curled-but-awake posture. Five of the ten rats dosed with 1080 showed convulsive behaviour between 4 to 10 hours after the 1080 was administered.

McIlroy (1982b) reported that ship rats exhibited a 0.8 - 27.8 hour latent period and died 2.4 - 36.5 hours after a lethal dose of 1080 was administered. Norway rats had a 0.4 – 2.3 hour latent period and a 2.5 – 112.0 hour time to death. Mice had a 1.3 – 2.8 hour latent period and 2.2 - 68.3 hour time to death. In rats observed symptoms included animals initially appearing depressed, often sitting quietly hunched in a corner or lying on their side, back or stomach with their eyes partially closed: hypersensitivity to touch or sounds; and uncoordinated movement with unsteady balance. Respiration was initially very rapid, but became slower, shallower and more irregular until death occurred. Convulsions were commonly observed.

In rats the animal welfare impacts of 1080 is described as intermediate when compared to other vertebrate toxic agents used to kill rats in New Zealand (MAFBNZ, 2010).

### *Cats*

The main poisoning symptoms in cats are lethargy and disorientation, which are unusual for carnivores and more closely resemble those seen in herbivores. Other symptoms include uncoordinated movements and occasional vocalisation (Eason and Frampton, 1991). Neurological signs associated with 1080 exposure are generally less severe in cats than in dogs (Eason and Wickstrom, 2001). McIlroy reported a latent period of 1.0 - 5.6 hours and time to death between 20.7 - 21.0 hours. In cats the animal welfare impacts of 1080 are described as intermediate when compared to other vertebrate toxic agents (MAFBNZ, 2010).

### *Rabbits*

In rabbits the animal welfare impacts of 1080 are described as intermediate (MAFBNZ, 2010). The onset of symptoms has been reported as occurring between 1.1 - 10.1 hours after exposure to a lethal dose and death occurring after 3.0 - 44.3 hours (McIlroy, 1982a). Gooneratne et al. (1994) reported the time to death ranging from 1 to 7.5 hours in rabbits following a lethal dose. Lying prone, lethargy, respiratory distress, sensitivity to noise or disturbance and convulsions have been reported in poisoned rabbits (MAFBNZ, 2010; McIlroy, 1982a).

### *Wallabies*

McIlroy (1982a) reported symptoms in poisoned wallabies included animals sitting hunched up; generally appearing non-alert, with shivering or shaking forelimbs and unsteady balance; convulsions and a white froth exuded from the mouth and nostrils. The latent period in Bennett's wallabies was <16.9 to 23.2 hours (7 wallabies observed), and the time to death was 8.9 – 38.9 hours (23 wallabies observed). For dama wallabies the time to death was 13.8 - 37.1 hours. MAFBNZ (2010) describe the overall animal welfare impacts of 1080 on wallabies as intermediate compared to other vertebrate toxic agents.

### *Deer*

In general, herbivores experience cardiac failure, whereas carnivores experience central nervous system disturbances and convulsions then die of respiratory failure (Egeheze and Oehme, 1979).

Daniel (1966) reported that deer became lethargic and lay down quietly without any of the convulsions or leg-thrashing commonly reported in Canidae. He reported that deer died between 2 and 30 hours after eating a lethal dose.

## 6.2. *Efficacy*

### 6.2.1. Is 1080 effective on the target pest, based on the LD50?

All the registered target species have relatively high susceptibility to 1080. The $LD_{50}$ values are presented in Table 34.

**Table 34.** Acute oral toxicity ($LD_{50}$ mg $kg^{-1}$) of 1080 to the target pests.

| Target Pest | $LD_{50}$ (mg $kg^{-1}$) | Ref. |
|---|---|---|
| Cat | 0.28 | 1 |
| Deer not specified | 0.50 | 2 |
| Mule deer | 0.27 – 0.90 | 3 |
| House mouse | 8.30 | 4 |
| Brush-tailed possum | 0.79[a] | 5 |
| Rabbit | 0.35 | 6 |
| Ship rat | 0.76 | 4 |
| Laboratory rat | 1.71 | 4 |
| male | 2.08 (95% CI 1.73, 2.49) | 7 |
| female | 1.85 (95% CI 1.56, 2.19) | 7 |
| Norway rat (wild) | 0.22-3.0 | 8 |
| Stoat | 0.49 ($LD_{90}$ = 0.70) | 9 |
| Bennett's wallaby | 0.21 | 10 |
| Dama wallaby | 0.27 | 6; 10 |

[a] Ambient temperature may affect the acute toxicity of 1080 to possums, with increased toxicity at low temperatures (Veltman and Pinder, 2001).

1 Eason & Frampton(1991); 2 Rammell & Fleming (1978); 3 Tucker & Crabtree (1970); 4 McIlroy (1982b); 5 Bell (1972); 6 McIlroy (1982a); 7 (McCranor et al., 2019); 8 Chenoweth (1949); 9 Spurr (2000b); 10 Munday (1978).

### 6.2.2. How much bait does the target pest have to ingest in order to be poisoned, within what timeframe?

Target pests would have to eat at least the amounts given in Table 35 in one feeding session (at least three hours) to be likely to receive an acute lethal dose.

**Table 35.** Amount of bait a target pest needs to ingest to result in death based on $LD_{50}$.

| Species | $LD_{50}$ (mg $kg^{-1}$) | Av. Weight Female (g) | Amount of 0.2g $kg^{-1}$ Bait (g) for $LD_{50}$ | Amount of 0.4g $kg^{-1}$ Bait (g) for $LD_{50}$ | Amount of 0.6g $kg^{-1}$ Bait (g) for $LD_{50}$ | Amount of 0.8g $kg^{-1}$ Bait (g) for $LD_{50}$ | Amount of 1.0g $kg^{-1}$ Bait (g) for $LD_{50}$ | Amount of 1.5g $kg^{-1}$ Bait (g) for $LD_{50}$ | Amount of 2.0g $kg^{-1}$ Bait (g) for $LD_{50}$ | Amount of 50g $kg^{-1}$ Bait (g) for $LD_{50}$ | Amount of 100g $kg^{-1}$ Bait (g) for $LD_{50}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Bennetts wallaby | 0.21 | 11000 | | - | | - | - | 1.5 | 1.2 | 0.05 | 0.02 |
| Cat | 0.28 | 2500 | | - | | - | 0.7 | - | - | - | - |
| Dama wallaby | 0.27 | 4300 | | - | | - | - | 0.8 | 0.6 | 0.02 | 0.01 |
| House Mouse | 8.30 | 20 | | | | 0.21 | | 0.1 | | | |
| Norway rat | 0.22 | 220 | | - | | 0.06 | - | 0.03 | - | - | - |
| Possum | 0.8 | 3000 | | - | 4.0 | 3.0 | - | 1.6 | - | - | - |
| Rabbit | 0.35 | 800 | 1.4 | 0.7 | 0.47 | - | - | - | - | - | - |
| Red deer | 0.5 | 80000 | | - | | - | - | 26.67 | - | - | 0.4 |
| Ship rat | 0.76 | 140 | | | | 0.13 | | 0.07 | - | - | - |

*Palatability*

Palatability of a bait will also influence the whether the target pest will ingest a lethal dose.

*Possums*

Morgan (2004) reported that under field conditions double wax coated 1080 pellets left in Philproof bait stations had a 20% decline in palatability after 4 months.

*Mice*

Wild caught mice demonstrate marked avoidance of baits containing 1080 in pen studies (Fisher et al., 2009; Morriss et al., 2008). In paired choice tests (using toxic pellets and non-toxic rodent pellets), only 8% of mice died when offered 0.15% 1080 baits. Pellet type (Wanganui #7 or RS5), the presence or absence of green dye, the presence or absence of 0.3% cinnamon and bait size (2g and 12g) did not have any effect on the amount of toxic bait eaten by mice (Morriss et al., 2008). In similar paired choice tests, Fisher et al. (2009) reported that mice had a low acceptance of 0.08% and 0.15% 1080 pellets and mortality rates were similar (25%) for both concentrations of 1080. The authors also found that pre-feeding with non-toxic pellets did not improve the acceptance of 0.15% 1080 pellets by mice.

Based on the marked avoidance of 1080 by mice, O'Connor et al. (2005) recommended that 1080 should not be used for mouse control operations until new methods are developed to improve 1080 bait acceptance by mice.

*Other factors*

Parkes (1991) noted that the when 10% 1080 gel with a carbopol carrier was applied to mahoe leaves, the baits had a maximum life of about 60 days because phytotoxicity caused most leaves to absciss within 46 days. When mahoe leaves were smeared with 10% 1080 gel in a petrolatum carrier, the baits could remain effective as baits for at least 110 days, after which time most leaves had abscissed. However, abscissed leaves could remain toxic to animals that eat leaf-fall for at least 300 days.

### 6.2.3. What is the latent period between bait ingestion and onset of symptoms?

The latent period is hours. Possums receiving a sub-lethal dose of 1080 have been known to develop bait shyness (O'Connor and Matthews, 1999; Ogilvie et al., 2000) and this can persist for at least three years (O'Connor and Matthews, 1999). Conditioned food aversion to diets containing 1080 has been reported in rats (Nachman and Hartley, 1975).

Note: A short latent period increases the likelihood of the target pest developing poison shyness.

### 6.2.4. What field evidence is there that this pesticide use causes a population decline of the target pest species at sites where it is used?

*Possums*

*Aerially distributed 1080 cereal pellets*

The percentage kills obtained during aerial operations using 0.15% 1080 cereal pellets between 2010 and 2017 are presented in Table 36. The mean percentage kill was 89.1% (±2.0% s.e., n=37). The results for earlier operations are in Appendix 1.

The percentage kills obtained during aerial operations using 0.08% 1080 cereal pellets are presented in Table 37. For non-prefed aerial operations using 0.08% cereal pellets the mean kill was 69.1% (±10.4% s.e., n=10). The mean kill for prefed aerial operations using 0.08% cereal pellets was 82.2% (n=1).

**Table 36.** The percentage possum kill for aerial operations using 0.15% 1080 cereal pellets.

| Kill | Location | Sowing Rate (kg ha$^{-1}$) | | Ref. |
|---|---|---|---|---|
| | | Prefeed | Toxic | |
| 95.6% | Willowflat Forest, Hawke's Bay, Oct 2021 | 1.5 (Prodeer, 6g pellets) | 2 (Prodeer, 12g pellets, 13 days later) | Morriss and Gormley 2022 |
| 100% | Molesworth and Muller Stations, June 2021 | 0.8-1.0 (Prodeer, 6g pellets) | 0.8-2 (Prodeer, 6g pellets, 19-21 days later) | Morriss et al 2021 |
| 98.6% | Upper Awatere South 2019 | 1 (Pestex®, 6g) | 2 (Pestex®, 6g, 19-20 days later) | Morriss et al 2019 |
| 100% | Clarence West/Waiautoa 2019 | 1.0 (Pestex ®DR, 6g) | 2 (Pestex ®DR, 6g, 17-18 days later) | Morriss et al 2019 |
| 100% | Otahu, Coromandel, Nov 2017 | 1.5 (6g pellets) | 2 (12g #7 pellets, 21 days later) | 1718HAU 01 |
| 100% | Hollyford BfoB, Oct 2017 | 1 (6g pellets) | 2 (12g RS5 pellets, 13 days later) | 1718TEA 01 |
| 97.5% | Papakai, Coromandel, Oct 2017 | 1.5 (6g pellets) | 2 (12g #7 pellets, 19 days later) | 1718WH T04 |

| | | | | |
|---|---|---|---|---|
| 95.2% | Moehau, Coromandel, Oct 2017 | 1.5 (6g pellets) | 2 (12g #7 pellets, 26-40 days later) | 1718WH T01 |
| 88.6% | Cleddau BfoB, Sept 2017 | 1 (6g pellets) | 2 (12g RS5 pellets, 16 days later) | 1718TEA 02 |
| 94.3% | Rotoehu Forest, Sept 2017 | 1.5 (6g pellets) | 2.5 (12g #7 pellets, 8 days later) | 1718TAU 01 |
| 94.0% | Whareorino, Jul 2017 | 1.5 (6g pellets) | 2 (12g #7 pellets, 14 days later) | 1617MPT 06 |
| 58.1% (est.) | Egmont NP, Dec 2016 | 1 (6g pellets) | 2 (6g RS5 pellets, 59 days later) | 1617TAR 01 |
| 100% | Waitutu BfoB, Nov 2016 | 1 (6g pellets) | 1 (12g RS5 pellets, 13 days later) | 1617TEA 01 |
| 85% | Tawarau Management Area, Oct 2016 | 1.5 (6g pellets) | 1.5 (12g #7 pellets, 24 days later) | 1617MPT 01 |
| 98.1% | Abel Tasman BfoB, Aug 2016 | 1.5 (6g pellets) | 3 (10g RS5 pellets, 25 days later) | 1718MO T06 |
| 66.7% | Kia Wharite Project - Mangapurua Block, Whanganui, Oct 2015 | 0.5 (6g pellets) | 0.5 (6g #7 pellets, 31 | 1516WH A01 |
| 91.1% | Mokaihaha Ecological Area, Rotorua, Aug 2015 | 2 (12g pellets) | 2 (12g #7 pellets, 15 days later) | 1516ROT 02 |
| 78.9% | Rotoiti BfoB, Dec 2014 | 1 (6g pellets) | 1 (6g RS5 pellets, 25 days later) | 1415STA 02 |
| 100% | Eglinton Valley BfoB, Dec 2014 | 1 (6g pellets) | 1 (12g RS5 pellets, 48 days later) | 1314TEA 05 |
| 73.7% | Matukituki BfoB Nov 2014 | 1 (6g pellets) | 2 (12g RS5 pellets, 26 days later) | 1415WA N01 |
| 91.1% | Lower Holyford BfoB, Nov 2014 | 1 (6g pellets) | 2 (12g RS5 pellets, 38 days later) | 1314TEA 06 |
| 99.9% | Iris Burn BfoB, Sept 2014 | 1 (6g pellets) | 2 (12g RS5 pellets, 8 days later) | 1415TEA 01 |

| | | | | |
|---|---|---|---|---|
| 98.6% | Waitutu BfoB, Aug 2014 | 1 (12g pellets) | 2 (12g RS5 pellets, 6 days later) | 1314TEA 07 |
| 93.1% | Pirongia FP, Aug 2014 | 2 (6g pellets) | 2 (12g RS5 pellets, 30 days later) | 1415WAI 02 |
| 63.6% | Project Kaka, Tararuas, Dec 2013 | 1 (6g pellets) | 1 (12g #7 pellets, 10 days later) | 1314WRP 02 |
| 67.7% | South Hurunui, Dec 2013 | 1 (6g pellets) | 2 (12g RS5 pellets, 21 days later) | 1314WM K03 |
| 87.1% | Poulter Valley, Dec 2013 | 1 (6g pellets) | 2 (12g RS5 pellets, 21 days later) | 1314WM K03 |
| 79% | Mataketake block 2, Haast, Nov 2013 | 1 (6g pellets) | 2 (12g RS5 pellets, 11 days later) | 1314SWS |
| 82% | Mataketake block 5, Haast, Nov 2013 | 1 (6g pellets) | 2 (12g RS5 pellets, 11 days later) | 1314SWS |
| 80.8% | Tennyson Inlet Reserve - Mt Stanley, Nov 2013 | 1 (6g pellets) | 1 (6g RS5 pellets, 13 days later) | 1314SND 02 |
| 94.0% | Waitaanga, Oct 2013 | 1 (8g pellets) | 2 (12g #7 pellets, 16 days later) | 1314TAR 10 |
| 80.5% | Waitaanga, Oct 2013 | 1 (8g pellets) | 1 (6g #7 pellets, 16 days later) | 1314TAR 10 |
| 100% | Central Coromandel-Papakai, Jun 2013 | 2 (12g pellets) | 2 (12g #7 pellets, Orange lure, 7 days later) | 1314HA U02 |
| 100% | Moehau, Jun 2013 | 2 (12g pellets) | 2 (12g #7 pellets, Orange lure, 6 days later) | 1314HA U01 |
| 100% | Te Kopia SR, Dec 2012 | 2 (6g pellets) | 2 (12g #7 pellets, 16 days later) | 1213ROT 03 |
| 75.2% | Waipoua Forest, Sept 2011 | 1 (6g pellets) | 2 (12g #7 pellets, 22 days later) | 1112KAU 01 |
| 94.4% | Waihaha Ecological Area, May 2011 | 1.5 (12g pellets) | 1.5 (12g #7 pellets, Orange lure, 19 days later) | 1112MPT 05 |

| | | | | |
|---|---|---|---|---|
| 95.3% | Project Kaka, Tararuas, Nov 2010 | 1.4 (6g pellets) | 2 (12g #7 pellets, 16 days later) | 11011PON20 |
| 95.1% | Ruahine Corner, Oct 2010 | 1.1 (8g pellets) | 2.03 (12g #7 pellets, 13 days later) | 1011PNT09 |
| 99.6% | Waitutu, Oct 2010 | 1 (12g pellets) | 2 (12g RS5 pellets, 26 days later) | 1011MRH03 |
| 100% | Tawarau, Aug 2010 | 2 (12g pellets) | 2 (12g RS5 pellets, 33 days later) | 1011MPT02 |

**Table 37.** The percentage possum kill for aerial operations using 0.08% 1080 cereal pellets.

| Kill | Location | Sowing Rate (kg ha$^{-1}$) | | Ref. |
|---|---|---|---|---|
| | | Prefeed | Toxic | |
| 100% | Station Creek A Trial, Jul 2006 | - | 5 (12g #7 pellets) | Josh Kemp pers. comm. |
| 82.2% | Station Creek B Trial, Jul 2006 | 2 (12g pellets) | 5 (12g #7 pellets, 7 days later) | Josh Kemp pers. comm. |
| 0% | Mapara, October 1992 | - | 8 | Spurr (1993) |
| 89% | Isolated Hill SR Nelson August 1992 | - | 4 | Spurr (1993) |
| 96% | Titirangi Reserve Wanganui June 1992 | - | 5 | Spurr (1993) |
| 50% | Puketi Forest Northland March 1992 | - | 5 | Spurr (1993) |
| 32% | Mapara October 1991 | - | 5 | Spurr (1993) |
| 91% | Whitecliffs Wanganui July 1991 | - | 6 | Spurr (1993) |
| 61% | Waipapa EA June 1991 | - | 10 | Spurr (1993) |
| 79% | Mapara September 1990 | - | 8 | Spurr (1993) |
| 93% | Rangitoto Island October 1990 | - | 12 | Spurr (1993) |

*Aerially distributed 1080 carrots*

The mean percentage possum kill for operations using 0.8 g $kg^{-1}$ 1080 carrots (Table 38) is 91.1% (±1.4% s.e., n=7).

Table 39 lists aerial operations using 1.5 g $kg^{-1}$ 1080 carrots where the percentage kill could be calculated. The mean kill for these operations was 93.7% (n=4).

**Table 38.** The percentage possum kill for aerial operations using 0.8 g $kg^{-1}$ 1080 carrot.

| Kill | Location | Sowing Rate (kg $ha^{-1}$) | | Ref. |
|---|---|---|---|---|
| | | Prefeed | Toxic | |
| 93.4% | Te Kopia SR, 11-25/7/2006 | 2 (6g baits) | 5 (6g baits, 12 days later) | 0607ROT01 |
| 91.8% | Whirinaki Rata Block 30/8-8/9/2005 | 3 | 5 (8 days later) | 0506RAN01 |
| 87.8% | Hunua Ranges, 7-8/9/2001 | 5 | 5 | 0203AKD13 |
| 86% | Otupaka EA, 17-18/05/2000 | 5 | 10 (6g baits) | 0304RAN08 |
| 96.0% | Paeroa Range, 18/08/1999 | 5 | 10-15 (6g baits) | 0304ROT05 |
| 88.4% | Marokopa/Tawerau, 5/7/1998 | 5 | 5 (6g baits) | 0203MPT08 |
| 94.2% | Marokopa/Tawerau, 5/7/1998 | 5 | 10 (6g baits) | 0203MPT08 |

**Table 39.** The percentage possum kill for aerial operations using 1.5 g $kg^{-1}$ 1080 carrot.

| Kill | Location | Sowing Rate (kg $ha^{-1}$) | | Ref. |
|---|---|---|---|---|
| | | Prefeed | Toxic | |
| 98.1% | Matakuhia, Tataraakina, July 2003 | 5 | 5 (6g baits) | Nugent et al. (2004) |

| | | | | |
|---|---|---|---|---|
| 96.3% | Wakeman's Block, Tataraakina, July 2003 | 5 | 5 (6g baits with EDR deer repellent ) | Nugent et al. (2004) |
| 86.6-100% | Hampden, North Otago, 28/6/2002 | 2 | 2 (6g baits) | Lorigan et al. (2002) |
| 92.5% | Lake Okataina SR, 27/7/1999 | 5 | 12 (6g baits) | 0304ROT04 |

*1080 cereal pellets in bait stations*

Table 40 contains the percentage possum kills for bait station operations using 0.15% 1080 cereal pellets. The mean kill for these operations was 93.3% (±1.9% s.e., n=8).

**Table 40.** The percentage possum kill for 0.15% 1080 cereal pellets in bait stations.

| Kill | Location | Method | Ref. |
|---|---|---|---|
| 83.7% | Opuiaki, Sept-Oct 2009 | 100 x 100 m grid, 2 prefeeds (600g per bait station), 1 toxic fill (300gbait per station) | 0800TAU01 |
| 95% | Fox Valley, Apr-May 2008 | 100 x 200 m grid, 2 prefeeds (460g per bait station), 1 toxic fill (460g bait per station) | 0809SWS04 |
| 88.9% | Fox Valley, July 2007 | 100 x 200 m grid, 2 prefeeds (500g per bait station), 1 toxic fill (500g bait per station) | 0809SWS04 |
| 97.1% | Rotoehu EA, Oct-Nov 2007 | 1 bait station/ha, 2 prefeeds (1500g per bait station), 1 toxic fill (700g bait per station) | 0708ROT03 |
| 96.2% | Mokaihaha EA, Oct 2001 | 1 bait station/ha, 3 prefeeds, 1 toxic fill (1500g bait per station) | 0304ROT06 |
| 94.8% | Minganui Faces, Oct 1999 | 0.53 bait stations/ha, 3 prefeeds, 1 toxic fill (750g bait per station) | 0304RAN12 |
| 100% | Kaharoa CA, Jan 1997 | 0.25 bait stations/ha, 3 prefeeds, 1 toxic fill (1000g bait per station) | 0304ROT09 |
| 90.6% | Minganui Faces, Nov 1996 | 0.53 bait stations/ha, 3 prefeeds, 1 toxic fill | 0304RAN13 |

*Handlaid 1080 cereal pellets*

The mean percentage possum kill for operations using handlaid 0.15% 1080 cereal pellets (Table 41) is 88.8% (±4.7% s.e., n=6).

**Table 41.** The percentage possum kill for operations using handlaid 0.15% 1080 cereal pellets.

| Kill | Location | Sowing Rate (kg ha$^{-1}$) | | Ref. |
|---|---|---|---|---|
| | | Prefeed | Toxic | |
| 91.7% | Stewart Island, Dec 07 – Jan 2008 | No | Not specified | 0809SIS02 |
| 100% | Colenso Basin, Ruahines, Sept-Oct 2007 | 2 (6g pellets) | 1.5 (12g pellets, 31 days later) | 0708PNT17 |
| 66.7% | Awarua, 3/3/2000 | | 0.4 (8g pellets, traps and Feratox also used) | 0203SWS30 |
| 90.6% | Fox Valley, 23/9/1999 | | 0.5 (8g pellets, traps also used) | 0203SWS34 |
| 94.6% | Abbey Rocks B, 2/6/1999 | | 0.5 (6g pellets, traps also used) | 0203SWS28 |
| 89.3% | Abbey Rocks C, 3/6/1999 | | 0.5 (6g pellets, traps also used) | 0203SWS28 |

*1080 cereal pellets in bait bags*

The percentage kills obtained following the use of 1080 cereal pellets in bait bags are presented in Table 42. The mean is 82.9%.

**Table 42.** The percentage possum kill for operations using 0.15% 1080 cereal pellets in bait bags.

| Kill | Location | Method | Ref. |
|---|---|---|---|
| 96% | Stewart Island, Oct-Nov 2008 | 20 x 100 m grid (not prefed) | 0809SIS03 |
| 97.6% | Pegasus/Tin Range Oct-Nov 2004 | Grid (not prefed) | 0405SIS04 |
| 85% (Range: 68.8%-100%) | Paterson Inlet Blocks, Oct 2003 | Bags put on recent sign (not prefed) | 0304SIS19 |

| | | | |
|---|---|---|---|
| ~92.6% | Mt Anglem/Hananui, Oct-Nov 2003 | 4.3-5.3 bait bags/ha, 1 prefeed, 2 toxic bag placements (6g baits). | 0304SIS20 |
| 53.1-73.2% | Warawara Forest Blocks, Mar-Jun 2003 | Bags put on recent sign (not prefed) | 0203KAI12 |

*1080 paste in bait bags*

See Table 43 for the percentage kill during operations using 0.15% 1080 paste in bait bags.

**Table 43.** The percentage possum kill for operations using 0.15% 1080 paste in bait bags.

| Kill | Location | Method | Ref. |
|---|---|---|---|
| 56.4% | Minganui Faces, Sept-Oct 2000 | Bags placed on a 75m x 10m grid, not prefed. | 0304RAN09 |

*Handlaid 1080 paste*

The mean percentage possum kill for operations using handlaid 0.15% 1080 paste under good weather conditions is 83.1% (n=5) (Table 44).

**Table 44.** The percentage possum kill for operations using handlaid 0.15% 1080 paste.

| Kill | Location | Method | Ref. |
|---|---|---|---|
| ~84% | Rangitikei Snail Area, Kaimanawa FP, 2000-2002 | Prefed, set on recent sign. | 0304RAN09 |
| 86.6% | Mortens, Canterbury | Spits 5-6m apart around forest edge, not prefed | Ross & Henderson (2003) |
| 84.7% | Steventon, Canterbury | Spits 5-6m apart around forest edge, not prefed | Ross & Henderson (2003) |
| 84% (Range : 50-96%) | 9 sites around NZ (1996-98) – good weather conditions | Spits 5m apart around forest edge, prefed | Thomas & Morgan (1998) |
| 34% (Range | 4 sites (1997) - where rain washed out baits | Spits 5m apart around forest edge, prefed | Thomas & Morgan (1998) |

| | | | |
|---|---|---|---|
| : 0-59%) | or hot weather dried out the baits | | |
| 76% (Range : 68-93%) | 9 sites around NZ (1996-98) – good weather conditions | Spits 5m apart around forest edge, not prefed | Thomas & Morgan (1998) |
| 30% (Range : 11-46%) | 4 sites (1997) where rain washed out baits or hot weather dried out baits. | Spits 5m apart around forest edge, not prefed | Thomas & Morgan (1998) |

### *Rats*

*Aerially distributed 1080 cereal pellets*

The percentage rat kills obtained during aerial operations using 0.15% 1080 cereal pellets between 2010 and 2015 are presented in Table 45. Based on this data, the mean kill for prefed operations is 93.0% (n=87). The results for earlier operations are presented in Appendix 1.

The percentage rat kill for the aerial operations using 0.08% cereal pellets is presented in Table 46.

**Table 45.** The percentage rat kill for aerial operations using 0.15% 1080 cereal pellets.

| Kill | Location | Sowing Rate (kg ha$^{-1}$) | | Ref. |
|---|---|---|---|---|
| | | Prefeed | Toxic | |
| 100% | Northern Ruahine BfoB, Nov 2017 | 2 (6g pellets) | 2 (6g RS5 pellets, 25 days later) | 1718PNT01 |
| 100% | Kahurangi West and Kahurangi North BfoB, Nov 2017 | 1.5 (6g pellets) | 1.5 (6g RS5 pellets, 28 days later) | 1718GDB01 |
| 100% | Hollyford BfoB, Oct 2017 | 1 (6g pellets) | 2 (12g RS5 pellets, 13 days later) | 1718TEA01 |
| 97.4% | Abel Tasman NP, Oct 2017 | 2 (6g pellets) | 2 (6g RS5 pellets, 7 days later) | 1718MOT09 |
| 95.2% | Moehau, Coromandel, Oct 2017 | 1.5 (6g pellets) | 2 (12g #7 pellets, 26-40 days later) | 1718WHT01 |

| | | | | |
|---|---|---|---|---|
| 100% | Matemateaonga, Whanganui, Oct 2017 | 0.5 (6g pellets) | 0.5 (6g RS5 pellets, 30 days later) | 1718WHA01 |
| 97.4% | Waitotara, Whanganui, Oct 2017 | 0.5 (6g pellets) | 0.5 (6g RS5 pellets, 30 days later) | 1718WHA01 |
| 100% | East & West Matukituki BfoB, Oct 2017 | 1.5 (6g pellets) | 1.5 (6g RS5 pellets, 9 days later) | 1718CNO06 |
| 88.6% | Cleddau BfoB, Sept 2017 | 1 (6g pellets) | 2 (12g RS5 pellets, 16 days later) | 1718TEA02 |
| 96.4% | Rotoehu Forest, Sept 2017 | 1.5 (6g pellets) | 2.5 (12g #7 pellets, 8 days later) | 1718TAU01 |
| 95.7% | Whitecliffs/Parininihi, Sept 2017 | 3 (6g pellets) | 3 (6g RS5 pellets, 29 days later) | 1718TAR02 |
| 90.6% | Dart/Routeburn BfoB, Sept 2017 | 1.5 (6g pellets) | 1.5 (6g RS5 pellets, 7 days later) | 1718WAK01 |
| 100% | Whirinaki Te Pua a Tane BfoB, Sept 2017 | 1.5 (6g pellets, with EDR) | 1.5 (6g RS5 pellets with EDR, 16 days later) | 1718WHK01 |
| 100% | Whirinaki Te Pua a Tane BfoB, (EDR Block), Sept 2017 | 1.5 (6g pellets, no EDR) | 1.5 (6g RS5 pellets no EDR, 16 days later) | 1718WHK01 |
| 100% | Paparoa North BfoB, Oct 2017 | 1.5 (6g pellets) | 3 (12g RS5 pellets, 9 days later) | 1718BUL01 |
| 100% | ZIP Jackson Arawhata #1, Jul 2017 | 2 (6g pellets, 2 prefeeds 11 days apart, Orange lure) | 4 (6g RS5 pellets, 19 days later, Orange lure) | 1718SWS01 |
| 100% | Whareorino, Jul 2017 | 1.5 (6g pellets) | 2 (12g #7 pellets, 14 days later) | 1617MPT06 |

| | | | | |
|---|---|---|---|---|
| 100% | Makarora-Wilkins BfoB, Feb 2017 | 1 (6g pellets) | 1 (6g RS5 pellets, 7 days later) | 1617CNO04 |
| 86.4% | Beresford Range (Catlins) BFOB Dec 2016 | 1 (6g pellets) | 1 (6g RS5 pellets, 41 days later) | 1617MRH03 |
| 91.8% | Pukaha/Mt Bruce, Dec 2016 | 1 (6g pellets) | 1 (6g RS5 pellets, 9 days later) | 1617WRP03 |
| 96.8% | Landsborough BfoB, Dec 2016 | 2 (6g pellets) | 2 (6g RS5 pellets, 32 days later) | J. Kemp pers. comm, 1617SWS04 |
| 85.4% (est.) | Egmont NP, Dec 2016 | 1 (6g pellets) | 2 (6g RS5 pellets, 59 days later) | 1617TAR01 |
| 97.4% (est.) | Waitutu BfoB, Nov 2016 | 1 (6g pellets) | 1 (12g RS5 pellets, 13 days later) | J. Kemp pers. comm, 1617TEA01 |
| 94.1% | Te Maruia BfoB, Nov 2016 | 1 (6g pellets) | 1 (6g RS5 pellets, 9 days later) | 1617GRY01 |
| 100% | Waikaia Forest BfoB, Nov 2016 | 1 (6g pellets) | 1 (6g RS5 pellets, 26 days later) | 1617MRH02 |
| 100% | Hawdon BfoB, Nov 2016 | 2 (6g pellets) | 2 (6g RS5 pellets, 7 days later) | 1617WMK01 |
| 0% | Poulter BfoB, Nov 2016 | 2 (6g pellets) | 2 (6g RS5 pellets, 7 days later) | 1617WMK01 |
| 99.5% (est.) | Wangapeka, Oct 2016 | 1.5 (6g pellets) | 1.5 (6g RS5 pellets, 38 days later) | J. Kemp pers. comm, 1617MOT01 |
| 100% (est.) | Clinton BfoB, Oct 2016 | 1 (6g pellets) | 1 (6g RS5 pellets, 26 days later) | J. Kemp pers. comm, 1617TEA04 |
| 100% | Whareorino Frog Protection Area Oct 2016 | 1.5 (6g pellets) | 1.5 (6g Whanganui #7 pellets, 24 days later) | 1617MPT01 |

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|---|---|---|---|---|
| 84.9% (est.) | Dart-Caples BfoB, Oct 2016 | 1 (6g pellets) | 1 (6g RS5 pellets, 29 days later) | J. Kemp pers. comm, 1617WAK01 |
| 80.7% (est.) | Eglington Valley BfoB, Oct 2016 | 1 (6g pellets) | 2 (12g RS5 pellets, 25 days later) | J. Kemp pers. comm, 1617TEA05 |
| 96.3% (est.) | Oparara BfoB D+E, Sept 2016 | 1.5 (6g pellets) | 1.5 (6g RS5 pellets, 10 - 13 days later) | J. Kemp pers. comm, 1617MOT01 |
| 88.7% (est.) | Oparara BfoB A, Sept 2016 | 1.5 (6g pellets) | 1.5 (6g RS5 pellets, 10 - 13 days later) | J. Kemp pers. comm, 1617MOT01 |
| 100% (est.) | Arthur-Sinbad BfoB, Sept 2016 | 1 (6g pellets) | 2 (12g RS5 pellets, 42 days later) | J. Kemp pers. comm, 1617TEA02 |
| 100% | Okarito South, Sept 2016 | 1.5 (6g pellets) | 1.5 (6g RS5 pellets, 11 days later) | J. Kemp pers. comm, 1617SWS03 |
| 90.7% (est.) | Kepler BfoB, Sept 2016 | 1 (6g pellets) | 2 (12g RS5 pellets, 12 days later) | J. Kemp pers. comm, 1617TEA03 |
| 99.1% (est.) | Haast Kiwi Sanctuary BfoB, Aug 2016 | 1.5 (6g pellets) | 3 (12g RS5 pellets, 11 days later) | J. Kemp pers. comm, 1617SWS01 |
| 100% (est.) | Arawhata BfoB, Aug 2016 | 1.5 (6g pellets) | 3 (12g RS5 pellets, 11 days later) | J. Kemp pers. comm, 1617SWS01 |
| 100% (est.) | Abbey Rocks BfoB, Aug 2016 | 1.5 (6g pellets) | 1.5 (6g RS5 pellets, 12 days later) | J. Kemp pers. comm, 1617SWS02 |
| 100% | Waipapa Pureora BfoB Jul 2016 | 1 (6g pellets) | 2 (12g #7 pellets, 24 days later) | 1617MPT04 |
| 87.3% | Kia Wharite Project - Mangapurua Block, Whanganui, Oct 2015 | 0.5 (6g pellets) | 0.5 (6g #7 pellets, 31 | 1516WHA01 |

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|---|---|---|---|---|
| 100% | Mokaihaha Ecological Area, Rotorua, Aug 2015 | 2 (12g pellets) | 2 (12g #7 pellets, 15 days later) | 1516ROT02 |
| 97.9% | Mt Bruce/Pukaha, Wairarapa, Jul 2015 | 1 (12g pellets) | 1 (12g #7 pellets, 12 days later) | 1516WRP01 |
| 100% | South Branch Hurunui BfoB, Feb 2015 | 1.5 (6g pellets) | 1.5 (6g RS5 pellets, 6 days later) | 1314WMK04 |
| 100% | Poulter Valley BfoB, Feb 2015 | 1.5 (6g pellets) | 1.5 (6g RS5 pellets, 6 days later) | 1415WMK05 |
| 76.4% | Rotoiti BfoB, 170m flight path, Dec 2014 | 1 (6g pellets) | 1 (6g RS5 pellets, 25 days later) | 1415STA02 |
| 100% | Rotoiti BfoB, 150m flight path, Dec 2014 | 1 (6g pellets) | 1.18 (6g RS5 pellets, 25 days later) | 1415STA02 |
| 38.5% | Hawdon & Andrews Valleys BfoB, Dec 2014 | 1 (6g pellets) | 1 (6g RS5 pellets, 8 days later) | 1415WMK01 |
| 100% | Eglinton Valley BfoB, Dec 2014 | 1 (6g pellets) | 1 (12g RS5 pellets, 48 days later) | 1314TEA05 |
| 100% | Blue Mountains BfoB, Dec 2014 | 1 (6g pellets) | 1.5 (6g RS5 pellets, 25 days later) | 1314MRH03 |
| 100% | Abbey Rocks, Nov 2014 | 1 (6g pellets) | 1 (6g RS5 pellets, 13 days later) | 1314SWS06 |
| 100% | Landsborough/Clark BfoB, Nov 2014 | 1 (6g pellets) | 1 (6g RS5 pellets, 15 days later) | 1314SWS04 |
| 87.2% | Tennyson Inlet Reserve - Mt Stanley BfoB, Nov 2014 | 1 (6g pellets) | 1 (6g RS5 pellets, 44 days later) | 1314SND03 |
| 100% | Catlins BfoB, Nov 2014 | 1 (6g pellets) | 1.1 (6g RS5 pellets, 15 days later) | 1415MRH01 |
| 100% | Oparara BfoB Kahurangi NP, Nov 2014 | 1 (6g pellets) | 2 (12g RS5 pellets, 22 days later) | 1415GDB04 |

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|---|---|---|---|---|
| 77.1% | Pukaha Mt Bruce, Nov 2014 | 1 (6g pellets) | 1 (6g RS5 pellets, 16 days later) | 1415WRP04 |
| 100% | Mataraua/Waipoua, Nov 2014 | 1 (6g pellets) | 2 (12g #7 pellets, 25 days later) | 1415KAU02 |
| 96.2% | Cobb BfoB, Kahurangi NP, Nov 2014 | 1 (6g pellets) | 2 (12g RS5 pellets, 24 days later) | 1415GDB02 |
| 100% | Lower Holyford BfoB, Nov 2014 | 1 (6g pellets) | 2 (12g RS5 pellets, 38 days later) | 1314TEA06 |
| 100% | Clinton BfoB, Nov 2014 | 1 (6g pellets) | 2 (12g RS5 pellets, 24 days later) some EDR deer repellent used | 1415TEA02 |
| 98.8% | Anatoki BfoB Kahurangi NP, Oct 2014 | 1 (6g pellets) | 1 (6g RS5 pellets, 16 days later) | 1415GDB01 |
| 60.9% | Gouland BfoB Kahurangi NP, Oct 2014 | 1 (6g pellets) | 2 (12g RS5 pellets, 14 days later) | 1314GDB01 |
| 77.5% Gibbs | Wangapeka BfoB Kahurangi NP, Oct 2014 | 1 (6g pellets) | 1 (6g RS5 pellets, 14 days later) | 1415MOT05 |
| 73.3% Fyfe | Wangapeka BfoB Kahurangi NP, Oct 2014 | 1 (6g pellets) | 2 (12g RS5 pellets, 14 days later) | 1415MOT05 |
| 38.8% | Te Maruia North BfoB Oct 2014 | 1 (6g pellets) | 1 (6g RS5 pellets, 24 days later) | 1314GRY03 |
| 100% | Iris Burn BfoB, Sept 2014 | 1 (6g pellets) | 2 (12g RS5 pellets, 8 days later) | 1415TEA01 |
| 100% | Kia Wharite – Matemateaonga & Waitotara, Sept 2014 | 0.5 (8g pellets) | 0.5 (8g RS5 pellets, 9 days later) | 1415WHA01 |
| 100% | Waitutu BfoB, Aug 2014 | 1 (12g pellets) | 2 (12g RS5 pellets, 6 days later) | 1314TEA07 |

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|---|---|---|---|---|
| 96.8% | Waikaia BfoB Aug 2014 | 1 (6g pellets) | 1 (6g RS5 pellets, 7 days later) | 1314MRH02 |
| 97.3% | Abel Tasman BfoB, Aug 2014 | 1 (6g pellets) | 2 (12g RS5 pellets, 7 days later) | 1415MOT01 |
| 91.7% | Tongariro Forest, Aug 2014 | 0.75 (6g pellets) | 0.75 (6g RS5 pellets, 9 days later) | 1415RUA01 |
| 91.7% | Dart, Routeburn, Caples BfoB, Aug 2014 | 1 (6g pellets) | 1 (6g RS5 pellets, 5 days later) | 1415WAK01 |
| 64.6% | Te Kauri, Pirongia FP, Aug 2014 | 2 (6g pellets) | 2 (12g RS5 pellets, 30 days later) | 1415WAI02 |
| 100% | Project Kaka, Tararuas, Dec 2013 | 1 (6g pellets) | 1 (12g #7 pellets, 10 days later) | 1314WRP02 |
| 100% | Mataketake block 2, Haast, Nov 2013 | 1 (6g pellets) | 2 (12g RS5 pellets, 11 days later) | 1314SWS |
| 100% | Mataketake block 5, Haast, Nov 2013 | 1 (6g pellets) | 2 (12g RS5 pellets, 11 days later) | 1314SWS |
| 70.1% | Whitecliffs/Parininihi, Nov 2013 | 1 (8g pellets) | 2 (12g #7 pellets, 47 days later) | 1314TAR09 |
| 100% | Tennyson Inlet Reserve - Mt Stanley, Nov 2013 | 1 (6g pellets) | 1 (6g RS5 pellets, 13 days later) | 1314SND02 |
| 92.8% - 100% | Catlins Maclennan Forest, Aug 2013 | 0.75 (6g pellets) | 1 (12g RS5 pellets, 9 days later) | 1314COT02 |
| 97.5% | Moehau, Jun 2013 | 2 (12g pellets) | 2 (12g #7 pellets, Orange lure, 6 days later) | 1314HAU01 |
| 100% | Hawdon Valley, Athurs Pass NP, Dec 2013 | 1 (6g pellets) | 2 (12g RS5 pellets, 15 days later) | 1213WMK02 |

| | | | | |
|---|---|---|---|---|
| 100% | Lewis Pass – Station Creek, Nov 2012 | 1 (6g pellets) | 1 (6g RS5 pellets, 7 days later) | 1213GRY02 |
| 95.8% | Tongariro Forest, Sept 2011 | 1.5 (6g pellets) | 2 (12g #7 pellets, Orange lure+EDR, & cinnamon 20 days later) | 1112RUA02 |
| 98.2% | Waipoua Forest, Sept 2011 | 1 (6g pellets) | 2 (12g #7 pellets, 22 days later) | 1112KAU01 |
| 97.3% | Waihaha Ecological Area, May 2011 | 1.5 (12g pellets) | 1.5 (12g #7 pellets, Orange lure, 19 days later) | 1112MPT05 |
| 94.7% | Project Kaka, Tararuas, Nov 2010 | 1.4 (6g pellets) | 2 (12g #7 pellets, 16 days later) | 11011PON20 |

**Table 46.** The percentage rat kill for aerial operations using 0.08% 1080 cereal pellets.

| Kill | Location | Sowing Rate (kg ha$^{-1}$) | | Ref. |
|---|---|---|---|---|
| | | Prefeed | Toxic | |
| 100% | Whakapohai E, Jan 2007 | 5 (6g baits) | 2 (12g #7 pellets, 5 days later) | J Kemp pers. comm. |
| 1.2% | Station Creek A Trial, Jul 2006 | - | 5 (12g #7 pellets, 5 days later) | J Kemp pers. comm. |
| 96.3% | Station Creek B Trial, Jul 2006 | 2 (12g pellets) | 5 (12g #7 pellets, 7 days later) | J Kemp pers. comm. |
| <70% | Mapara, Oct 1992 | - | 8 | Bradfield. (1993) |
| 80% | Mapara, Oct 1991 | - | 8 | Bradfield. (1993) |
| 100% | Mapara, Sept 1990 | - | 8 | Bradfield. (1993) |

*Handlaid 1080 cereal pellets*

During the Rotoiti Battle for our Birds (BfoB) in December 2014 part of the operational area was handlaid with 0.15% 1080 pellets. The area was aerially prefed at 1 kg $ha^{-1}$ (6g pellets). 25 days later 6g RS5 toxic pellets were hand broadcast at 1 $ha^{-1}$. The operation achieved a 66.7% rat kill (Pestlink reference: 1415STA02).

A 61% rat kill was achieved at Beam Head, Northland, in October 2008 when 0.08% 1080 rodent pellets were laid in clusters 50 metres apart along an existing track system. The operational area was prefed at a rate of 1 kg $ha^{-1}$ and 30 days later the toxic bait was laid at a rate of 0.8 kg $ha^{-1}$ (Pestlink reference: 0809WNG05).

*1080 cereal pellets in bait stations*

Table 47 contains the percentage rat kills for bait station operations using 0.15% 1080 cereal pellets.

**Table 47.** The percentage rat kill for 0.15% 1080 cereal pellets in bait stations.

| Kill | Location | Method | Ref. |
|---|---|---|---|
| 59.5% | Aislabies Block, Kaharoa, Sept 2012 | Bait stations 100m arpart along ridges/spurs. 1 prefeed (1500g per bait station), 1 toxic fill (500g bait per station) | 1213ROT02 |
| 30.4% | Mataraua, Jan 2010 | 120 x 100 m bait station grid, 1 prefeed (200g per bait station), 1 toxic fill (100g bait per station) | 0910KAU04 |
| 91.3% | Mataraua, Oct 2009 | 120 x 100 m bait station grid, 2 prefeeds (1000g per bait station), 1 toxic fill (500g bait per station) | 0910KAU04 |
| 97.0% | Opuiaki, Sept-Oct 2009 | 100 x 100 m bait station grid, 2 prefeeds (600g per bait station), 1 toxic fill (300g bait per station) | 0800TAU01 |
| 91.2% | Waipapa East, Waipapa EA, Aug 2000 | 150 x 150 m bait station grid, 2 prefeeds, 1 toxic fill | Matthew et al. (2004) |
| 87.7% | Waipapa North, Waipapa EA, Aug 2000 | 150 x 150 m bait station grid, 2 prefeeds, 1 toxic fill | Matthew et al. (2004) |
| 85.5% | Waipapa South, Waipapa EA, Aug 2000 | 150 x 150 m bait station grid, 2 prefeeds, 1 toxic fill | Matthew et al. (2004) |
| 100% | Trounson Kauri Park, Nov 1996 | 100 x 100 m bait station grid, 4 prefeeds, 1 toxic fill | Gillies et al. (2003) |

### *Mice*

*Aerially distributed 1080 cereal pellets*

The percentage mice kills obtained during aerial operations using 0.15% 1080 cereal pellets are presented in Table 48. Based on this data, the mean kill for prefed operations is 78.3% (n=26). The percentage mouse kill for the aerial operations using 0.08% cereal pellets is presented in Table 49.

**Table 48.** The percentage mouse kill for aerial operations using 0.15% 1080 cereal pellets.

| Kill | Location | Sowing Rate (kg ha$^{-1}$) | | Ref. |
|---|---|---|---|---|
| | | Prefeed | Toxic | |
| 96.6% | East & West Matukituki BfoB, Oct 2017 | 1.5 (6g pellets) | 1.5 (6g RS5 pellets, 9 days later) | 1718CNO06 |
| 57.7% | Makarora-Wilkins BfoB, Feb 2017 | 1 (6g pellets) | 1 (6g RS5 pellets, 7 days later) | 1617CNO04 |
| 98.5% | South Branch Hurunui, Feb 2017 | 2 (6g pellets) | 2 (6 g RS5 pellets, 10 days later) | 1617WMK02 |
| 99.8% | Landsborough BfoB, Dec 2016 | 2 (6g pellets) | 2 (6g RS5 pellets, 32 days later) | J. Kemp pers. comm, 1617SWS04 |
| 50% (est.) | Clinton BfoB, Oct 2016 | 1 (6g pellets) | 1 (6g RS5 pellets, 26 days later) | J. Kemp pers. comm, 1617TEA04 |
| 100% (est.) | Arthur-Sinbad BfoB, Sept 2016 | 1 (6g pellets) | 2 (12g RS5 pellets, 42 days later) | J. Kemp pers. comm, 1617TEA02 |
| 0% (est.) | Kepler BfoB, Sept 2016 | 1 (6g pellets) | 2 (12g RS5 pellets, 12 days later) | J. Kemp pers. comm, 1617TEA03 |
| 97.3% (est.) | Abbey Rocks BfoB, Aug 2016 | 1.5 (6g pellets) | 1.5 (6g RS5 pellets, 12 days later) | J. Kemp pers. comm, 1617SWS02 |

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|---|---|---|---|---|
| 0% (est.) | Eglington Valley BfoB, Oct 2016 | 1 (6g pellets) | 2 (12g RS5 pellets, 25 days later) | J. Kemp pers. comm, 1617TEA05 |
| 60% | Beresford Range (Catlins) BFOB Dec 2016 | 1 (6g pellets) | 1 (6g RS5 pellets, 41 days later) | 1617MRH03 |
| 66% | Poulter Valley BfoB, Feb 2015 | 1.5 (6g pellets) | 1.5 (6 g RS5 pellets, 6 days later) | 1415WMK051 |
| 100% | Abbey Rocks, Nov 2014 | 1 (6g pellets) | 1 (6 g RS5 pellets, 13 days later) | 1314SWS06 |
| 81.1% | Matukituki BfoB Nov 2014 | 1 (6g pellets) | 2 (12 g RS5 pellets, 26 days later) | 1415WAN01 |
| 82.5% | Clinton BfoB, Nov 2014 | 2 (6g pellets) | 2 (12 g RS5 pellets, 24 days later) | 1415TEA02 |
| 100% | Catlins BfoB, Nov 2014 | 1 (6g pellets) | 1.1 (6 g RS5 pellets, 15 days later) | 1415MRH01 |
| 72.7% | Iris Burn BfoB, Sept 2014 | 1 (6g pellets) | 2 (12 g RS5 pellets, 8 days later) | 1415TEA01 |
| 50.0% | Dart, Routeburn, Caples BfoB, Aug 2014 | 1 (6g pellets) | 1 (6 g RS5 pellets, 5 days later) | 1415WAK01 |
| 92.0% | Waikaia BfoB Aug 2014 | 1 (6g pellets) | 1 (6 g RS5 pellets, 7 days later) | 1314MRH02 |
| 93.4% | Poulter Valley, Oct 2008 | 1 (6g pellets) | 2 (6g #7 pellets, 17 days later) | J Kemp pers. comm. |
| 100% | Pihanga, Nov 07 | 2 (12g pellets) | 2 (12g #7 pellets, 8 days later) | J Kemp pers. comm. |
| 86.2% | Parapara 07C Trial, May 2007 | - | 3 (12g RS5 pellets) | J Kemp pers. comm. |
| 37.3% | Parapara 07D Trial, May 2007 | - | 3 (12g #7 pellets) | J Kemp pers. comm. |

| | | | | |
|---|---|---|---|---|
| 97.0% | Parapara 07A Trial, May 2007 | 3 (6g pellets) | 3 (12g RS5 pellets, 43 days later) | J Kemp pers. comm. |
| 92.0% | Parapara 07B Trial, May 2007 | 3 (6g pellets) | 3 (12g #7 pellets, 43 days later) | J Kemp pers. comm. |
| 100% | Whakapohai A, Jan 2007 | 5 (6g pellets) | 2 (12g #7 pellets, 5 days later) | J Kemp pers. comm. |
| 66.7% | Whakapohai B, Jan 2007 | 2 (6g pellets) | 2.5 (12g #7 pellets, 5 days later) | J Kemp pers. comm. |
| 96.4% | Whakapohai C, Jan 2007 | 2 (6g pellets) | 2.5 (12g #7 pellets, 5 days later) | J Kemp pers. comm. |
| 86.0% | Whakapohai D, Jan 2007 | 1 (6g pellets) | 2.5 (12g #7 pellets, 5 days later) | J Kemp pers. comm. |

**Table 49.** The percentage mouse kill for aerial operations using 0.08% 1080 cereal pellets.

| Kill | Location | Sowing Rate (kg ha$^{-1}$) | | Ref. |
|---|---|---|---|---|
| | | Prefeed | Toxic | |
| 58% | Whakapohai E, Jan 2007 | 5 (6g pellets) | 2 (12g #7 pellets, 5 days later) | J Kemp pers. comm. |

*1080 cereal pellets in bait stations*

Table 50 contains the percentage mouse kills for bait station operations using 0.15% 1080 cereal pellets.

**Table 50.** The percentage mouse kill for 0.15% 1080 cereal pellets in bait stations.

| Kill | Location | Method | Ref. |
|---|---|---|---|
| 94% | Trounson Kauri Park, Nov 1996 | 100 x 100 m bait station grid, 4 prefeeds, 1 toxic fill | Gillies et al. (2003) |

## *Rabbits*

The majority of rabbit operations have operational targets based on the Modified Mclean Rabbit Infestation Scale. The Mclean Scale is not suitable for estimating

a percent kill because it is not linearly related to rabbit population density. However, during aerial 1080 carrot field trials by Landcare Research in Otago and Hawkes Bay between 2011 and 2014, based on pre- and post-control spotlight counts of rabbits, kills of greater than 90% were achieved. These operations were prefed twice and the toxic carrot was either broadcast or strip sown. The actual sowing rate varied depending on the pre-control estimate of rabbit density (Latham et al., 2015).

### *Wallabies*

The percentage kill of wallabies using aerially distributed 1.5 g $kg^{-1}$ 1080 pellets is presented in Table 51, in Table 52 for 1.5 g $kg^{-1}$ 1080 carrots and in Table 53 for handlaid 5% and 10% 1080 gels.

**Table 51.** The percentage wallaby kill for aerially distributed 1.5 g $kg^{-1}$ 1080 pellets.

| Kill | Location | Sowing Rate (kg $ha^{-1}$) | | Ref. |
|---|---|---|---|---|
| 96.9% | Rotoehu Forest, Sept 2017 | 1.5 (6g pellets) | 2.5 (12g #7 pellets, 8 days later) | 1718TAU01, & Commins (2017) |

**Table 52** The percentage wallaby kill for aerially distributed 1.5 g $kg^{-1}$ 1080 carrots.

| Kill | Location | Sowing Rate (kg $ha^{-1}$) | | Ref. |
|---|---|---|---|---|
| | | Prefeed | Toxic | |
| 93.1% | Okataina SR, 1999 (Dama wallabies) | 5 | 12 | 0304ROT04 |

**Table 53.** The percentage wallaby kill for handlaid 5% and 10% 1080 gel.

| Kill | Location | Method | Ref. |
|---|---|---|---|
| 86.2% | Okataina SR, 1988 (Dama wallabies) | 5-10 m x 50-100 m transects, 5 baited leaves/branch (5% 1080 gel) | Warburton (1990) |
| 91.3% | Tasman Smith SR, Hunter hills, 1983 (Bennett's wallabies) | 10 branches/ha, 25 baited leaves/branch (10% 1080 gel) | Warburton (1990) |

### *Deer*

The percentage kill of deer is presented in Table 54 for aerially distributed 1.5 g $kg^{-1}$ 1080 carrot is and in Table 55 for handlaid 10% 1080 gel.

**Table 54.** The percentage deer kill for aerially distributed 1.5 g $kg^{-1}$ 1080 carrots.

| Kill | Location | Sowing Rate (kg $ha^{-1}$) | | Ref. |
|---|---|---|---|---|
| | | Prefeed | Toxic | |
| 92% | Titiraupunga, 1997 | 5 | 15 | Fraser & Sweetapple (2000) |
| 34% | Pureora, 1994 | 5 | 15 | Fraser et al. (1995) |
| 42% | Pureora, 1994 | 15 | 15 | Fraser et al. (1995) |

**Table 55.** The percentage deer kill for handlaid 10% 1080 gel.

| Kill | Location | Method | Ref. |
|---|---|---|---|
| 79% | Hauhangaroa Range, 1997 | 2 branches/ha, 10 baited leaves/branch | Sweetapple (1997) |
| 80%+ | Stewart Island, 1981 | 2.5 branches/ha, 20 baited leaves/branch | Nugent (1990) |
| 100% | Stewart Island, 1981 | 5 branches/ha, 20 baited leaves/branch | Nugent (1990) |

### *Goats*

*10% 1080 gel (100 g kg-1 1080), handlaid*

The percentage kill of goats using handlaid 10% 1080 gel is presented in Table 56.

**Table 56.** The percentage kill of goats following the use of handlaid 10% 1080 gel.

| Kill | Location | Method | Ref. |
|---|---|---|---|
| 88% | Whitecliffs, Buller River, Jul 2007 | 2.2 branch/ha in preferred habitat, 10 - 20 baited leaves/branch | Anderson (2008) |
| 87% | Motu River, Jan 1986 | 1 branch/ha in preferred habitat, 20 baited leaves/branch | Veltman & Parkes (2002) |
| 97% | Motu River, March 1982 | 2.5 branches/ha, 20 baited leaves/branch | Parkes (1983) |

### *Stoats (bykill)*

*Aerially distributed 1080 cereal pellets*

The percentage by-kill of stoats during aerial 1080 operations is recorded in Table 57

**Table 57.** The percentage stoat bykill for aerial operations targetting rats, mice and possums with 0.15% 1080 cereal pellets.

| Stoat Bykill | Location | Kill Of Target Pest | | | Ref. |
|---|---|---|---|---|---|
| | | Possums | Rats | Mice | |
| 100% | Rainbow Valley (OSPRI treatment) 2024 | | 100% | 93.8% | Griffin et al 2024 |
| 87.8% | Whirinaki Te Pua a Tane BfoB (EDR Block), Sept 2017 | | 100% | | 1718WHK01 |
| 100% | Whirinaki Te Pua a Tane BfoB, Sept 2017 | | 100% | | 1718WHK01 |
| 100% | Makarora-Wilkins BfoB, Feb 2017 | | 100% | 57.7% | 1617CNO04 |
| 100% | Okarito South, Sept 2016 | | 100% | | 1617SWS03 |
| 100% | Kia Wharite Project - Mangapurua Block, Whanganui, Oct 2015 | 66.7% | 87.3% | | 1516WHA01 |
| 50.0% | Dart, Routeburn, Caples BfoB, Aug 2014 | | 100% | 100% | 1314SWS06 |
| 100% | Catlins BfoB, Nov 2014 | | 100% | 100% | 1415MRH01 |
| 100% | Tongariro Forest, Aug 2014 | | 91.7% | | 1415RUA01 |
| 90% | Project Kaka, Tararuas, Dec 2013 | 63.6% | 100% | | 1314WRP02 |
| 95.8% | Tongariro Forest, Sept 2011 | | 95.8% | | 1112RUA02 |

### *Feral cats (bykill)*

*Aerially distributed 1080 cereal pellets*

The percentage by-kill of feral cats during aerial 1080 operations is recorded in Table 58.

**Table 58.** The percentage feral cat bykill for aerial operations targetting rats, mice and possums with 0.15% 1080 cereal pellets.

| Feral cat Bykill | Location | Kill Of Target Pest | | | Ref. |
|---|---|---|---|---|---|
| | | Possums | Rats | Mice | |
| 100% | Rainbow Valley (OSPRI treatment) 2024 | | 100% | 93.8% | Griffin et al 2024 |

# 7. Appendix 1

The efficacy data for possum and rat aerial 0.15% 1080 pellet operations that occurred before 2010 along with information about de-registered 1080 products (No Possums® 1080 gel) is stored in DOC-2534486.

# 8. Glossary of Terms

**µg** $kg^{-1}$, **µg** $l^{-1}$

See ppb.

**µg** $g^{-1}$, **µg** $ml^{-1}$

See ppm.

**Absciss**

Part of a plant breaking off naturally (e.g. leaves dying)

**Aconitase**

An enzyme occurring in many animal and plant tissues that accelerates the conversion of citric acid first into aconitic acid and then into isocitric acid.

**Biological Exposure Index (BEI)**

A reference value below which exposure to a substance will not create an unreasonable risk of disease or injury. BEIs are set by the American Conference of Governmental Industrial Hygienists (ACGIH).

**Biosynthesis**

The production of a chemical compound by a living organism.

**b.w.**

Body weight

**Carcinogenic**

The ability of a substance to cause cancer.

**Citrate**

A salt or ester of citric acid.

**Cyanosis**

Blueness of the skin and mucous membrane due to insufficient oxygen in the blood.

**Defluorination**

To remove fluorine

**Endocardium**

The lining of the interior surface of the heart chambers. The endocardium consists of a layer of endothelial cells and an underlying layer of connective tissue. a thin serous membrane lining the cavities of the heart.

**Epicardium**

The inner layer of the pericardium, a conical sac of fibrous tissue that surrounds the heart and the roots of the great blood vessels / the visceral part of the pericardium that closely envelops the heart

### Epiglottis

The flap that covers the trachea during swallowing so that food does not enter the lungs.

### Fluorocitrate

The toxic metabolite of fluoroacetate that causes inhibition of aconitase.

### Gastrointestinal tract

The stomach and intestine as a functional unit

### Glial cells

A supportive cell in the central nervous system. Glial cells do not conduct electrical impulses (as opposed to neurons, which do). The glial cells surround neurons and provide support for them and insulation between them.

### Half-life

During each half life (t½ or elimination half-life) 50% of the pesticide in the body at the beginning of that half-life is eliminated. The half-life is established in laboratory trials, and is used to predict the rate of elimination of a single dose of pesticide from the body and to estimate how long the disappearance of cumulative intakes of a pesticide from the body would take.

### Hypotension

Abnormally low pressure of the blood -- called also low blood pressure

### Intravenous

Administered into a vein.

### $LC_{50}$

Lethal Concentration 50%. The calculated concentration of a gas/liquid that kills 50% of the test organisms

$LD_{50}$

Lethal Dose 50%. The estimated dose that kills 50% of the test organisms.

### LOEL

Least Observable Effect Level. The lowest dose in a study in which there was an observed toxic or adverse effect

### MLD

Minimum Lethal Dose. The smallest amount of a toxin required to kill and individual.

### Mitochondrial aconitate hydratase

An iron-dependent enzyme that catalyzes conversion of citrate to cis-aconitate in the tricarboxylic acid cycle within the mitochondrion.

### Metabolites

The breakdown of compounds resulting from the metabolism of a parent compound.

**mg** $kg^{-1}$**, mg** $l^{-1}$

See ppm.

**mmol (mM)**

millimole: a unit of metric measurement that is equal to one thousandth (10-3) of a mole. It is the amount of a substance that corresponds to its formula mass in milligrams. [mol $l^{-1}$]x[mL] = mmol.

**Mutagenic**

The ability of a substance to cause damage to DNA and produce alterations or loss of genes or chromosomes

**NOEL**

No Observable Effect Level. A dosage of a toxicant that fails to produce any discernible signs of toxicosis, which may include a lack of morphological, biochemical, or physiological change

**Non-saponifiable lipids**

Non-polar compounds that cannot be broken down by a simple hydrolytic reaction. They include steroids and hormones.

**Oral**

Given or taken through or by way of the mouth, as in an oral solution.

**Phosphofructokinase**

An enzyme that functions in carbohydrate metabolism and especially in glycolysis by catalysing the transfer of a second phosphate to fructose.

**ppb**

parts per billion. This concentration unit is equivalent to 1 µg $l^{-1}$ in water (solution) or air and 1 µg $kg^{-1}$ in solid samples (soil/sediments/biological tissue).

**ppm**

parts per million. This concentration unit is equivalent to 1 mg $l^{-1}$ (or µg $ml^{-1}$) in water (i.e. solutions) or air and 1 mg $kg^{-1}$ (or µg $g^{-1}$) in solid samples (i.e. soil/sediments/biological tissue).

**Succinate dehydrogenase**

An iron-containing flavoprotein enzyme that catalyses, often reversibly, the dehydrogenation of succinic acid to fumaric acid in the presence of a hydrogen acceptor and that is widely distributed especially in animal tissues, bacteria, and yeast -- called also succinic dehydrogenase.

**Subepicardial**

Under the serious membrane which covers the heart situated or occurring beneath the epicardium or between the epicardium and myocardium.

### Teratogen

A compound that causes birth defects in a developing foetus.

### Toxicosis

A pathological condition caused by the action of a poison or toxin.

### Toxin

A natural occurring poison, e.g. 1080, cyanide.

### Toxicant

A synthetic man-made poison, e.g. brodifacoum.

### Trachea

The tube-like portion of the respiratory tract that connects the "voice box" (larynx) with the bronchial parts of the lungs. called also windpipe.

### Tricarboxylic acid cycle

A sequence of reactions in the living organism in which oxidation of acetic acid or acetyl equivalent provides energy for storage in phosphate bonds - called also citric acid cycle, Kreb cycle.

### Threshold Limit Values (TLV)

Recommended values for the highest level of exposure to airborne chemical concentrations in the workplace that does not produce adverse health effects. They are set by the American Conference of Governmental Industrial Hygienists (ACGIH).

### Viscera

Body organs.

### VPRD

Vertebrate Pesticide Residue Database. (DOCDM-32812)

# 9. Common and Scientific Names of Species

### *Amphibians*

| | |
|---|---|
| Archeys frog | *Leiopelma archeyi* |
| American Bullfrog | *Rana catesbeiana* |
| Hochstetters frogs | *Leiopelma hochstetteri* |
| Leopard frog | *Rana pipiens* |
| South African clawed frog | *Xenopus laevis* |
| Spotted grass frog | *Limnodynastes tasmaniensis* |

### *Aquatic invertebrates/Crustaceans*

| | |
|---|---|
| NZ cockle | *Austrovenus stutchburyi* |
| Daphnia | *Daphnia magna* |
| Koura | *Paranephrops planifrons* |
| Mussel (freshwater) | *Echyridella menziesii* |
| Mussel (green lipped marine) | *Perna canaliculus* |

### *Birds*

| | |
|---|---|
| Australasian harrier | *Cirus approximans* |
| Bellbird | *Anthornis melanura* |
| Blackbird | *Turdus merula* |
| Chaffinch | *Fringilla coelebs* |
| Chicken | *Gallus gallus* |
| Whio (Blue duck) | *Hymenolaimus malacorhynchos* |
| Duck (Grey) | *Anas superciliosa* |
| Duck (Mallard) | *Anas platyrhynchos* |
| Duck (Maned) | *Chenonetta jubatta* |
| Fantail | *Rhipidura fuliginosa* |
| Fernbird | *Bowdleria punctata* |
| European goldfinch | *Carduelis carduelis* |
| Grey warbler | *Gerygone igata* |
| Kaka | *Nestor meridionalis* |

| | |
|---|---|
| Kakariki | *Cyanoramphus sp.* |
| Kea | *Nestor notabilis* |
| Kereru / kukupa | *Hemiphaga novaeseelandiae* |
| Kiwi (Haast tokoeka) | *Apteryx australis* 'Haast' |
| Kiwi (NI brown) | *Apteryx mantelli* |
| Kiwi (Little spotted) | *Apteryx owenii* |
| Kiwi (Rowi) | *Aptreyx rowi* |
| Kiwi (Great spotted) | *Apteryx haastii* |
| Kokako (NI) | *Callaeas cinerea wilsoni* |
| Magpie (Australian) | *Gymnorhina tibicen* |
| Magpie (Eurasian) | *Pica pica* |
| Morepork/ruru | *Ninox novaeseelandiae* |
| N.Z. Falcon | *Falco novaeseelandiae* |
| partridge (Chukar) | *Alectoris graeca* |
| Pheasant (Ring-necked) | *Phasianus colchicus* |
| Common pigeon | *Columba livia* |
| Quail (California) | *Callipepla californica* |
| Rifleman | *Acanthisitta chloris* |
| Robin (North Island) | *Petroica australis longipes* |
| Robin (South Island) | *Petroica australis australis* |
| Silvereye | *Zosterops lateralis* |
| Sparrow (Hedge) | *Prunella modularis* |
| Sparrow (House) | *Passer domesticus* |
| starlings | *Sturnus vulgaris* |
| Tomtit (NI) | *Petroica macrocephala toitoi* |
| Tomtit (SI) | *Petroica macrocephala macrocephala* |
| Tui | *Prosthemadera novaeseelandiae* |
| Weka | *Gallirallus australis* |

### *Eutherian mammals*

| | |
|---|---|
| Bat (Short-tailed) | *Mystacina tuberculata* |
| Cat | *Felis catus* |

| | |
|---|---|
| Cattle | *Bos taurus* |
| Deer (red) | *Cervus elephus* |
| Deer (fallow) | *Dama dama* |
| Deer (mule) | *Odocoileus hemionus* |
| Deer (sika) | *Cervus nippon* |
| Dog | *Canis familiaris* |
| Ferret | *Mustela furo/ Mustela putorious* |
| Goat | *Capra hircus* |
| Horse | *Equus caballus* |
| Mink | *Mustela vison* |
| House mouse | *Mus musculus* |
| Pig | *Sus scrofa* |
| Rabbit | *Oryctolagus c. cuniculus* |
| Rat (Laboratory/Norway) | *Rattus norvegicus* |
| Rat (Ship/Brown) | *Rattus rattus* |
| Sheep | *Ovis aries* |
| Stoat | |

### *Fish*

| | |
|---|---|
| longfin eels | *Anguilla dieffenbachia* |
| koaro | *Galaxias brevipinnis* |
| Harlequin fish | *Rasbara heteromorpha* |
| upland bullies | *Gobiomorphus breviceps* |
| Bluegill sunfish | *Lepomis macrochirus* |
| Trout (Rainbow) | *Oncorhynchus mykiss* |

### *Marsupial mammals*

| | |
|---|---|
| Brushtail possum | *Trichosurus vulpecula* |
| Wallaby (Bennett's) | *Macropus rufogriseus* |
| Wallaby (Dama) | *Macropus eugenii* |

### *Reptiles*

| | |
|---|---|
| Blotched blue-tongued lizard | *Tiliqua nigrolutea* |
| Common Skinks | *Oligosoma nigriplantare* |
| Gould's monitor | *Varanus gouldi* |
| Grand skink | *Oligosoma grande* |
| MacCann's skink | *Oligosoma maccanni* |
| Otago skink | *O. otagense* |
| Shingle-back lizard | *Tiliqua rugosa* |

### *Terrestrial invertebrates*

| | |
|---|---|
| Cockroaches | *Blattidae* |
| Compost worms | *Eisenia fetida* |
| Honeybees | *Apis mellifera* |
| Housefly | *Musca domestica* |
| Leaf-veined slugs | *Athoracophorus bitentaculatus* |
| Wasp | *Vespula spp.* |
| Weta (bush) | *Hemideina broughi* |
| Weta (Cave) | *Pharmacus sp. and Isoplectron sp.* |
| Weta (tree) | *Hemideina spp.* |
| Weta (Auckland tree) | *Hemideina thoracica* |
| Weta (Wellington tree) | *Hemideina crassidens* |

### *Plants*

| | |
|---|---|
| Broad bean | *Vicia faba* |
| box poison | *Gastrolobium parviflorum* |
| cabbage | *Brassica oleracea* |
| gifblaar | *Dichapetalum cymosum* |
| heart-leaf poison | *Gastrolobium bilobum* |
| käpuka (New Zealand broadleaf) | *Griselinia littoralis* |
| käramuramu | *Coprosma robusta* |
| lettuce | *Lactuca sativa* |
| Mahoe | *Melicytus ramiflorus* |

| | |
|---|---|
| peanut | *Archis hypogeae* |
| perennial ryegrass | *Lolium perenne* |
| puha | *Sonchus* spp. |
| pikopiko | *Asplenium bulbiferum* |
| rat weed | *Palicourea margravii* |
| ratsbane | *Dichapetalum toxicarium* |
| sugar cane | *Saccharum spp.* |

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