Response to the Department of Conservation's reply to "Aerial 1080 poisoning in New Zealand: reasons for concern"

J.C. Pollard (BSc (Hons), PhD)
Independent scientist

Abstract

A recent review highlighting several reasons for concern regarding the New Zealand Government's policy of widespread aerial poisoning with sodium monofluoroacetate (1080), was sent to several Government ministers and staff (in August 2016). A letter in reply, in support of the ongoing use of 1080, was received from the Department of Conservation (DoC). The letter claims that there is foundational evidence aerial 1080 poisoning is 'safe', will retain its efficacy against rats throughout repeated applications, has desirable biodiversity outcomes, and that there are no current alternatives to its continued use. These claims are refuted based on documented evidence. Further, examination of documents concerning the management of two species, kea (*Nestor notabilis*) and mohua (*Mohoua ochrocephala*), reveals no scientific, ecological basis supporting pest control by DoC. There is an urgent need to review conservation management in New Zealand.

Introduction

A recently published review paper (Pollard, 2016) demonstrating reasons for concern regarding the Government's policy of widespread aerial poisoning with 1080 was sent to several government ministers and staff in August 2016.

A three-page letter in reply, supporting the use of 1080, was received from the Department of Conservation's Susan Timmins (Acting Director, Threats) (DoC letter, see Appendix 1). The following discusses and contests the claims made in the letter.

Claims regarding the 'safety' of 1080 use

The absence of information on the effects of 1080 was highlighted on at least 300 occasions in the 2007 Environmental Risk Management Authority's (ERMA's) Reassessment documents (see http://1080science.co.nz/1080-data-quality.) It can hardly be dismissed as just an '*assertion*' (DoC letter, p. 1 para. 4).

Contrary to the DoC letter of reply ERMA's controls applied since 2007 have <u>not limited</u> the exposure of *"humans, animals, plants and the environment*" to 1080 (DoC letter, p.1 para. 4). Since 2007, the environment has been exposed to increasing amounts of this poison (Parkes *et al.*, 2017). Moreover, in 2007 ERMA relaxed requirements for warning signs and removed controls for protecting invertebrates. It also retained the "*possibly excessive*" maximum application rate of 30g 1080/ha when 2-8g was normally used; because DoC wanted *"flexibility particularly when considering multi-species pest control"* (ERMA, 2007, Appendix Q, p. 793; Decision, pp. 167-169).

ERMA's new control regime gave the appearance of requiring monitoring of effects of 1080 on pest species, non-target species and water quality (ERMA Decision, p 92). But this was not borne out in the finer detail, where it stated this information only needed to be provided "if available" (ERMA Decision, p .188).

The research recommended by ERMA in the 2007 reassessment has not substantially filled in gaps in knowledge as implied (DoC letter, p. 1, para. 4). Only two of ERMA's four recommended topics for technical research have been addressed. The research that was recommended on the loss of 1080 in bait samples, and on degradation in water, have not been carried out[1].

The two of ERMA's recommended topics that *have* been addressed, in one experiment each, are incomplete with the experiments generating some important concerns:

Northcott *et al.* (2014) studied degradation rates of 1080 in three NZ soils. The soil samples were taken from places where 1080 had been applied in the past, even though this had been recognised previously as a problem in interpreting results (ERMA, 2007, Agency Appendix C, p. 446). The known harmful breakdown products fluorocitrate and fluoromethane were not measured, with additional research recommended "if the role of these other SFA degradation pathways in soil was of concern..." The study found that degradation was slowest at low temperatures, while effects of soil moisture and type varied (Northcott *et al.*, 2014).

Srinivasan *et al.* (2012) studied the fate of 1080 leaching from baits during rainfall. They found evidence that 1080 dropped on land entered streams, and concluded that research was needed into 1080 in overland (surface) flow, in subsurface flow, and whether it enters groundwater.

ERMA's 2007 Evaluation and Review Report was <u>not</u> independently assessed, as implied in the statement that it was "*externally peer reviewed*". Contrary to the statement in the Doc letter of reply, the reviewer Dr Abdul Moeed was not external to ERMA, historically. He had been a government ecologist, then worked for ERMA for many years as Senior Science Adviser, New Organisms (e.g. see ERMA, 2000; 2002; 2006). A truly independent assessment by Drs Pat and Quinn Whiting-O'Keefe concluded that "*the government's reassessment of the use of 1080 in 2007 was flawed because of committee composition, biased ex-DoC employees, prejudgement, and failure to acknowledge or hear countervailing evidence*." (Whiting-O'Keefe & Whiting-O'Keefe, 2013).

The non-independence of reviewers is a recurring theme in 1080 approvals. The Government's own Parliamentary Commissioner for the Environment's report on 1080 is also held to be "*independent*" (DoC, 2017). In 2015, "*independent*" reviews of the science underpinning bovine Tb control in NZ (supporting aerial 1080 poisoning) were written by scientists Drs Peter Caley and John Hellström who had been involved in Tb research in NZ over many years (see Pollard, 2016).

Claims regarding efficacy of 1080

DoC's letter (p. 2, para. 1). claims that modern aerial baiting techniques, which use pre-feeding, high 1080 poison concentrations and rarely occur in sequential years, will allow 1080 to maintain efficacy against one of its main targets, ship rats (*Rattus rattus*).

[1] Personal Communications, Penny Fisher, Landcare, 24 September 2015; 23 October, 2015; Sarah Gardner, Environmental Protection Authority, 17 November 2015. According to Penny Fisher (24/9/15) "Unfortunately the recommendations did not say who was to undertake such things, and who would pay for them to be done!"

The average kill rate of rats from 43 pre-fed operations using a high bait concentration (0.15% 1080) carried out between 2010 and 2015 was 91% (range 39-100%) (Fairweather *et al*., 2015). Therefore many rats may survive due to bait avoidance or physical tolerance. Twigg *et al*. (2002) found evidence of genetic selection for physiological resistance to 1080 in rabbit populations that had been repeatedly poisoned with oats so toxic that only 1/3 of an oat grain was lethal. It was suggested that sub-lethal poisoning occurred due to 1080 leaching out of baits and/or animals just eating a very small piece (and that further research was urgently required) (p. 560). Rats that behaviourally avoid bait are likely to be copied by their offspring, so this passes between generations (Bennett & Galef, 2009).

Sequential application of 1080 has occurred recently, for example in the Catlins area:

"Following a partial mast in 2011/2012 an aerial toxin operation in conjunction with the Animal Health Board (AHB), was undertaken in winter 2012 and winter 2013. The area was again treated with aerial 1080 as part of Battle for our Birds in 2014." (Manno & Bardsley, 2015, unpublished).

Claims regarding beneficial biodiversity outcomes

1. Rat and mouse suppression

DoC's letter referring to outcomes (DoC letter, p. 2 para. 4-6) fails to acknowledge one of the most concerning adverse outcomes of aerial 1080 poisoning: the irrefutable published evidence that the poison causes vastly elevated numbers of mice (*Mus musculus*) and rats, within weeks to months following the operations (Ruscoe *et al*., 2011; Griffiths & Barron, 2016).

2. Mortality rates of native birds

It is stated (DoC letter, p. 2, para. 5) that reliably calculated mortality rates from 1080 poisoning are available for only five birds (kokako *Callaes cinerea*), kiwi (*Apteryx* spp.), kaka *Nestor meridionalis*, whio (*Hymenolaimus malacorhynchos*) and fernbirds (*Megalurus punctatus*), and that for fernbirds, it is 9.4%. The omission of any reference to intensively studied kea (*Nestor notabilis*) mortality, in DoC's letter is noted. An average of 12% of marked kea have been reported dead from 1080 poisoning (DoC, 2016; Kemp *et al*., 2016, unpublished); range up to 78% (Graf, 2011). Such figures should cause alarm. 1080 is not only toxic to birds, but also bacteria, fungi, plants, nematodes and insects (ERMA Review, 2007). When broadcast in cereal-based food pellets, the poison is also available on fragments, in bait-dust and spread by animals (see Pollard, 2016), as well as in water (Srinivasan *et al*., 2012). An experimental study found a severe negative impact of aerial 1080 on a wide range of terrestrial invertebrates, persisting for at least a year in some species (Meads, 1994, unpublished, cited in Whiting-O'Keefe & Whiting-O'Keefe, 2007). However followup studies by DoC, severely compromised by poor design, have been used erroneously since to back up claims of a lack of effect of 1080 on invertebrates (Whiting-O'Keefe & Whiting-O'Keefe, 2007).

3. Net benefit

Without citing any references DoC's letter claims (p. 2, para. 5), that the reduction in predators that results from 1080 operations provides a "*net benefit*" to native species.

"*Net benefit*" as used by DoC is the recorded *mortality* of marked birds due to poisoning, and the recorded increase in *nesting success* following the poisoning. But *nesting success* of survivors increases when a bird population is culled (see Pollard, 2016).

Mortality from predators is likely to be artificially created by DoC's intensive monitoring of nests, which increases the risks to birds as noted by Ellenberg *et al*. (2015), pp. 231-241:

> *"subtle and accumulating effects of human disturbance on susceptibility to disease, fertility, and life expectancy are currently not well understood. Human disturbance can alter hormonal stress response [sic] (Walker et al. 2005; Ellenberg et al. 2007) as well as energy budgets of adult birds (Ellenberg et al. 2013); reduce breeding success, fledgling weights, and subsequent first-year survival (McClung et al. 2004; Ellenberg et al. 2006, 2007); and defer prospecting pairs from establishing a nest in disturbed habitats (Hockey & Hallinan 1981)."*

> *"dependent on predation pressure, breeding stage, and ambient climatic conditions, nest failure rates following human disturbance can be considerable (e.g. Hockey & Hallinan 1981)."*

> *"Predators may learn to follow humans and profit from the distraction they cause (author's personal experiences with stoats in New Zealand)"*.

The likelihood that nest monitoring by researchers attracts predators has been overlooked by DoC staff. This is described in a recent rock wren nesting study:

> *"We conducted a nesting study of rock wrens during the 2012/13 summer season in the Homer and Gertrude Valleys, Fiordland. All 20 nests we monitored failed; ten were attributed to stoat predation...however only low numbers of both stoats and mice were detected through tracking tunnel monitoring. Our results point to the episodic nature of predation on rock wrens, which can occur even when predators are at low density...Work plan 2013-2014...Continue rock wren nesting success study."* (Monks, 2013, unpublished, p. 2-4).

Considerable effort has been made by DoC to show a net benefit of 1080 poisoning to kea, through heavily monitored nests and radiotelemetry, but none of it stands up to scientific scrutiny (Appendix 2).

4. Claims regarding the Kea Code of Practice

DoC's letter (p. 2 para. 5) states the DoC Code of Practice (COP) for applying 1080 aerially in kea habitat is "*designed to minimise kea deaths during 1080 operations."* This COP contains six Compulsory Performance Standards (DoC, 2016). Standard 1 states that the usual type of bait must be used, while Standards 2 and 3 prescribe maximum bait sowing rates. Standards 4-6 concern the timing of operations relative to masting vegetation (masting is the intermittent production of large seed crops) and whether any monitoring of pest numbers is required before using 1080.

The COP (DoC, 2016) seems designed to *facilitate* poisoning, as follows:

- 1080 is now permitted to be applied in open areas above the treeline, whereas this was once prohibited to protect kea:
    - *"A previous standard has been removed, which prevented baits from being sown in areas of low structural vegetation cover (eg alpine herb fields and tussock) above the tree line. This was intended to protect*

> *kea by keeping baits out of open areas that could be easily avoided."* (DoC, 2014, p. 7))

- 1080 is permitted to be applied in kea habitat without any pest monitoring, during a 14 month period around the time of forest or tussock masting, on the basis that masting reliably predicts stoat plagues (Compulsory Performance Standard 4). It doesn't (O'Donnell & Hoare, 2012; Smith & Jamieson, 2003; Griffiths & Barron, 2016).
- Prior to the above period, 1080 is permitted to be applied in kea habitat on the basis of high mouse numbers (Compulsory Performance Standard 5), even though mice do not normally eat 1080 poisoned bait (Fisher & Airey, 2009).
- Operators can apply for exemptions to the Compulsory Performance Standards.

Recently it was claimed that in remote areas there was less need to consider the restrictions placed by the COP Standards 4-6 (Kemp *et al*., 2016, unpublished, p. 13). This was because kea in remote areas "*retain their innate caution and do not tend to consume 1080 baits.*" However at a monitoring site chosen for its remoteness, Kahurangi (Kemp, 2014a, unpublished, p. 3), 9% of marked birds were killed by 1080 ((Kemp *et al*., 2016, unpublished, p. 3). Also, rather than having "*innate caution*" kea are known to be extremely curious and attempt to eat anything at all (Currie, 2012).

The COP (DoC, 2016) contains many unjustified, unreferenced statements. For example:

> *"Kea are nationally endangered, due to recruitment failure caused by predation at the nest and to pulses of increased predation of adults and juveniles during stoat irruptions."* (p. 5)
>
> *"evidence suggests that kea are poisoned directly by eating 1080 cereal baits, not by scavenging possum carcasses"* (p. 7)[2]
>
> "*Both rats and mice are effective poison vectors for stoats in aerial 1080 cereal operations*" (p. 9)

5. Claims regarding long-term monitoring of bird populations

DoC's letter claims (p. 2, para. 6) that two long-term studies *"have shown native forest birds benefit from aerial 1080 operations"* and cites "*O'Donnell and Hoare 2012*" and "*G. Elliott, DOC, unpubl.*".

Despite the importance of this type of information it was a surprise to discover that there is almost no substance or indeed empirical data to substantiate this claim. O'Donnell & Hoare (2012) studied native birds in the Landsborough Valley subjected to *continuous* ground trapping for stoats *plus* trapping and ground-based poisoning of possums and four aerial 1080 operations over 11 years. The technique of five-minute bird counts, considered very unreliable due to the number of variables affecting counts (Westbrooke & Powlesland, 2005; ERMA, 2007; Green & Pryde, 2012; Hartley, 2012) was used to monitor numbers. There was no pre-treatment monitoring and no control. Reported results were decreases in four species, no change in two, and increases in nine. The authors stated that "*we are unable*

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[2]Mortality was usually monitored for 3-10 days only (Kemp *et al.* 2016, unpublished, p. 1) but poisoned baits (Eason, 1997) and carcasses (Ross & McCoskery, 2012) persist for months. Other risks are sub-lethal poisoning (Ataria *et al*., 2000) and reduced food resources (e.g. invertebrates (Jackson, 1960) may be depleted by the poisoning (Meads *et al*., 1994, unpublished) or the ensuing rodent plagues (e.g. Sweetapple & Nugent, 2007)).

to apportion increased abundance of mohua to a particular component of the pest control programme..."

The other citation (G. Elliott, DOC, unpubl.) turned out to be made in error and should have been cited as "*pers. comm.*" (Ann Thompson, DoC, personal communication, 2/10/16).

In lieu of the G. Elliott, DoC, unpubl. citation another unpublished report on mohua (Manno & Bardsley, 2015, unpublished) was provided. It presented the 2015 year's results of mohua (plus some bellbird (*Anthornis melanura*) and tomtit *(Petroica macrocephala toitoi*)) monitoring for the Catlins area. Pest control had been stoat trapping, followed by ground-based control of rats, then aerial poisoning in 2008, 2012, 2013 and 2014. (The decision to use aerial poisoning was made in spite of noted success with the ground-based rat control (Elliott & Suggate, 2007).)

The Manno & Bardsley (2015, unpublished) mohua study again relied on the flawed technique of five minute bird counts, with the authors noting "*There were concerns with reviewing the methods brought up in the Mohua recovery Group held in April 2014*". Methodological problems were encountered during the running of the programme meaning that data quality was further compromised and questions over potentially missing mohua could not be addressed (Manno & Bardsley, 2015, unpublished).

Reading Elliott & Suggate (2007) to find out more about DoC's mohua management was advised (Susan Timmins, personal communication, 11/11/16). That document is a progress report on management of mohua over seven areas. In six of the areas, management began with trapping stoats. After a few years, rat plagues had followed in five of the six areas, and were responded to in various ways including aerial 1080 poisoning. In the one area where stoat trapping was not used (Blue Mountains) there was no rat plague (Elliott & Suggate, 2007).

Comments made by DoC managers in the ***Rare Bits*** Newsletter support a possibility that the stoat trapping had brought on the rat plagues:

> "*Mohua populations in the Hurunui Mainland Island have decreased significantly following a rat plague...Over the last six seasons, mohua productivity and numbers were increasing as a result of stoat control, however rat plagues are a new phenomenon for DOC in the South Island with swift and catastrophic impacts.*" (DoC, 2002).

> "*The Mt Stokes mohua population has dropped dramatically...Predation by ship rats is thought to be the cause of the sudden decline. Intensive trapping of stoats had been sufficient to protect the birds because rats had almost never been recorded at this altitude on Mt Stokes.*" (DoC, 2000).

Therefore far from showing beneficial effects of aerial 1080 on native birds, the long term studies cited by DoC reveal a muddled government department lacking in ecological management skills which has inadequately investigated the long term effects of 1080.

Alternatives

The Department of Conservation letter refers to itself as a "*pest control agency*" (p. 1, para. 1). As such [over several decades] it has invested heavily in broadscale poisoning programs to kill vertebrate pests that appear or *may* appear in very large numbers (DoC, 2016; Elliott, 2016) and by contrast investment in monitoring of <u>effects of these programs</u> on native organisms has been extremely limited in scope and arguably also in scientific merit.

DoC's letter cites the NZ Parliamentary Commissioner for the Environment and the NZ Royal Society (p. 2, para. 7) claiming that although there is currently no alternative to using 1080 there is endorsement of innovative research and development of better poisons and possibly biocontrol options. Investment in species-selective toxins as well as fertility and biological control is seen as a far off prospect and in the meantime the emphasis is on "the *need to maintain and improve existing tools*" [i.e. poisons].

A creditable alternative is *conservation of ecosystems*, informed by scientific monitoring and applying pest control only as justified scientifically. Networks for ground-based monitoring and targeted pest control have been applied in several areas and have been used successfully in the past (Brown *et al*., 2015, p.10). Since then self-resetting technology has dramatically increased the efficiency of trapping (Nicoll, 2015). In addition a strong demand for pest resources (meat and fur) ensures that commercial use of some pest species can help offset costs (see Pollard, 2016).

Conclusion

Claims by DoC that there is evidence aerial 1080 poisoning is safe, will retain its efficacy against rats, has desirable outcomes and has no alternatives are readily refuted. Moreover, examination of DoC's internal unpublished documents regarding rare kea and mohua reveals no scientific or ecological basis underlying their management. There is an urgent need to review conservation management in New Zealand.

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Appendix 1. Letter from Susan Timmins (Acting Director, Threats), NZ Department of Conservation

Department of Conservation
Te Papa Atawhai

6 September 2016

Dr Jo Pollard
PO Box 35
Otago

jo@happypet.co.nz

Dear Jo

Thank you for your letter dated 26 August 2016 sent to both the Honourable Maggie Barry, Minister of Conservation and the Prime Minister, regarding your concerns that scientific facts about 1080 are being ignored by the Department of Conservation (DOC) and other pest control agencies. I am responding to you on behalf of the Minister and the Prime Minister as the issues you have identified fall under my portfolio as acting Director, Threats at the Department of Conservation.

I would like to start by reassuring you that the Department does not ignore scientific evidence, whether positive or negative concerning 1080 and its application, but does objectively weigh up the risks and benefits for each and every situation.

I have read the review on 1080 you provided to the Minister and believe your concerns fall broadly into the categories of safety, efficacy, outcomes, and alternatives. I will address each in turn in my response. I do not intend, however, to provide a detailed critique of your review and I note you have already contacted two of my staff regarding the same.

Safety

You express concerns that there are deficiencies in the knowledge of the effects of 1080. To support this assertion, you quote examples from the Environmental Risk Management Authority's (ERMA) Reassessment (2007) Evaluation and Review Report. However, you have focused solely on what you consider a lack of data/studies, without noting that ERMA did not consider these gaps significant and that it could still undertake a comprehensive risk assessment. The committee was satisfied that it had sufficient information to enable it to consider the application. In approving 1080, ERMA put in place controls to limit exposure to humans, animals, plants and the environment. They also recommended some research to fill in gaps in knowledge. This led to research into the degradation of 1080 in New Zealand soils (Northcott et al. 2014) and fate of 1080 during rainfall events (Srinivasan et al. 2012).

Furthermore, the Evaluation and Review Report was externally peer reviewed by Dr Abdul Moeed. Had the peer reviewer considered any of the gaps significant, this would have been noted and taken into account when the Committee made its decision.

Efficacy

You are quite correct that the efficacy of 1080 could decline if it is used inappropriately This decline could be a result of over-use of 1080 (e.g. annually as reported by Innes et al. 1995)

doc-2863655/16-H-224

leading to bait shyness or genetic resistance developing in a population (Howard et al 1973). Modern 1080 operations, however, use pre-feeding and higher 1080 concentrations, and rarely occur in sequential years. Also, few forest dwelling ship rats live more than 12 months (Innes 2005). This means that most ship rats exposed to 1080 baits will die during an aerial 1080 operation, and sub-lethally poisoned survivors are unlikely to survive the intervening period until the next control operation.

The poor rat kills you highlight during some of the Battle for our Birds 2014 operations were primarily as a result of bait distribution which gave rise to gaps too large for the density of rats present. This led to rats surviving because not all were exposed to the toxic baits. This has been identified as an issue and measures, such as recalibrating all buckets, are being taken to address it during the current Battle for our Birds operations.

Additionally, very good mouse kills occurred during some of the 2014 Battle for our Birds operations. Research is being undertaken during this year's operations to determine how to replicate these high mouse kills at all sites.

Outcomes

You list native species that have died during 1080 operations based on Spurr (1979), Spurr and Powlesland (1997), and Fairweather et al (2015). The significance of the loss of individuals from a population of native species as a result of 1080 poisoning depends on the context. Those species, such as robins and tomtits, with a large population and/or a high rate of increase can compensate for small loses. Threatened species usually have a poor ability to recover from additional mortality, making the consequences of individual deaths theoretically more concerning.

There have been numerous studies examining the effects of aerial poisoning on native non-target populations over the last 20 years. Twenty-one 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, whio and fernbirds (Veltman and Westbrooke 2011, van Klink et al. 2013). The upper 95% mortality rates for kokako, kiwi, kaka, whio are all less than 3.5%. The mean mortality rate for fernbirds is 9.4% (van Klink et al. 2013). Since 2010 DOC has implemented a Code of Practice when applying 1080 aerially in kea habitat which is designed to minimise kea deaths during 1080 operations. The levels of mortality during current operations are not considered as being significant at a population level, and the reduction in predators that result from the operations provides a net benefit to native species.

Long-term monitoring of bird populations has also been undertaken in the Landsborough Valley (O'Donnell and Hoare 2012) and the Catlins (G. Elliott, DOC, unpubl.) to assess the responses of bird populations to repeated aerial 1080 operations. These two studies have shown native forest birds benefit from aerial 1080 operations. Additional long-term studies are ongoing in the Tararua Ranges, Marlborough Sounds and South Westland.

Alternatives

You imply that the New Zealand Parliamentary Commissioner for the Environment and New Zealand Royal Society do not promote the development of alternatives to 1080. This is incorrect. The New Zealand Parliamentary Commissioner's report states 'Research to develop better poisons (and possibly biocontrol options) should absolutely continue', and the Royal Society's report recommends research into species-selective toxins and fertility and biological control. However, they also recognise this research will take time and until these are developed there will be a need to maintain and improve existing tools, hence the statements you quote from their reports.

I struggle with your review that concludes with a quote from King (1984) that NZ's ecological heritage is probably better left alone and native species are adapting to the threat of introduced predators. This is clearly not occurring, and has been directly refuted by other scientists (e.g. Basse et al. 1999, Innes et al. 2010). Even King has revised her view (King 2005), stating that the continued declines on a number of bird species are due mainly to stoats, possums and rats.

While I must disagree with your interpretation of the science concerning 1080 and its use as a pest control tool and your belief that the facts are being ignored, I do appreciate you raising your concerns. The Department believes that the survival of many of our highly threatened species depends on our ability to control pests on a landscape scale. At present 1080 is one of the most efficient and well researched tools we have to do this. But this should not stop us from looking for alternatives and I can assure you the Department supports this approach.

Yours sincerely,

Susan Timmins
Director Threats (Acting)

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Appendix 2. Claimed net benefit to kea

For kea populations, the claim of a net benefit from 1080 operations originates from DoC's Mr Josh Kemp who has stated that up to 26% of kea in a population could be killed in a 1080 operation, without losses to population numbers, because 1080 kills stoats (*Mustela erminea*) that would otherwise kill kea (Kemp, 2014b, unpublished, p. 5). Kemp has changed his position on kea mortality. In 2004 he & colleague Graeme Elliott stated:

> *"Given the birds' relatively high extinction risk, continued killing of kea is unjustifiable." ...*
>
> "*To use the destruction of kea as a tool in their management we would need to be confident that the population was stable or increasing and safe from extinction."* (Elliott & Kemp, 2004).

The total number of kea is unknown (Roberts, 2014; DoC, personal communication 11/11/16), but estimates as low as 1000 individuals have been made since 1986 (Bond & Diamond, 1992; Harper, 2012; Roy, 2016). Such rarity combined with their outstanding intelligence (Werdenich & Huber, 2006) and uniqueness among parrots (Anon, 2013) indicates they deserve careful management.

Previous research concluded that kea were not vulnerable to stoat predation:

> *"During the last hundred years Keas have shared their environment with rats Rattus spp. And stoats Mustela erminea. I have found no evidence of these animals affecting Keas. ..Twice I have found a dead possum Trichosurus vulpecula within five yards of a Kea nest. The opossum frequently chooses holes similar to a kea nest as a den and perhaps these two opossums prospected the Kea nests."* (Jackson, 1969)
>
> *"Kea nests appear to be relatively immune to predation from introduced mammals…Our results agree with a previous study of kea nesting at Arthur's Pass, where no evidence of significant nest predation was found (Jackson 1963)."* (Elliott & Kemp, 1999).

In March 2014 Mr Kemp stated:

> *"This year (2014-15) the DOC is gearing up to broadcast 1080 to poison pests over about 500,000 hectares of beech forest inhabited by kea under the Battle for our Birds campaign. These operations* ***are approved on the basis*** *that benefit derived to kea from stoat and possum control will outweigh the non target risk..."* (Kemp, 2014a, unpublished, p. 1.) (Bold emphasis added.)

There is very little documented evidence that stoats *are* kea predators, and none of it is published for scientific scrutiny:

- A study of 40 monitored nests of radio-tagged kea concluded "*The only nest failure we can confidently attribute to a specific predator was caused by a stoat*" (Elliott & Kemp, 2004, p. 9.) (Method of predator identification not described.)

- Predation by stoats was *inferred* from 5 kea nest visits by stoats, caught on motion-triggered still images outside of the nest which "assisted in identification of predators". Further details of identification were not provided but the unreferenced claim was made that "analysis of predator photographs...is presented elsewhere." Nests had multiple visits from stoats and other species (Kemp *et al.*, 2014, unpublished).

- Predation by a stoat was *inferred* from DNA testing of saliva as the cause of death of one kea in one study, and in another study, 7 kea were *inferred* to have died due to stoat predation due to the signs "corpse cached underground" and/or "puncture wounds on the skull". (Kemp *et al*., 2014, unpublished). However identifying predators is very difficult (Boulton & Casey, 2006). The facts that rats as well as stoats cache food (Innes, 2005, p. 189) and kea may have been dying or dead from other causes, were not considered by Kemp *et al*. (2014, unpublished).

- Historic nesting and survival records were used in analyses showing claimed effects of stoat predation on kea (Kemp *et al.* 2016, unpublished) as follows.

    - Deaths of 20 of 271 kea monitored with radio-harnesses between 1994 and 2015 were assessed against an unexplained binary index of plague or normal stoat numbers assigned to each year of recording. It was claimed the analysis showed survival was substantially lower in plague years. Nine of the 20 deaths occurred in normal years, while 11 deaths occurred in plague years.

    - Outcomes of 164 heavily monitored nesting attempts by kea (of which 77 failed) recorded between 1993 and 2015, were assessed against a three-point predator scale (low, moderate, or high predator year) and it was concluded that nesting success of the monitored birds was inversely related to the predator scale. No scientific basis for the scale was provided but it "*relied largely on seed rain assessments.*"

    - The authors admitted that the *"best example"* of aerial 1080 improving productivity of kea and preventing mortality from stoats was an operation at Okarito in 2011. Kemp *et al.* (2015, unpublished, p. 12) had already criticised this study as having a lack of replication, non-random assignment of the treatments and observers that were not blind to the treatments. Furthermore the 1080 operation was followed by large increases in mice, then rats, then a stoat plague in late 2012 (Kemp *et al.*, 2015, unpublished).

Seemingly critical information on kea has been left unpublished, for example:

> *"recent data shows a rapid decline in density during the period 1998-2011 at a site without predator control. (Josh Kemp unpublished data.)"* (Kemp *et al*., 2014, unpublished, p.1).
>
> *"In 2010, remote cameras recorded both possums and stoats attacking and killing kea at their nests in South Westland"* (B. Barrett, personal communication, cited in O'Donnell *et al*. (2017)).

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> "*Most of this work [study on kea numbers and nesting success 1992-1999] is described in detail in two papers that have been submitted for publication (Kemp & Elliott, in press and Elliott & Kemp, in press). This report summarises the findings of the two papers*" (Elliott & Kemp, 2004). (Neither of the "*in press*" citations was published.)

There is evidence of misleading reporting on the threat of stoats to kea. DoC employees O'Donnell *et al*. (2017) stated:

> *"For kea, predation in adjacent high altitude forests appears to be a significant threat. Although Jackson (1963, 1969) found no evidence of predators preying on adult kea or their nests, Elliott and Kemp (2004) found that predators, mainly stoats and possums, had reduced kea populations in the St Arnaud Range in Nelson Lakes National Park, and increased the likelihood of local extinction."*

Whereas Elliott and Kemp (2004) actually stated:

> *"Our modelling indicates that kea have suffered substantially since the arrival of humans and introduced predators in New Zealand. The significant effect of predation and hunting suggests that kea populations declined following the introduction of mammalian predators and hunting in the 1800s, but that the decline has slowed or even stopped."*

Even if stoats *were* a major predator of kea, then poisoning with 1080 is a poor method of controlling them for many reasons, including highly variable kill rates (King & Murphy, 2005; Dilks *et al*., 2011; Kemp *et al*., 2014, unpublished, p. 4). Stoats are unlikely to be poisoned by preying on mice, because mice do not normally eat 1080 pellets (Fisher & Airey, 2009), and alpine areas have very few rats for stoats to eat (Christie *et al*., 2016). Stoats that remain after poisoning can "prey-switch" to eat more birds than beforehand (DoC, 2002; King & Murphy, 2005), and the escalations in mouse numbers which follow 1080 operations are likely to fuel increases in stoat numbers (Byrom *et al*., 2013).

Harmful management to control stoat plagues for the sake of protecting kea nests is contra-indicated because natural stoat plagues last for only a few months (King 1984; 1990). Survival of kea adults, rather than any short -term threat to nests, is more important, because they are a long-lived species with a high juvenile mortality rate (estimated as 50-68%) (Jackson, 1969; King, 1984, p 34; Bond & Diamond, 1992). Any risk is spread because the nesting season is very broad (Jackson 1963, p. 321) and only a portion of adults breed in any year (Kemp *et al,*. 2016, unpublished, p. 6; Jackson, 1963, p. 322). Also there are indications that nesting increases in mast years (Kemp *et al*., 2015a, cited in DoC, 2016, unpublished, p. 6) potentially offsetting any increase in stoat predation. Fears that a mast-driven stoat plague would devastate birds in the Murchison Mountains turned out to be unfounded; when the food supply (mice) crashed, stoats shifted to eating ground weta (*Hemiandrus* spp.), not birds (Smith & Jamieson, 2003).

Additional threats to kea include starvation (Jackson, 1963), cars (Orr-Walker, 2012a), environmental degradation (Roberts, 2014), killing by DoC and members of the public due to causing damage (Roberts, 2014)), kill-traps set for stoats (Orr-Walker, 2012b) and cyanide baits used by DoC to control possums (Orr-Walker, 2012c).

Rather than poisoning and attempting to show a "*net benefit*", ecological monitoring quantifying limiting factors and science-based, low risk management are indicated for kea. Positive changes could include ceasing intrusive monitoring[3] and using live trapping for any pest control (instead of poisons or kill traps).

A report from the Kea Conservation Trust in 2012 painted a bleak picture of kea under DoC management:

> "*At the start of the 2011 season there were twenty-one kea radio tagged in the Hawdon valley, Arthurs Pass, to be monitored. Six transmitters were found to be in mortality mode (4 of which were adult breeding females). The loss of these birds significantly reduces the possible sample size of nests to monitor. Additionally, nine transmittered birds remained unaccounted for resulting in only six kea able to be followed. Three of these kea are adult females of which only one has been identified as attempting to breed (Queen Pow Pow). The other two females showed no indication of having active cavities or notable courtship or nesting behaviour. Nest cameras set up at the Queen Pow Pow's nest showed that this nest was abandoned with an egg intact and this pair moved to another nest site which also did not produce chicks. Information gleaned from this nesting season appears to indicate that the high number of deaths of both adult and sub-adult birds may now be affecting productivity. A case in point is the late 2010 nesting by Mrs Moon (one chick fledged at the end of April 2011). Mrs Moon died one month later on 8 June 2011.*" (Orr-Walker, 2012d).

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[3] E.g. Ceasing entering and monitoring nests: female kea invest many years in building their nests before finally laying, and normally use the same nest throughout their lifetimes (Jackson, 1963).

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