Research Plan

Kea risk mitigation and monitoring for Arthur's Pass west and central Westland during 2022 DOC & OSPRI aerial 1080 operations

Kea 1080 Risk Mitigation Technical Advisory Group

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

DM-6947199

Department of Conservation
Te Papa Atawhai

New Zealand Government

Cover: Fledgling kea, Arthur's Pass. *Photo: Andrew Newark.*

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Contents

1 Background and context

Under the *Aerial 1080 in Kea Habitat Code of Practice* (COP) principles, any agency undertaking aerial 1080 operations is required to make the best use of aerially applied 1080 for pest mammal management while minimising negative impacts on kea populations, long term. Compulsory performance standards to mitigate the risk to kea are outlined in the COP and if these are not met, an exemption must be applied for. Often these exemptions will stipulate that additional kea mitigation work should be undertaken to minimise risk to kea during aerial 1080 operations, and/or that appropriate monitoring should take place as part of the operation e.g., kea survivorship monitoring, predator abundance monitoring. Because options around mitigation and risk reduction to kea are still being investigated, it is not clear what the most appropriate methodologies are in terms of mitigation methods in different types of kea habitat and how to achieve the best outcomes for kea overall.

The operational standards contained in the COP are regularly updated and refined by DOC's Pesticide Advisory Group (PAG) as new research around kea 1080 risk mitigation measures become available. PAG will adopt new measures as performance standards within the COP if there is sufficient evidence that these will either further reduce kea mortality in aerial 1080 operations or optimise benefits to kea from those operations. This research aims to improve the evidence available for PAG to assess the effectiveness of both the use of d-pulegone as a primary repellent and aversion training with anthraquinone at reducing kea mortality.

The Kea 1080 Risk Mitigation Technical Advisory Group was established in early 2021 consisting of representatives from Te Runanga O Ngāi Tahu (TRONT), Department of Conservation (DOC), OSPRI, Zero Invasive Predators (ZIP) and the Kea Conservation Trust (KCT). A document was formulated, identifying research priorities, knowledge gaps and roles of the group (DOC-6530802). This included assessing the upcoming (2021 and 2022) aerial DOC and OSPRI 1080 operations to identify priority work and sites to focus on for kea risk mitigation activities and research trials to address knowledge gaps. An overall working operational plan document exists alongside this and covers all the planned 1080 operations and outlines generally the work planned for kea risk mitigation associated with each operation (DOC-6601473).

The aerial 1080 operations planned for winter 2022 - 'Otira', 'Taramakau', 'Upper Taipo', 'Taipo South' and 'Arthur's Pass West, SOIK', that surround Arthur's Pass village / Otira highway are arguably the most at-risk areas for 1080-related kea mortality in the South Island. The area is a well-known, long-term 'scrounge-influenced' site; work to date indicates that kea that live close to areas where they can scrounge food from people are at higher risk of being poisoned than birds in remote areas (Kemp et al., 2018).The number of individual kea that have been banded at or around Arthur's Pass village or Otira viaduct lookout carpark since 2017 is >300 (to January 2022), with many more unbanded individuals coming and going. Most of these individuals will be moving in and out of the village to spend time foraging, feeding, interacting with, and perhaps nesting in areas most likely within one or more of these 1080 operational areas (see keadatabase.nz for kea movement data and

Arthur's Pass area radio-tracking studies by Kemp et al 2022). Younger kea (juveniles aged 1-4 years) are likely to have significantly large dispersal distances from the natal site and utilise large areas of the landscape from forest floor to the mountain tops up to 100km or more. Paired adult kea have relatively small home range areas, particularly during nesting (July to December), perhaps 5-20 sq. km (see Kea Survivorship Database managed by Josh Kemp).

Individuals with a scrounge-influenced history, (including all banded birds) are thought to exhibit more neophilic tendencies and thus interact with novel objects such as 1080 baits. This effect may not be limited to currently active scroungers; individual birds that no longer visit scrounge sites but have done so in the past are thought to retain this enhanced neophilia. Recent research indicates that this behaviour has a negative impact on kea survivorship within 20 km of scrounge sites but no measurable impact further than 40 km from such sites (Kemp et al., 2018). Therefore, these sites have been given the highest priority for further repellent trials (anthraquinone aversion training) and D-pulegone because of the high risk of 1080-related mortalities during these operations (see Performance Standard 6 of the Kea COP (timing between masts) – the operation falls within kea habitat defined as 'scrounge influenced').

These operational areas cover >100,000 ha and provide an ideal opportunity to utilise and refine existing methods of aversion-training wild kea (Nichols et al 2020) and post-operational monitoring. The concerted efforts in aversion training kea using repellent baits in this area, particularly around the Arthur's Pass village, will likely have substantial flow-on benefits to kea across a much wider area, including for some kea likely to be present within aerial 1080 operations adjacent to the areas that aren't being included as part of this work plan per se.

2 Trialling an improved form of primary repellent D-pulegone on wild kea

Primary repellent D-pulegone has previously shown promise as an effective kea repellent, as well as promising results on not reducing the efficacy of rat and possum kill rates. An obvious advantage of a primary repellent such as D-pulegone is that it has the potential to be directly applied to toxic baits during a 1080 operation, thereby minimising behavioural intervention with kea and negating the need to 'train' individuals prior to the operation. Reducing the amount of behavioural intervention with kea, particularly behaviours associated with scrounging, is an important consideration given the negative relationship that has been identified between scrounging individuals and enhanced risk of mortality during 1080 operations (Kemp et al 2018).

A substantial body of work has been carried out on D-pulegone and kea to date (Cowan et al., 2015; Cowan and Crowell, 2017; Crowell et al., 2015; Crowell and Klink, 2015; Orr-Walker et al., 2012) however, a major limiting factor in field trials was that D-pulegone was not able to be stabilised in the bait matrix, losing efficacy over very short time frames. Recent work by bait manufacturer Orillion has led to a new, purportedly improved version where D-

pulegone is stabilised in the bait matrix through an encapsulation process. This new preparation is now ready for further field trials. Previous trials suggested that possums are not significantly repelled by 0.17% D-pulegone laced baits, with both rat and possum tracking indices satisfactorily reduced in treatment blocks near Haast both where repellent was and was not added to baits blocks near Haast (Crowell et al 2015). Given the promising results of past trials, and that D-pulegone has now potentially been stabilised in the bait matrix, future research and appropriate resources should be focused on testing D-pulegone at an operational level and make this an urgent priority. However, because of the stabilisation process, higher concentrations of D-pulegone are likely needed to repel kea and therefore, all trials outlined below will initially focus on testing various (higher) concentrations of the repellent on kea. If this initial testing phase continues to support D-pulegone as a kea repellent, then further testing will test for effects of the repellent on bait consumption by possums and rats.

2.1 Aims of D-pulegone trials

1. Identification of optimal D-pulegone repellent concentration to achieve best kea repellency using non-toxic RS5 cereal baits and wild kea at Arthur's Pass village.
2. Using the optimal concentration/s defined in 1 above, identify D-pulegone repellency effects on wild kea at alpine sites using non-toxic RS5 cereal baits (two months prior to 1080 operations).
3. Identification of optimal D-pulegone repellent concentration for pest palatability and efficacy using possums and rats in pen trials.
4. Determination of stability and repellent longevity of D-pulegone in non-toxic cereal baits (lab testing and field degradation trials).

If the above research needs can be answered within the time frame required before the toxic operation, then the following will also be addressed as part of this operation. If these trials do give us confidence that use of D-pulegone will reduce bait take by kea and not that of possums and rats, testing its effectiveness as a primary repellent in a large-scale operation will be the next step, and we will carry out the following:

5. Verification of kea repellence in wild kea trials during 1080 operations with D-pulegone added to the prefeed and toxic RS5 cereal baits.
6. Verification of kea survival in aerial 1080 operations with D-pulegone added to the prefeed and toxic RS5 cereal baits
7. Determination of pest efficacy in 1080 operations with D-pulegone added to the prefeed and toxic RS5 cereal baits.

If 5-7 above cannot be addressed as part of this research trial because 1-4 are not answered within the required time frames for this operation, these questions will be addressed as part of ongoing research in other DOC and/or OSPRI 1080 aerial operations later at other sites. The above trials are each outlined in more detail below, and each one will be reported on separately as results are analysed, enabling the decision to carry on with each further step (or not).

If the addition of d-pulegone to pre-feed and/or toxic bait used in aerial 1080 operations is shown to reliably reduce kea mortality without reducing efficacy against target species, then it could be considered as a bait additive allowed under Performance Standard 1 of the COP.

2.2 Testing D-pulegone concentrations and repellency on wild kea at 'scrounge' site

The first part of this work involves trialling varying concentrations of newly encapsulated form of the primary repellent D-pulegone by presenting these to wild kea frequenting 'scrounge' sites around/at Arthur's Pass village. Trials will focus on measuring kea interaction with D-pulegone in six different concentrations (1%, 2%, 4%, 6%, 10% and 50% as well as control 0%) encapsulated in non-toxic, green dyed, cinnamon lured RS5 baits, the standard (non-toxic) bait matrix (supplied by Orillion). The aim of this work is to test for the most ideal concentration needed to repel kea. The ultra-high (50%) concentration will be tested as a last resort. If lower concentrations demonstrate no repellent effects to kea, then the final testing using the extremely high concentration is to understand if the substance is effective at all as a repellent or should be ruled out completely.

D-pulegone is a primary repellent, acting on the olfactory system, and expected responses if successfully repelled, is that kea should not physically touch the bait, or should reject baits soon after picking them up in the bill (tossing them away is a common response). Trials will take place between October and December 2021 to arrive at the optimal concentration suitable to deter kea and proceed with further steps as outlined above. Over 90% of kea in the area at the time of the study are banded, therefore observations of individuals and their interactions with repellent trials and any repeat observations can be accounted for.

Decision Point: Depending on the success of outcomes from this trial, i.e., repellent effects are observed from one or more of the above concentrations of D-pulegone among at least some individuals, we will proceed to trial 2, beginning in March 2022. The lowest possible concentrations indicating a kea repellent effect will be selected because these are the most likely to not significantly deter possums and rats during palatability pen trials.

2.3 Testing best D-pulegone concentration/s in wild kea at alpine sites

Eighteen suitable alpine sites will be selected based on known areas of high kea activity, helicopter landing access and other factors (Figure 1). The selected concentration/s will be presented to kea (within the same standard non-toxic bait matrix) at these alpine sites. The two most promising repellent concentrations will be tested during these trials, half (nine) of the sites will be used for each (e.g., 6% and 10%, nine sites each).

Sites will be set up with automated audio lures to initially draw kea to the area and trail cameras to record kea interactions with D-pulegone baits. This will be repeated twice, approximately 5-15 days apart (pending a good weather window of at least three days after deployment), as if to emulate a pre-feed then a toxic round in an aerial 1080 operation. This

will take place two months prior to the expected toxic deployment date (likely March for a May/June operation).

This trial will be conducted without the use of ungulate carcasses to gain an understanding of repellent bait interaction without the added distraction of carcass consumption likely averting kea's attention and activity. Behaviour and bait interaction responses will be recorded (banded and unbanded kea observations) using a combination of trail camera videos and still images (images will help verify band ID) and some live observations by DOC staff, and RFID readers for those kea with RFID tags in their radio transmitter or bands.

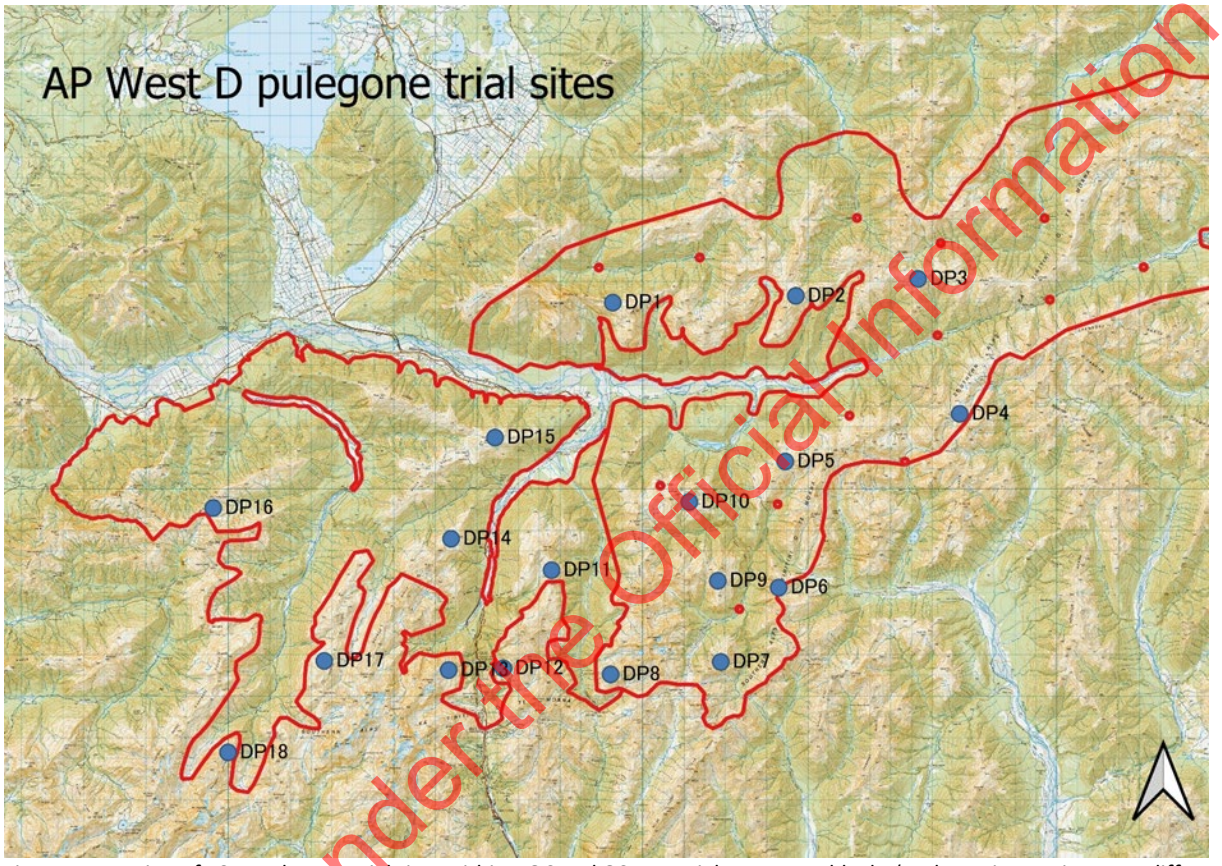

Figure 1. Location of 18 D-Pulegone trial sites within DOC and OSPRI aerial treatment blocks (anthraquinone sites may differ slightly, tbc).

Decision Point: If sufficient bait interactions are observed during round 1 and 2 of this trial, and outcomes are promising, i.e., overall behavioural responses demonstrate the majority of kea are repelled by D-pulegone and bait interactions by individuals decrease over time, particularly between round 1 and 2, then there is sufficient evidence to progress to pen trials.

2.4 Identification of optimal D-pulegone repellent concentration for pest palatability and efficacy using possums and rats in pen trials

Captive pen trials to assess bait efficacy will be carried out on rats and possums separately at an animal facility in Lincoln. For each species, 12 animals per treatment will be tested across four treatments (three levels of D-pulegone concentration and a control). Trials will consist of a non-toxic prefeed followed by a gap, then toxic baits with mortality rates calculated for

each D-pulegone level against the non-treatment sample. A contract agreement has been arranged between Manaaki Whenua and OSPRI and will take place once results from the 'scrounge' and 'alpine' D-pulegone trials on kea have been obtained and show suitable promise as a repellent for kea.

2.5 Determination of stability and repellent longevity of D-pulegone in non-toxic cereal baits (lab testing and field degradation trials)

D-pulegone stability testing will also take place at regular intervals to determine whether concentrations are stable or degrading over time. This will largely be carried out over a 12-week period at the same time as pest efficacy trials under a contract with MWLR, however some bait stability testing will also occur at the time kea field trials are being run, so that kea bait interaction data are analysed with respect to actual D-pulegone concentration.

Decision Point: Field trials will commence when (and if) an optimal D-pulegone concentration has been determined suitable as a kea repellent, while not reducing pest efficacy and remaining stable in the baits.

2.6 Field trials incorporating D-pulegone into the 1080 operation to measure kea survival and pest efficacy

This part of the work addresses Aims 5-7. During this phase, we will monitor radio tagged kea, possums, and rats to measure survivorship during the aerial 1080 operation in repellent-added compared with standard RS5 (non-repellent) trials in adjacent blocks. This trial is designed to answer the question: Do survival rates of radio-tagged wild kea differ between 1080 operations where repellent is used in prefeed and 1080 baits compared with a standard RS5 1080 operation without repellent? As well as this, is a high kill rate of possums and rats still able to be achieved where repellent is used? It is possible this trial will not be incorporated into the winter 2022 DOC and OSPRI Arthur's Pass west operations if prior trials cannot determine D-pulegone effectiveness within the time frames needed for this piece of work to go ahead. However, if all other trials are successful this year, it is recommended that this field trial be the next major focus of work for other upcoming operations. Regardless of whether conditions to proceed with the D-pulegone trial have been met or not, kea mitigation using methods already being trialled elsewhere will be incorporated into the 1080 operations.

See also AEC403 (DOC-6778545) for full details on methods and outcome monitoring for all the above D-pulegone research trials.

3 Alpine kea aversion training using secondary repellent anthraquinone

Most recent kea 1080 risk mitigation work involves aversion training kea for *c*. two months leading up to a 1080 operation using non-toxic cereal pellets laced with secondary repellent anthraquinone, with the goal of training kea to become averse to the similar toxic cereal baits (see also ZIP Technical Reports) (McLean et al., 2022; Nichols et al., 2020). Alpine aversion training consists of several strategically placed mitigation sites at sites above 1500 m (to avoid target pest mammal exposure to the repellents). At each site, non-toxic 2.7% anthraquinone-laced cereal baits are spread on the ground in conjunction with audio lures and animal carcasses used to attract and maintain kea interest and maximise exposure to the baits.

Whilst captive trials have shown that a 'learned aversion' to cereal baits can last for up to two years (McLean et al., 2022), the specific role of aversion training in reducing mortality to wild kea during 1080 operations has not been quantified and the overall cost/benefit ratio has not been determined. There has also been no previous work on discriminating between the effectiveness of the anthraquinone repellent baits with and without the use of carcass lures, and no work on the role of carcasses as lures versus distraction measures.

This approach has a high level of behavioural intervention with the birds, given that birds are required to be 'trained' in the months leading up to a 1080 operation to ensure repeated exposures to the anthraquinone baits. As anthraquinone is a secondary repellent, this approach also requires the birds to ingest the repellent to experience the emetic response, compared to a primary repellent such as D-pulegone that work by repelling the birds by sight, taste, or smell. The use of carcasses as lures and/or a distraction technique is also of concern for several reasons (high level of behavioural intervention, secondary poisoning, lead poisoning, etc.) and therefore the benefits of carcasses as part of this approach need to be clearly understood before considering their inclusion within any standard risk mitigation approach.

3.1 Aims of Anthraquinone Trials

1. Measure the effectiveness of the alpine aversion training method in relation to survival through aerial 1080 operations.
2. Determine the effectiveness of anthraquinone aversion training using audio lures.

3.2 Anthraquinone Trials

At least one month prior to the operation and for one month post operation, alpine 1080 kea aversion training will be carried out. This involves up to four sessions of training with 2.7% anthraquinone in non-toxic standard RS5s with automated audio lures (one per site) to attract and retain kea in an area (see Nichols et al. 2020). Repellent bait (1-2 kg) should be spread in front of each lure and refreshed every 10-15 days (with camera battery and SD card replacements). Deployment should be kept to similar weather windows as operations, i.e., at least three fine nights to follow (for bait degradation). Audio lures, a proven kea attractant

over large distances) will be used to attract kea, with the objective of attracting as many as possible to the sites. This trial will be conducted without the use of ungulate carcasses to quantify the role of aversion training on kea survival through an operation, without the added distraction of carcass consumption confounding results. However, if after the first 10–15 days, visitation to mitigation sites is <50%, then introducing carcasses as lures to the sites will be considered. Behaviour and bait interaction responses will be recorded (banded and unbanded kea observations) using a combination of trail camera images and video, live observations by DOC staff, and RFID readers for kea with RFID tags.

If trials in South Westland indicate that kea can effectively use artificial feeders for anthraquinone aversion training in lowland settings, then these will also be considered for aversion training at Arthur's Pass village (a lowland site) one month prior to the operations.

4 Timing and overall workplan

Aerial 1080 operations in this area are scheduled from May (potentially through to October) 2022. Decisions on which mitigation activities need to take place and when will be dependent on work leading up to this time and results of each of these trials. A live timeline for this project is available here: DOC-6984492

October – December 2021: Trial phase 1 will take place with kea using D-pulegone at varying concentrations at active scrounge sites around Arthur's Pass, to determine the optimal concentration suitable to deter kea and initiate trial 2 of D-pulegone testing.

January – February 2022: Experienced kea staff will work in the mountains and front country capturing, banding and radio tagging a large sample size of kea to follow through the operations. Also identify sites, organise logistics and contracts and prepare alpine work.

March 2022: Two rounds of D-pulegone trials will be carried out, roughly 10-15 days apart. Field trials of D-pulegone as a primary repellent for wild kea will need to be at sites where aversion training with anthraquinone or any other secondary repellent has not yet been carried out, hence these need to take place first at alpine mitigation sites on a 'naïve' population of kea that have not yet experienced aversion training.

April 2022: At least one month prior to the operation, aversion training of kea as per the anthraquinone trial detailed above (3.2) will be conducted. Aversion training will also opportunistically take place at Arthur's Pass/Deaths Corner prior to the operations, focused on creating learned aversion to 1080 pellets for high risk individuals at this 'scrounge' site.

May 2022 onwards: Aerial 1080 operations to begin, potentially ongoing or sporadic through to October. The potential variation in timing between OSPRI and DOC operations leaves uncertainty about continuity and timing of mitigation work in these sites over this period. This will either happen all at once if OSPRI and DOC operations are run close together, or separately if not. Both eventualities will be adequately prepared for and covered.

Aerial radiotracking of birds carrying transmitters will be undertaken to focus on kea movement and activity before and after the operations. Therefore, monthly flights will take place to track locations and status of all kea and this will be increased before and after the 1080 operation takes place to ensure all kea are accounted for through the operation and survival determined in relation to their interaction with repellents and/or mitigation trials. Recommended aerial radio tracking timing is immediately prior to toxic sowing (the day before at best), 3-4 days later, and then a follow-up a week or so later.

5 Monitoring and measuring outcomes

This work is being carried out as part of an overarching research plan, involving multiple locations, to improve our ability to reduce risk to kea in predator control operations.

- D-pulegone repellent effects on wild kea will be assessed by measuring the behavioural responses, number and types of interactions, and any changes over time, particularly in relation to individual kea responses.
- Anthraquinone aversion training effectiveness and the fate of kea (survival/mortality) through the 1080 operations with respect to this, will be monitored using visitation indices at remote cameras alongside a large sample (ca. 100) of kea which are fitted with leg bands and radio transmitters (most of which have RFID tags inserted). Monthly aerial radio tracking flights will be conducted to keep track of kea so they are not 'lost' from the study and any kea transmitters that change into 'mortality' mode will be followed up by helicopter and/or foot.

To measure definitive outcomes of mitigation effectiveness we will use a combination of visitation indices (with cameras placed at all alpine trial sites), mark-resighting data of banded kea and survivorship of those kea (using radio-tagged individuals) in relation to their interactions with one, two or none of the repellent-laced cereal bait trials. Radio-transmitters last around four years, therefore we can also measure annual survivorship for these radio-tagged kea to determine relative predator impact before and after 1080 operations and whether there is an overall benefit to kea because of the 1080 operations (this could be considered as a proxy for pre- and post- 1080 predator monitoring across some of these sites). There is also an opportunity to monitor ongoing productivity among radio-tagged kea in these areas (alongside ongoing predator monitoring) and determine the cost benefit ratio of this mitigation work and measure both short- and longer-term benefits.

6 Deliverables

- AEC approval for all repellent research trials.
- Preliminary results and summary report on each trial above needed at every decision point to inform kea repellence and survival projects.
- Draft report for DOC/OSPRI comment.
- Final report and recommendations for the *Aerial 1080 in Kea Habitat Code of Practice.*

7 Team, roles, and responsibilities

Within DOC, responsibilities, accountable managers, and Single Point Accountability (SPA, at Director level) for this research are as follows:

Task	Single Point Accountability	Accountable Manager	Responsible Person/s
Research Plan & Decision Points	Ian Angus (Terrestrial Science)	9(2)(a), 9(2)(g)(ii)	9(2)(a), 9(2)(g)(ii)
Research Implementation	Hilary Aikman (Ops Programmes)	9(2)(a), 9(2)(g)(ii)	9(2)(a), 9(2)(g)(ii)
Kea Mitigation TAG, Kea Recovery	Ian Angus (Terrestrial Science)	9(2)(a), 9(2)(g)(ii)	9(2)(a), 9(2)(g)(ii)
Kea Code of Practice for 1080 Ops	Meg Rutledge (Threats)	9(2)(a), 9(2)(g)(ii)	9(2)(a), 9(2)(g)(ii)
Te Rūnanga o Ngāi Tahu Relationship	Ian Angus (Terrestrial Science)	9(2)(a), 9(2)(g)(ii)	9(2)(a), 9(2)(g)(ii)
Local Rūnanga Relationships	ESI & WSI Directors	Ops Managers	Rangers
Regional Director Comms (ESI & WSI)	Hilary Aikman (Ops Programmes)	9(2)(a), 9(2)(g)(ii)	9(2)(a), 9(2)(g)(ii)
Local Ops Relationships	Hilary Aikman (Ops Programmes)	9(2)(a), 9(2)(g)(ii)	9(2)(a), 9(2)(g)(ii)
Research Communications Plan	Hilary Aikman (Ops Programmes)	9(2)(a), 9(2)(g)(ii)	9(2)(a), 9(2)(g)(ii)

Technical advice and recommendations for the research plan are to come from the Kea 1080 Risk Mitigation Technical Advisory Group, led by 9(2)(a), 9(2)(g)(ii). Recommendations are to be raised to 9(2)(a), 9(2)(g)(ii) as accountable manager and may be elevated to the SPA if required.

Concerns, issues, etc. raised by any responsible person or TAG member can be elevated to SPA for their consideration, ideally through the accountable line above.

To ensure common understanding and appropriate risk management, the three key SPA directors (Directors of Terrestrial Science, Threats, and National Ops Issues & Programmes) will meet monthly, together with their accountable managers and responsible persons, and Regional Ops Directors.

Outside of DOC, responsibilities are as follows:

- 9(2)(a), 9(2)(g)(ii), and 9(2)(a), 9(2)(g)(ii) are responsible for funding and OSPRI input. The Upper South Island service delivery team will be responsible for delivering the OSPRI component of the 1080 operation.
- OSPRI and Zero Invasive Predators (ZIP) are responsible for providing input to the Kea 1080 Risk Mitigation Technical Advisory Group, as members of the TAG.

- Te Runanga o Ngai Tahu, represented by [redacted], also has membership on the TAG and is to be kept informed on progress of the research and any related work by the TAG lead ([redacted]). [redacted] to relay any key information to Mana Whenua as and when required.

8 Communications

A communications plan (DOC-6889661) has been created for the Arthurs Pass West Kea repellent for aerial 1080 operations research trials by DOC media team and OSPRI.

A fact sheet has also been created for the D-pulegone trials: (DOC-6862743)

Media queries to [redacted] (DOC) and [redacted] (OSPRI).

9 References

Cowan, P.; Booth, L.; Crowell, M. 2015. Repellents with potential to protect kea and other native birds from aerial poisoning for possum and rat control. *New Zealand Journal of Ecology 40*.

Cowan, P.; Crowell, M. 2017. Visual and taste cues for minimising native bird interactions with toxic 1080 baits – A review of current practices. *New Zealand Journal of Ecology 41*.

Crowell, M.; Booth, L.; Cowan, P.; Fairweather, A.; Westbrooke, I. 2015. Stability of bird repellents used to protect kea (Nestor notabilis) during aerial 1080 cereal operations. *New Zealand Journal of Ecology 40*: 42-48.

Crowell, M.; Klink, P. 2015. Kea (Nestor notabilis) survivorship through a 1080 operation using cereal baits containing the bird repellent d-pulegone at Otira, central Westland. *DOC Research and Development Series DOC Research and Development Series 344.*

Kemp, J.R.; Mosen, C.C.; Elliott, G.P.; Hunter, C.M.; van Klink, P. 2018. Kea survival during aerial poisoning for rat and possum control. *New Zealand Journal of Ecology 43*: 1-11.

McLean, L.; Nichols, M.; Taylor, A.; Nelson, X. 2022. Memory retention of conditioned aversion training in New Zealand's alpine parrot, the kea. *The Journal of Wildlife Management*.

Nichols, M.; Bell, P.; Mulgan, N.; Taylor, A. 2020. Conditioned aversion in kea to cereal bait: A captive study using anthraquinone. *Applied Animal Behaviour Science 230*: 105077.

Orr-Walker, T.; Adams, N.J.; Roberts, L.G.; Kemp, J.R.; Spurr, E.B. 2012. Effectiveness of the bird repellents anthraquinone and d-pulegone on an endemic New Zealand parrot, the kea (Nestor notabilis). *Applied Animal Behaviour Science 137*: 80-85.