

1080

A Weighty Ethical Issue



1080: A Weighty Ethical Issue

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About the Invasive Species Council

The Invasive Species Council was formed in 2002 to advocate for stronger laws, policies and programs to keep Australian biodiversity safe from weeds, feral animals, exotic pathogens and other invaders. It is a not-for-profit charitable organisation funded by donations from individuals and philanthropic organisations.

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Summary

1080 – sodium monofluoroacetate – is very important for conservation in Australia, used extensively to protect rare native species from foxes, cats, pigs and rabbits. But many people oppose its use because it is regarded as inhumane.

In this report the Invasive Species Council considers the conservation and welfare consequences of 1080 baiting. We do this as an environmental organisation whose mission is to strengthen protection for Australian species from harmful introduced species, but also as people who care about the welfare of animals, whether introduced or native.

Diagnosing pain and distress in animals is difficult, and there is much uncertainty about the welfare impacts of 1080 poisoning, because the extent to which animals are conscious during some of the worst symptoms is unknown. However, it seems highly likely that 1080-poisoned animals suffer pain and distress before they become unconscious, although the extent and duration are highly variable and poorly understood. A 2010 assessment by an independent expert panel in New Zealand concluded that 1080 had severe to extreme impacts on the welfare of the species assessed (including cats, pigs and rabbits) lasting from hours to days, depending on the species. The panel had only a low level of confidence in most assessments due to the lack of information about many impacts.

1080 has been essential for enabling the survival or recovery of many threatened species and their reintroduction to sites where introduced predators have been suppressed or eradicated.

The use of 1080 also has welfare benefits for native animals who are freed from the pressure of heavy predation or competition by introduced animals. A ban on 1080 without an effective replacement would overall result in greater suffering (as well as declines in native species).

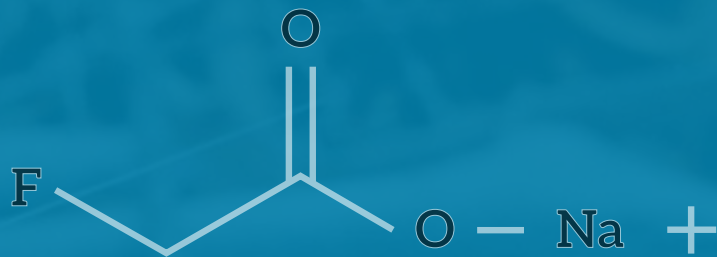
As a high priority, we recommend research into effective replacements for 1080 that are more humane. Four new more-humane baits have been approved in Australia since 2016, but they cannot totally replace 1080 due to their non-target impacts and limited delivery options.

We believe that an ethical approach to the welfare problems of 1080 requires the following:

- Develop and deploy more-humane and effective ways of controlling harmful introduced animals.
- Design long-term control programs that minimise the overall extent of killing of introduced animals – for example, by eradicating or substantially suppressing their populations, and by intervening ecologically to help native animals withstand invasive pressures.
- Improve monitoring to ascertain whether 1080 baiting (and other methods) achieve conservation goals and are cost effective (it is unethical to

kill animals if no conservation benefit is achieved and wrong to waste scarce conservation funds).

- Strive to better understand (where feasible) the welfare consequences of 1080.
- Strengthen biosecurity prevention, eradication and containment to stop the establishment and spread of new introduced species.



The chuditch (or western quoll) once occurred in every mainland state and territory, but was wiped out by foxes and cats everywhere except in Western Australia (mainly in the south-west). Thanks to 1080 baiting of foxes and cat control, it was reintroduced in 2014 to Ikara-Flinders Ranges National Park in South Australia.

Photo: S J Bennett CC BY 3.0

1080 has been essential for enabling the survival or recovery of many threatened species and their reintroduction to sites where introduced predators have been suppressed or eradicated.

1. Introduction

Large-scale killing of introduced animals is one of the painful necessities of conservation in Australia. But should poisoning with 1080 remain a method of choice?

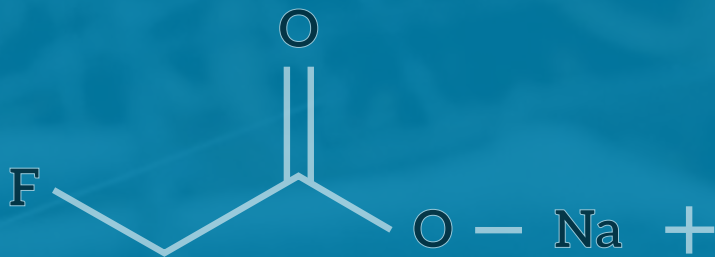
1080 (sodium monofluoroacetate) is used in Australia to protect rare native species from foxes, cats, pigs and rabbits (see Box 1). It is also used to kill dingoes and feral dogs, mainly to protect sheep and cattle. Non-target animals also sometimes die from taking baits or eating poisoned animals (see Box 2).

There are many different views about 1080. The RSPCA considers it inhumane and advocates research into alternatives.¹ Other groups want it immediately banned because it is thought to cause 'a great deal of suffering'.² But others regard 1080 as essential to save native animals such as the numbat from extinction. Without such baiting, says the Western Australian

Government, some native species 'could be lost forever, or only found in small, fenced reserves'.³

Here, we aim to take a clear-eyed look at the conservation and welfare consequences of 1080 baiting. We do this as an environmental organisation whose mission is to strengthen protection for Australian biodiversity from harmful introduced species, but also as people who care about the welfare of animals, whether introduced or native. We do not consider here the use of 1080 for agriculture or forestry, although many of the points made here are relevant to those sectors.





BOX 1

Biodiversity benefits of 1080 baiting for foxes

Foxes are one of the main causes of extinction of at least 12 Australian mammals⁷² and considered a threat to at least 76 species.⁷³ At greatest risk are small-to-medium-sized mammals, ground-nesting birds and turtles.

1080 baiting is considered the most effective way to reduce fox populations.⁵⁶ Species listed nationally as threatened for which there is evidence of benefit include endangered numbats, southern brown bandicoots, woylies, western barred-bandicoots and black-flanked rock-wallabies, and vulnerable long-nosed potoroos, boodies, greater bilbies, greater stick-nest rats, western quolls, yellow-footed rock-wallabies and golden bandicoots.^{48,74-79}

1080 baiting has enabled the reintroduction of several threatened species to sites where they used to occur.^{74,75} For example, a South Australian subspecies of tamar wallaby that became extinct there in the 1930s was reintroduced to southern Yorke Peninsula in 2004 (from an introduced population in New Zealand).⁸⁰ Due to intensive fox control, the population has become self-sustaining. Other species have reappeared (bush stone curlews after 40 years of no sightings) and populations of threatened malleefowl, hooded plovers and Rosenberg's goannas have stabilised or increased. It is now proposed to reintroduce other locally extinct species.

Western Australia has been the leader in fox control for conservation, baiting in reserves since the early 1980s. This was expanded in 1996 under the Western Shield recovery program and now occurs across almost 4 million hectares.^{77,81} 1080 control in the west is aided by the occurrence of natural sources of the 1080 toxin (in plants from the *Gastrolobium* genus⁸² to which many native animals have evolved resistance). The baiting has enabled threatened species to stabilise or rebound in many sites and be reintroduced to others. It led to the woylie, tamar wallaby and quenda being removed from the state's threatened species list.⁷⁷ However, in the early 2000s it became apparent that targeting only foxes is insufficient. Woylie populations, in particular, have plummeted. Rising feral cat numbers rising in fox-baited sites are thought to be the main cause,⁶⁵ but disease is another possibility.⁸³ There is now a much greater focus on feral cat baiting (the most effective control method), although it is not consistently effective.^{53, 84, 85}

Under South Australia's Bounceback program, 1080 baiting of foxes in combination with shooting of feral goats has been effective in increasing populations of threatened yellow-

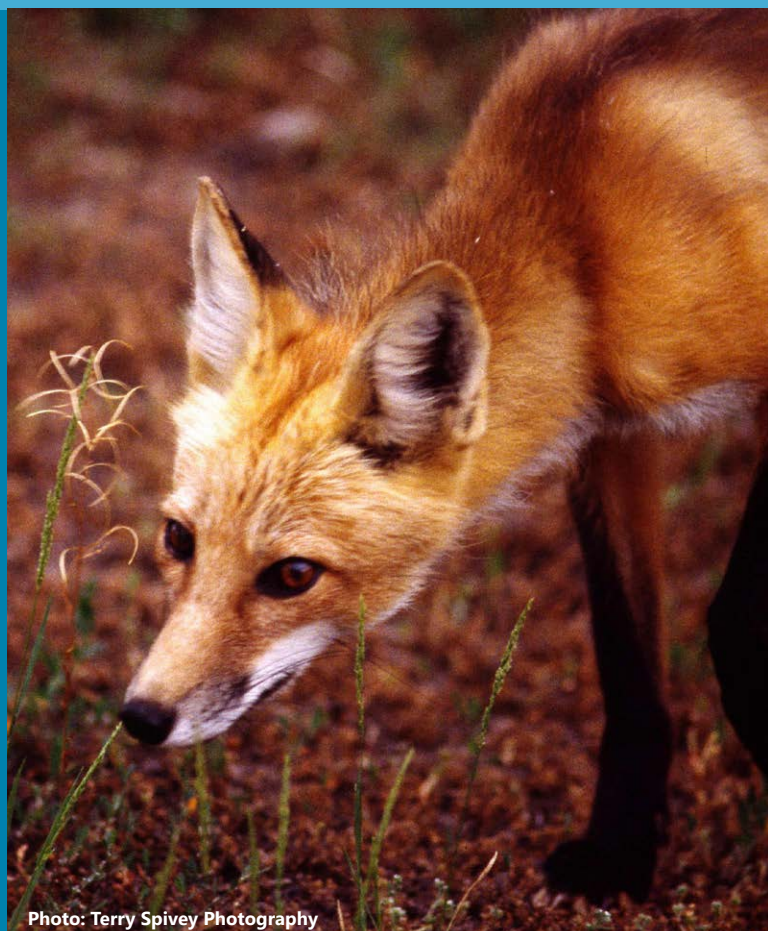


Photo: Terry Spivey Photography

footed rock wallabies.^{79,86} Fox baiting and control of cats in the Ikara-Flinders Ranges National Park also enabled the so-far successful reintroduction of western quolls (extinct in South Australia) and brushtail possums in 2014.^{87,88}

There is also evidence of effective baiting in eastern Australia.^{48,49,79,89,90} For example, a study in the eucalypt forests of East Gippsland (Victoria), one of the state's last strongholds for several rare mammals susceptible to foxes, found more mammals overall and more southern brown bandicoots, long-nosed potoroos, and brushtail possums after baiting compared to non-baited sites.⁴⁸ Baiting with 1080 has enabled the eradication of foxes from Phillip Island, achieved in 2017, to protect ground-nesting seabirds such as the little penguin.^{90, 91}

2. 1080 and animal welfare

There is much disagreement and uncertainty about the welfare impacts of 1080 poisoning.⁴⁻⁸ Diagnosing pain and distress in animals can be difficult because it relies on interpreting changes that can be observed or measured, in their behaviour, physiology and functional state. The observable symptoms of 1080 are diverse and vary between species and individuals.⁷ Many symptoms look to be distressing and painful, but because 1080 depresses the central nervous system it has been argued that affected animals are likely to have a low level of awareness much of the time and therefore not suffer much.^{6,9}

Sodium fluoroacetate acts in multiple and complex ways.^{10,12} It is toxic because of its similarity to acetate, which has a pivotal role in energy production in cells.¹² 1080 disrupts that process, leading to organ dysfunction. Citrate accumulates in blood and tissues, binding calcium, which leads to abnormal heart function and disrupts communication between nerve cells.

For species targeted in Australia (foxes, cats, pigs and rabbits), the time to death ranges from about 2.5 to 80 hours.⁵ It may result from cardiac failure or ventricular fibrillation (erratic heartbeat), depression of the central nervous system leading to cardiac or respiratory failure, or respiratory arrest following convulsions.^{7,11}

In 2010, the New Zealand National Animal Welfare Advisory Committee (an independent expert body) assessed and ranked the welfare impacts of 1080 and other toxins.⁸ They used the '5 domains' method, assessing the

published evidence for changes in behaviour, physiology, neurophysiology and function, and the negative feelings likely to arise from these, such as pain, nausea, thirst, hunger, malaise, fear and anxiety, taking into account the duration of impacts. They found that 1080 had a severe to extreme impact on the welfare of the species assessed (possums, rodents, stoats, ferrets, cats, rabbits, pigs and wallabies), which lasted from hours to days, depending on the species. They assigned 'intermediate' impact scores ranging from 5.5 to 6.5 out of a maximum score of 8 (see Table 1). 1080 scored better than anticoagulants such as pindone and brodifacoum (scored as 7.5 to 8), but much worse than cyanide, which causes rapid loss of consciousness (scored as 4 for possums, the only animal assessed).⁸ However, the panel had only a low level of confidence in most assessments due to the lack of information about many impacts, particularly about the level of consciousness of affected animals.

Carnivores poisoned by 1080 go from states of hyperactivity and uncoordinated movement to lethargy, recumbency, tremors and convulsions, and respiration is also affected.⁸ They are likely to experience lethargy, weakness, sickness and breathlessness before losing consciousness, but it is uncertain whether they are conscious during and after convulsions (because 1080 disrupts two major neurotransmitter pathways).⁶ The effects are complex, and the panel found it was not possible to assess pain levels.

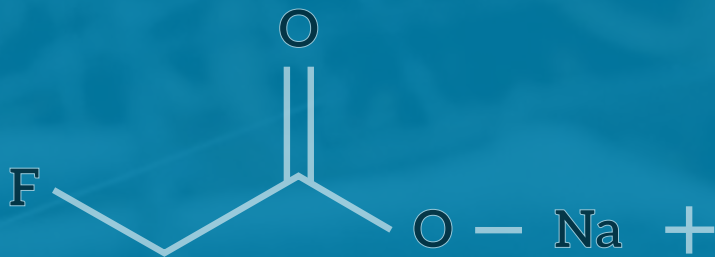
Herbivores tend to be 'relatively undemonstrative of pain and sickness', making it difficult to assess their welfare.⁸ The Centre for Invasive Species

Solutions says no studies have 'either proved or disproved the distress or pain' of herbivores poisoned by 1080.⁴ The expert panel reported that poisoned rabbits suffer respiratory problems, cardiac dysfunction and convulsions, but whether they are conscious during or after convulsions is unknown.⁸ They are likely to experience lethargy, weakness and breathlessness, and maybe pain, anxiety and fear. Although the impacts on deer were considered likely to be less severe than for other species, there was insufficient information for the panel to do an assessment.⁸

The one omnivore assessed by the New Zealand panel, pigs, often suffer intense retching and vomiting after 1080 ingestion, and probably also nausea, lethargy and breathlessness.⁸ It is not known whether they are conscious in later stages when some undergo spasms and convulsions.

In the rare cases of human poisoning, nausea, vomiting and abdominal pain are common, followed by sweating, confusion and agitation.¹² There can be respiratory distress, extreme anxiety, volubility, irritability and hyperactivity.¹³ Consciousness is progressively impaired after a few hours, sometimes leading to coma and death.

On the available evidence, we conclude that animals poisoned with 1080 are highly likely to suffer pain and distress, but the severity and duration in different species and individuals are variable and poorly understood.



Many Australian animals owe their survival to native pea bushes that manufacture a poison to defend their leaves and seeds. These plants in the *Gastrolobium* genus first became the focus of scientific attention in the mid-1800s due to large numbers of sheep and cattle dying in south-west Western Australia from eating 'poison peas'. The poison was found to be monofluoroacetic acid, the key ingredient of 1080. Its natural occurrence in Australia, mainly in the south-west, has facilitated the use of 1080 for conservation because many native animals are much more tolerant to it than introduced mammals. Plants with monofluoroacetate also occur in Africa and South America. The plant shown here is prickly poison (*Gastrolobium spinosum*). Photo: Jean and Fred Hort | Flickr CC | BY 2.0

Table 1: Summary of assessed welfare impacts of 1080 by an independent expert panel

	Carnivores	Rabbits	Pigs
Welfare impact	Severe–extreme	Severe	Severe–extreme
Duration of impact	Hours	Hours	Hours–days
Overall grade (out of 8)	6	6	6.5
Confidence level	Low	Low	Moderate

Only species relevant to Australia are included here. The review panel consisted of six members, with expertise in animal welfare science, pest animal management, veterinary science and toxicology. The assessment was based on a framework developed by Sharp and Saunders (2008)¹⁴, which combines welfare impact (low to extreme, based on the five domains method) with the duration of impact (seconds to weeks). For example, a grade of six can indicate a 'severe' impact that lasts for minutes or a 'moderate' impact that lasts for days. The higher the number, the greater the impact. The grade here is the median score of the panel members.

Source: Landcare Research, New Zealand (2010)⁸

3. The ethics of 1080

Saving Australia's unique species is at the ethical heart of the Invasive Species Council's work. Australia has global obligations, legal and moral, to prevent extinctions and recover threatened species. However, animal welfare is also ethically important. While our organisation prioritises the survival of native species, decisions to kill animals should not be taken lightly. The consequences for both biodiversity and sentient beings should be considered.

In many cases there is little conflict between these values – killing introduced animals is often the best overall outcome both for animal welfare and conservation. Introduced predators such as cats, foxes and rats can cause great suffering when they prey on native wildlife, as can other introduced species such as rabbits and pigs when they compete for food and degrade habitats. The numbers of native animals affected are usually much greater than the number of introduced animals causing that suffering. Feral cats, for example, each kill an average of 225 reptiles and 129 birds a year in natural environments.^{14,16} Before the eradication of a population of about 50 cats from Tasman Island, they were killing up to 60,000 seabirds a year.¹⁷ If we think over larger timescales, the death of those 50 cats will save millions of seabird lives. Particularly when 1080 is used on islands or in fenced reserves to eradicate harmful species, the ratio of averted-suffering to caused-suffering is enormous.

Those who want 1080 immediately banned rarely mention the suffering that is averted by its use. A ban on 1080 without an effective replacement would

overall result in greater suffering.

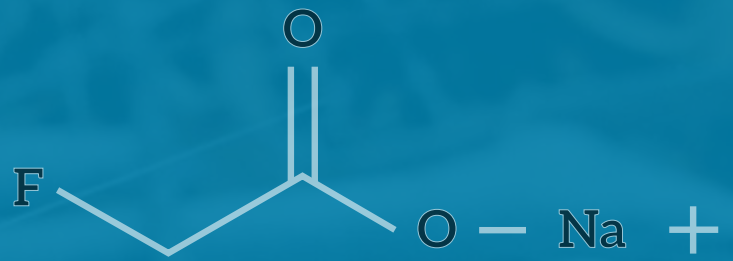
Recently, under the appealing banner of 'compassionate conservation', some researchers have argued against killing for conservation. Although we support their stated aim to 'safeguard Earth's biological diversity while retaining a commitment to treating individuals with respect and concern for their well-being',¹⁸ they do not, beyond a few limited examples, show how this can be done. In one article breathtaking for its disavowal of evidence, they claim that feral cats have not caused any extinctions and that native animals will adapt to them.¹⁹ To the contrary, there is evidence that cats were a major cause in the extinction of at least 22 Australian mammals and threaten at least 56 others.²⁰

Conservationists would embrace non-lethal methods for controlling harmful introduced animals if they were available and effective. But, unfortunately, conservation is currently not feasible in Australia without killing, and baiting is the only effective method for controlling cats, foxes and pigs over large areas.^{21,22} It does not mean that those who advocate or engage in this 'forfeit their humanity', regard introduced animals as 'inherently malicious' or are fundamentalists rooted in 'xenophobic ideology', as is claimed by the 'compassionate conservationists'.^{18,23} It seems to us neither compassionate nor consistent with conservation to prioritise the welfare of harmful and abundant introduced animals over the survival and welfare of often-rare native animals.

We believe it should be a high priority to develop replacements for 1080 that are effective and more humane. An ethical

approach to the welfare problems of 1080 requires the following:

- Develop and deploy more-humane and effective ways of controlling harmful introduced animals.
- Design long-term control programs that minimise the overall number of introduced animals killed – for example, by eradicating or substantially suppressing their populations or by intervening ecologically to help native animals withstand invasive pressures (for example, by protecting dingoes where they suppress cats and foxes).
- Improve monitoring to ascertain whether 1080 baiting (and other methods) achieve conservation goals and are cost effective – it is unethical to kill animals if no conservation benefit is achieved and wrong to waste scarce conservation funds.
- Strive to better understand (where feasible) the welfare consequences of 1080 baiting, particularly for herbivores.
- Strengthen biosecurity prevention, eradication and containment to stop the establishment and spread of new introduced species.



Each feral cat kills an average of 225 reptiles and 129 birds a year in natural environments, as well as many native mammals.

Photo: Mark Marathon - CC BY-SA 4.0

It seems to us neither compassionate nor consistent with conservation to prioritise the welfare of harmful and abundant introduced animals over the survival and welfare of often-rare native animals.

4. Alternatives to 1080

Almost all methods of killing animals in the wild are likely to cause some suffering, so the quest for 1080 replacements has so far been about reducing rather than eliminating welfare consequences.

Four new poison baits have recently been approved for use in Australia: one each for foxes (2016), dogs (2016) and cats (2020) using para-aminopropiophenone (PAPP) and one for pigs using sodium nitrite (2019).²⁴⁻²⁷ These toxins act more quickly than 1080 and have been assessed as considerably more humane.²⁸⁻³¹ Like carbon monoxide, they act by reducing the capacity of red blood cells to carry oxygen, causing animals to become lethargic, fall asleep, lose consciousness and die from lack of oxygen to the brain and heart, usually within one or two hours. There is still some potential for anxiety and distress, exposure to predation or weather and, in dogs, vomiting.²⁸

However, PAPP and sodium nitrite are currently intended as additional control options rather than total replacements.²⁷ They are not registered for aerial use and have different non-target impacts from 1080, which are reasons to maintain 1080 options. For example, lizards such as monitors and goannas are highly susceptible to PAPP (but not 1080, see Box 2), which may limit the use of PAPP to times when reptiles are not active.^{32,33} Because sodium nitrite is highly toxic to many species, it can only be used with

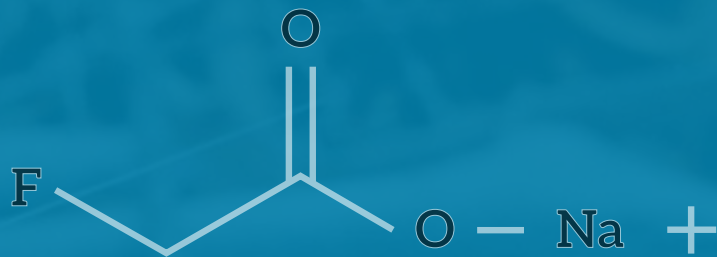
target-specific delivery mechanisms.²⁶ Having multiple options also reduces the risk of targeted animals developing tolerance or aversion to one toxin.³⁴ Therefore, the ethical imperative to develop more-humane and effective control options to replace 1080 remains high.

There has also been progress on delivery systems to reduce the risks of non-target animals finding and eating baits (see Box 2).²⁹ For example, a 'grooming trap' has been developed that detects cats and foxes and squirts a fatal dose of toxin onto their fur, which triggers grooming and ingestion.³⁵ Although there are still animal welfare consequences for target animals, depending on the toxin used, overall suffering is reduced because other animals are not poisoned.

Contraception is often touted as a humane alternative to poison. Immunocontraceptives, which stimulate an animal's immune system to produce antibodies to hormones or proteins involved in reproduction, have been used for managing populations of elephants, horses, bison, deer, boar, pigs and cats.^{36,37} While it is feasible to deliver immunocontraceptives over large areas in baits,^{38,39} contraception is unlikely to be effective as a primary method of control in Australia.⁴⁰ Modelling of feral fox populations baited annually with either a contraceptive or poison found that densities would drop by about 80% with poison but only by 30% with contraceptive.⁴⁰ This level of reduction

is not enough to protect threatened species, for sterile foxes continue to prey on wildlife. However, contraception may be useful in future as a supplement to other forms of control.⁴¹

Fertility control is also not necessarily humane, for it can affect the physiology, survival and behaviour of treated animals.^{37,42} For example, immunocontraception can extend the breeding season, which is energetically demanding and can compromise the condition of treated males.⁴²



Australia's largest fairy prion colony, with 300,000 to 700,000 pairs, occurs on Tasman Island (off the southeast tip of Tasmania). Cats, introduced as pets for lighthouse keepers, were killing some 30,000 to 60,000 prions a year. Within three years of all 50 cats being killed, the activity of fairy prions had increased three-fold.

Photo: Ed Dunens | CC BY 2.0

Killing introduced animals is often the best overall outcome both for animal welfare and conservation. Before the eradication of a population of about 50 cats from Tasman Island, they were killing up to 60,000 seabirds a year. If we think over larger timescales, the death of those 50 cats will save millions of seabird lives.

5. The ethics of efficacy

Whatever method is used to manage introduced animals, efficacy is essential. Otherwise, there is only pointless suffering, with little or no welfare or conservation benefit for native animals. To be effective, 1080 baiting must reduce the population of harmful species enough to achieve a net conservation benefit. It must also be cost-effective.

One big problem with much conservation management in Australia, including by poison baiting, is a lack of monitoring to assess effectiveness.⁴³⁻⁴⁶ One study found that from 1990-2003, there was no monitoring for about two-thirds of control actions for feral mammals.⁴⁷ As a result, management is often based on anecdotal information, ecological intuition or past practice.⁴⁶

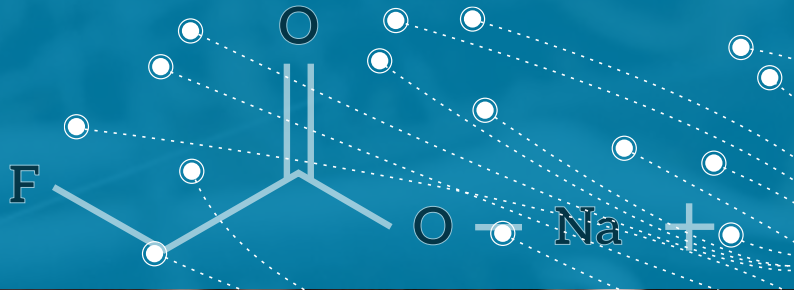
Nonetheless, evidence has accumulated that 1080 can be of great conservation benefit, enabling populations of threatened wildlife to recover and locally extinct species to be reintroduced (see Box 2 for examples).⁴⁸⁻⁵⁸ Fox baiting has 'arguably prevented the extinction of many native species'.³⁴ Toxins (not just 1080) have also been the primary method for 160 eradications of introduced animals on 111 Australian islands,⁵⁹ the best outcome for both conservation and animal welfare. One recent success was the eradication of cats from the 630km² Dirk Hartog Island (off the Western Australian coast), primarily through aerial 1080 baiting, which will allow threatened mammals to be reintroduced.⁶⁰ Cats had wiped out 10 of 13 native mammals and suppressed other species.

But there are also documented examples of ineffective baiting^{46, 54, 61-64}. For example, a 2012 assessment of

data from 64 monitoring sites found that malleefowl in southern Australia were mostly not benefiting from fox baiting.⁴⁶ The typical baiting intensity may have been too low (it was well below recommended levels) or frequent fire and grazing by introduced animals may be greater threats than foxes. Unintended cascading impacts are another problem: fox control in some cases leads to more cat predation (see Box 1).^{44, 65} Ineffective (and therefore pointless) baiting is likely to be a much greater problem on private properties due to inadequate coordination, resources, time and care leading to poor spatial coverage⁵⁰.

Controlling introduced animals for conservation is difficult. Usually, a large reduction (50-90% depending on the species and conditions) is needed to overcome the capacity of their populations to quickly rebound⁶⁶ – due to immigration, rapid reproduction and survival of young that would normally die due to starvation or disease. Ecological consequences such as higher numbers of cats due to fox control also have to be managed.

Efficacy and ethics require that management be evidence-based.⁴⁴ Evidence of damage to species and ecosystems is needed to justify control and evidence of benefit is needed to justify ongoing baiting (applying the precautionary principle when evidence is too difficult, time-consuming or costly to obtain).



1080 baiting for foxes and cats has been critical to the survival of numbats, listed as endangered.
Photo: Seashalia Gibb from Pixabay

Nationally threatened mammals that benefit from 1080 baiting for foxes include endangered numbats, southern brown bandicoots, woylies, western barred-bandicoots and black-flanked rock-wallabies, and vulnerable long-nosed potoroos, boodies, greater bilbies, greater stick-nest rats, western quolls, yellow-footed rock-wallabies and golden bandicoots.

6. Summing up

The available evidence and assessments by welfare experts indicate that 1080 causes suffering and distress in poisoned animals. But this does not mean 1080 should be banned. 1080 baiting has been essential for protecting and recovering threatened species, especially mammals threatened by foxes. It also benefits the welfare of native wildlife protected from the harm caused by invasive animals.

The search for effective and more-humane replacements for 1080 should be a high priority. Some progress has been made, with the recent release of

baits based on PAPP and sodium nitrite, but they are not a complete replacement for 1080. To avoid pointless suffering, it is important to ensure 1080 baiting programs achieve real conservation outcomes. The key to this is monitoring, which should focus on the outcomes for native species (not just on the numbers of target animals killed).

BOX 2

Non-target impacts of 1080 baiting

There have been few assessments of risks to non-target animals. The risks are difficult to quantify as species and individual animals vary widely in their tendency to find and eat baits and their sensitivity to 1080.^{21,67} Cats and dogs (including foxes and dingoes) are highly susceptible to small doses of 1080, while most native animals are less susceptible (see Figure 1).^{21,67} This is particularly so in south-western Australia, where many animals have evolved tolerance to the 1080 that occurs naturally in plants in the *Gastrolobium* genus. In some areas an adult quokka would need to eat at least 36 and up to 80 fox baits (each with 3 mg 1080) in a day to receive a lethal dose.⁶³

Generally, mammals are more sensitive than birds, which are more sensitive than reptiles and amphibians, and herbivores tend to be more sensitive than others (Figure 1).⁶⁸ Animals not native to Australia tend to be more sensitive than native animals, and those in eastern Australia are more sensitive than those in Western Australia.

Small native carnivores and rodents are likely to be susceptible to meat baits, particularly if they eat multiple baits, and

macropods and wombats to non-meat baits.^{67,69} But there have been very few documented non-target deaths. The only records for native animals listed in a 2013 review were for bush rats, silky mice, wood ducks, wombats and spotted-tailed quolls.⁶⁹ This lack of records is partly due to the difficulty of finding killed animals and establishing that they have died from 1080.⁶⁸ There are more anecdotal records than this, but few systematic studies.

There has been particular concern about quolls. However, five trials (in New South Wales, Queensland and Western Australia) found the risks to be low.²¹ Of more than 150 monitored quolls, only three were confirmed to die from 1080. Such losses are likely to be more-than-compensated by benefits to quolls from fewer foxes and cats.

Baiting of pigs is potentially risky due to the large doses of 1080 in each bait (72 mg in meat baits). However, a study of bird densities in Queensland's Culgoa National Park before and after aerial baiting found no significant changes in the abundance of potential bait-eating birds.²² Similarly, a study using fruit baits found 'negligible' risk to non-target species.⁷⁰

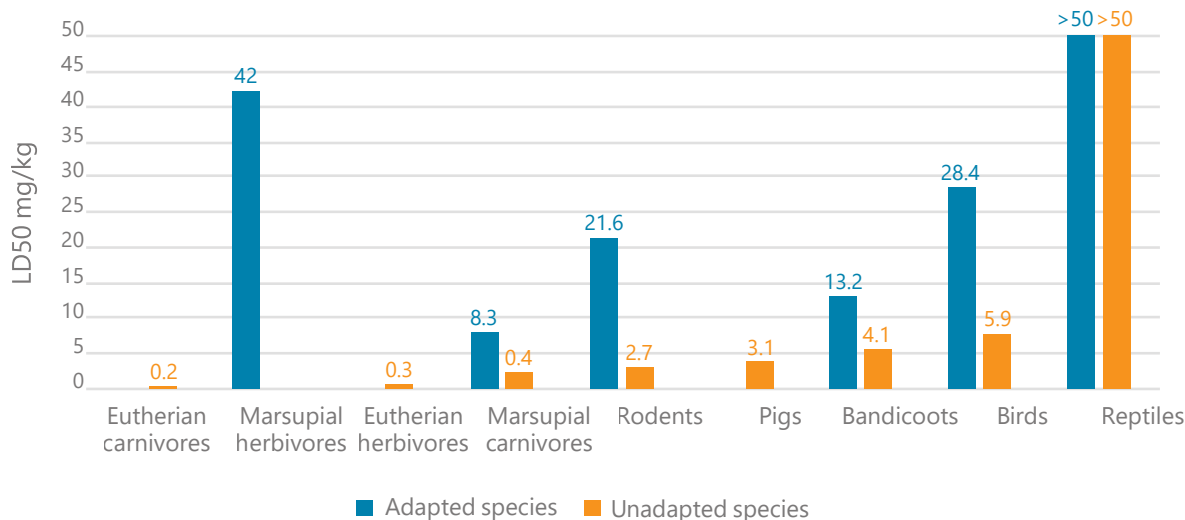
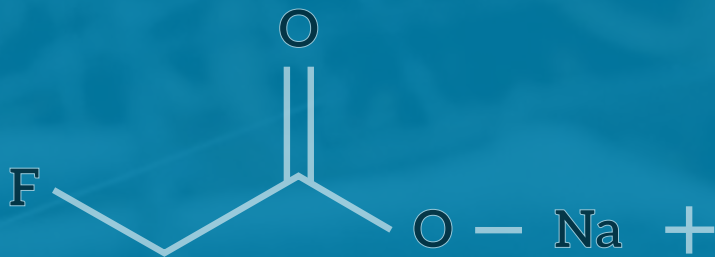


Figure 1. The average sensitivity (mean LD50) of different groups of animals to 1080.

Source: McIlroy (1992)⁶⁸

Notes: 'Adapted' species are those with an evolutionary history of exposure to sodium fluoroacetate in gastrolobium plants. LD50 is the amount of poison that will kill 50% of a population of animals. Within each group, the LD50 varies – eg for the first five unadapted groups (left to right): 0.1-0.4, 0.1-1.0, 0.4-0.5, 1.0-4.2, 0.7-9.2mg/kg.

Secondary poisoning could be a problem for carnivorous mammals and raptors and other scavenging birds that eat the carcasses of animals poisoned by 1080 but, again, there are few records of this occurring.⁶⁹

Non-target impacts can be limited by delivery methods that prevent or deter non-target animals from eating the toxin, including:²

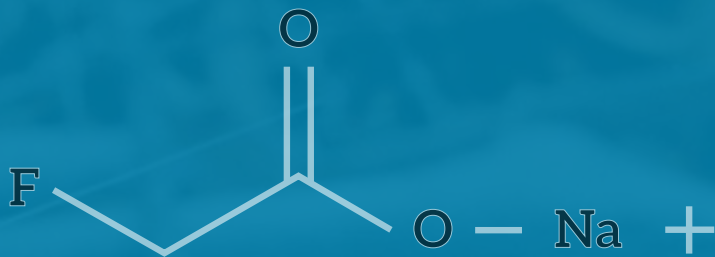
- Burial of baits.
- Incorporation of dyes or deterrent chemicals into baits.
- Use of the M-44 ejector, a device that delivers powdered toxin into the mouth of an animal that bites the trigger mechanism with sufficient force (limiting it to larger animals).
- Use of bait stations (a buried bait surrounded by smoothed sand to enable identification of animal tracks or with camera monitoring); initially, toxin-free baits are provided and stations where the bait was taken by a non-target animal are not used when toxic baits are provided.
- Grooming traps that detect cats and foxes and squirt a fatal

dose of toxin onto their fur.³⁵

- Encapsulation of toxin in a hard capsule that dissolves in the stomach and is rejected by many native animals.⁷¹

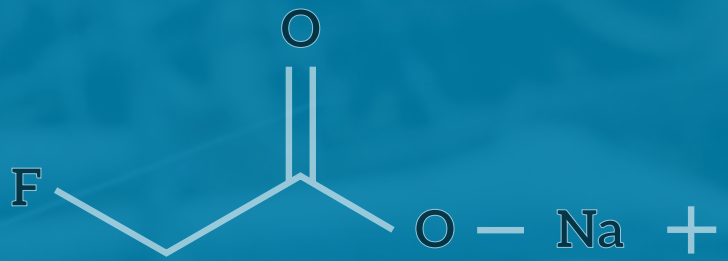
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