HUMANE SOCIETY INTERNATIONAL

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Committee Secretary
House of Representatives
Standing Committee on Agriculture, Fisheries and Forestry
Parliament House
Canberra ACT 2600

22nd March 2005

Dear Secretary of the Committee,

Re: Standing Committee on Agriculture, Fisheries and Forestry: Inquiry into the impact on agriculture of Pest Animals.

Humane Society International (HSI) wishes to lodge a submission on the Inquiry into the Impact on Agriculture of Pest Animals.

Should you require any further information on our submission please don't hesitate to contact me at HSI's Sydney office on (02) 9973 1728.

Yours sincerely,

Lizzie Bowman
Research Assistant
Humane Society International

House of Representatives

Standing Committee on Agriculture, Fisheries and Forestry

INQUIRY INTO THE IMPACT ON AGRICULTURE OF PEST ANIMALS

Submission by Humane Society International

Introduction:

Humane Society International (HSI) recognises the need for a coordinated, national approach to pest control in Australia. While HSI is one of Australia's leading conservation organisations campaigning for stronger biodiversity protection, we also promote the humane treatment of all animals. There does not need to be a conflict between the two objectives. Where animals are a confirmed problem for commercial interests or for native wildlife, we must strive for humane solutions.

HSI is seriously concerned that the Terms of Reference do not address any issues related to animal welfare and the need for humane methods in pest control. Thus the purpose of this submission is to recognise the importance of this matter when dealing with pest control issues. We also refer to the 3rd Term of Reference and talk about the conservation implications of some forms of pest control.

Animal Welfare:

HSI is deeply concerned that animal welfare is not considered sufficiently in many strategies for pest control. Animal welfare should never be compromised in pest control and should be a key issue when developing and adopting methods.

The use of 1080 baiting is widespread in Australia. This form of pest control is extremely inhumane and has a range of symptoms including anxiety, salivation, nausea, vomiting, incontinence, twitching, auditory hallucinations, organ congestion, renal tube degeneration, respiratory problems, spinal pressure, citrate accumulation in tissues, convulsions, coma and death. As a result, animals experience extreme pain and can take several hours to die. There is a heavy reliance on 1080 poison for pest control in Australia and this leads to a lack of incentives to develop and adopt alternative methods that may also be more effective to control pests.

Shooting is also a widespread method. HSI is primarily concerned that people carrying out shooting are rarely marksman experienced enough to ensure a quick kill. In regards to aerial shooting even experienced marksman are unable to ensure a humane kill. An example includes the mass suffering of animals wounded and left to die in the recent aerial shooting of brumbies in Guy Fawkes National Park, NSW. HSI does not condone mass shootings of native and non-native animals. Furthermore we do not condone bounties for the shooting of animals such as that introduced recently for cats in the town of Richmond, north-western Queensland.

There are several other methods of pest control that have animal welfare concerns including fumigants, trapping and deliberately introduced diseases.

Conservation:

1080 poison (sodium monofluoroacetate)

In a consultancy report to HSI on the suitability of 1080 poisoning for listing as a 'key threatening process' under the *Environment Protection and Biodiversity Conservation Act* (EPBC Act), Dr Martin Denny (2001) suggests that the required criteria could be met. According to Dr Denny, the range of non-target native fauna affected by 1080 poisoning is considerable. We have enclosed a copy of the report.

HSI is concerned of the effect that 1080 baiting has on native wildlife, particularly the tiger quoll (*Dasyurus maculatus maculatus* – south east mainland population). The south east mainland population of the tiger quoll has recently been upgraded from vulnerable to endangered under the EPBC Act.

The effect of 1080 on the tiger quoll is still being disputed, however there is research that does indicate that it is likely to be a threat to the species. Reports carried out by Blecher (1999, 2000a) makes particularly clear the threat to all quoll populations from 1080 baiting campaigns:

> "*Survey results from Otway Ranges found that the Tiger Quoll was critically endangered and that the decline was most likely due to 1080 poison baiting and clear fell logging*" (Blecher 1999).
>
> "*Population monitoring in south-eastern NSW and East Gippsland has documented population crashes and local extinctions following 1080 baiting*" (Blecher 2000a).
>
> "*Aerial, hand and mound 1080 poison baiting is widespread throughout the (Tiger Quoll) species range in QLD, NSW and VIC. The impact of baiting on populations monitored at Baja State Forest, Tallanganda State Forest and Suggan Buggan ranged from 60% to 100% reduction in local populations*" (Blecher 1999).
>
> "*The results of the analysis of Tiger Quoll records from the Otway Ranges and the Southwest of VIC indicate that the species is likely to become extinct within the next 10 years under current land management practices, such as clear-felling and 1080 poison baiting*" (Blecher 1999).

Furthermore, studies carried out by Glenn and Dickman (2003*a*) found that target animals took only 15% of baits. Tiger quolls were significantly the main species to take baits - tiger quolls compared with 8.5% wild dogs and 6.6% red foxes took 46.2% of baits.

The Department of Environment and Heritage's EPBC Act 'Administrative Guidelines on Significance: Supplement for the Tiger Quoll (southeastern mainland population) and the use of 1080', 2004 (The Guidelines), recognises the likely possibility that 1080 baiting significantly impacts on the tiger quoll. The Guidelines state that "*it is an offence for any person to undertake an action that is likely to have a significant impact on the southeastern mainland population of the Tiger Quoll without approval.....Activities that are likely to require referral under the EPBC Act include large scale 1080 baiting (aerial or broadscale surface baiting) as used for wild dog and dingo control*".

Despite this, aerial baiting campaigns continue to be carried out by state bodies without referral under the *Environment Protection and Biodiversity Conservation Act* (EPBC Act). A proposal for a 1080 baiting trial in northern NSW (Styx River State Forest and Cunnawarra National Park) and in Southern NSW (Byadbo and Pilot Wilderness Areas, Kosciuszko National Park), was recently referred under the EPBC Act, however the Department of Environment & Heritage concluded that the trial did not require assessment and approval.

It also should be noted here that there are increasing moves towards the protection of the dingo in Australia, as the purity of the species' genetics is diminished by cross-breeding with feral dogs. There is now recognition amongst the scientific community of the threatened nature of this species. 1080 baiting does not discriminate between dingoes, non-native dogs and foxes and thus it undoubtedly adds to the threats upon the species. Wild dog control needs to meet both agricultural and dingo conservation objectives. According to Davis (*in* Dickman and Lunney 2001) an alternative approach may be to identify large areas of suitable crown land habitat that contains dingos and to implement appropriate management and perimeter controls to support both dingo conservation and agricultural protection objectives.

HSI welcomed the Tasmanian Government's recent decision to ban the use of 1080 in state forests, however this means it can still be used on private land. In Tasmania 1080 baiting is permitted to control three native species, the Tasmanian Pademelon, the bennett's wallaby and the brushtail possum, therefore HSI was pleased when the Federal Government announced, at the recent October 2004 election, that it would provide funding for the Tasmanian Government to phase out the use of 1080 poison on public and private land no later than by December 2005. We look forward to the implementation of this commitment and we are now urging the government to follow up with a nation wide ban.

The current reliance on 1080 poison in Australia provides no incentive to investigate new options that may also prove to be more effective in controlling pests.

Culling of grey headed flying fox:

The grey headed flying fox is listed as vulnerable under the EPBC Act, Victoria's *Flora and Fauna Guarantee Act 1988* and NSW's *Threatened Species Conservation Act 1995*, as a result of HSI nominations. This species has suffered a significant decline due to habitat loss and unregulated culling.

HSI understands that flying foxes can damage crops and that in certain circumstances orchardists in particular may need to take measures to protect their livelihood. Full crop netting, at an appropriate mesh size, is a method proven to be completely effective in deterring flying-foxes, and trials are underway into alternative deterrents. However, limited shooting permits or licenses are still issued at the State level (Queensland, New South Wales and Victoria) and are very poorly policed.

HSI strongly opposes any lethal control methods for this threatened species. We find it highly unjustifyable to allow the culling of a listed threatened native species. We understand that the Australian Government is working with states to develop alternative control methods for orchardists and current state programs include trials for non-lethal control measures, zero or low interest loans for netting and research into species numbers and distribution. However HSI calls for an immediate end to the issuing of shooting permits and licenses.

In addition to this the use of electrical grids have been banned in Qld. However the government has not required them to be dismantled. It is known that the grids are still being used illegally, which is a serious conservation and animal welfare concern.

HSI feels that to allow the continued culling of this species, is to slow down incentives to adopt non-lethal methods.

In Summary:

HSI encourages the committee to consider the issues of animal welfare and conservation as key issues in pest control. We understand the importance of efficiency and cost effectiveness, however we do not believe that efficiency and cost effectiveness should come at the expense of animal welfare and conservation.

HSI feels that there is a current reliance on ineffective, inhumane and ecologically irresponsible methods, which has resulted in a failure to investigate and develop new options. Resources need to be further allocated to look at alternatives that could better meet animal welfare and conservation concerns and be more efficient, effective and better targeted in controlling feral animals.

References:

Belcher C.A. (1999), *The Range, Status and Distribution of the Tiger Quoll in the Otway Ranges, West Region , Regional Forest Agreement (RFA) Area.* Consultants report to the Department of Natural Resources and Environment. Ecosystems Environment Consultants, RMB 4269, Timboon, 3268 (on EA's RFA website).

Blecher C.A. (2000a), *Monitoring the Impact of Logging on the Tiger Quoll at White Ash Rd, Tallaganda State Forest, July-August 2000 – and the Impact of the 1080 Poison Baiting on the Tiger Quoll.* Consultants report to State Forests Southern Region. Ecosystems Environmental Consultants, RMB 4269, Timboon, 3268.

Denny M. (2001) *Application of Sodium Monofluoroacetate (1080) as a Poison in Vertebrate Pest Control in Australia: A Review.* Consultants report to Humane Society International, Sydney. **[enclosed].**

Dickman C. R. and Lunney D. (editors) (2001) *A Symposium on the Dingo*, Royal Zoological Society of New South Wales, Mosman, NSW.

Glenn S. and Dickman R. (2003a) Monitoring bait removal in vertebrate pest control: a comparison using track identification and remote photography. *Wildlife Research* **30**: 29-33. CSIRO Publishing.

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APPLICATION OF SODIUM MONOFLUOROACETATE (1080) AS A POISON IN VERTEBRATE PEST CONTROL IN AUSTRALIA: A REVIEW

1.0 INTRODUCTION

Humane Society International Inc. is concerned that the use of sodium monofluoroacetate (also called 1080) to control vertebrate pest species in Australia may be negatively affecting fauna species that are not targeted by this poison.

This review investigates the possibility that the application of 1080 poison during pest control campaigns may affect non-target animals, particularly native Australian species. The review also investigates the practices used to apply 1080 during pest control campaigns and assesses some of the concerns associated with these practices.

Part of the review is to determine whether the application of 1080 can be considered as a "Key Threatening Process" under the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act). There are precise guidelines for nominating a threatening process and these are discussed in this review.

Although this review does not describe or discuss the contribution that the application of 1080 in pest control programmes has had to the overall conservation of native species, by minimizing the threat from introduced predators and competitors, this contribution is acknowledged.

The review concentrates upon the conservation aspects of the use of 1080, and does not assess the issues of cruelty that may be associated with this poison.

2.0 KEY THREATENING PROCESS

According to Sub-Section 188 (3) of the EPBC Act, "A process is a **threatening process** if it threatens, or may threaten, the survival, abundance or evolutionary development of a native species or ecological community".

Further, Sub-Section 188 (4) states that:

"A threatening process is eligible to be treated as a key threatening process if:

(a) it could cause a native species or an ecological community to become eligible for listing in any category, other than conservation dependent; or
(b) it could cause a listed threatened species or a listed threatened ecological community to become eligible to be listed in another category representing a higher degree of endangerment; or
(c) it adversely affects 2 or more listed threatened species (other than conservation dependent species) or 2 or more listed threatened ecological communities".

The approach taken by the Threatened Species Scientific Committee to the listing of Key Threatening Process is that while many processes that occur in the landscape could be threatening there is a lesser number that should be regarded as key threatening processes and receive the appropriate legislative status and hence regulatory recognition. The Committee believes it is necessary to add context, for example, particular species or ecological community is put at risk, to understand the specific implications of a particular threatening process.

The Regulations accompanying the EPBC Act prescribe that each of the following must be addressed for a nomination to be accepted:

A description of the threatening process that distinguishes it from any other threatening process, by reference to:

(i) its biological and non-biological components, and

(ii) The processes by which those components interact (if known).

A nomination of a key threatening process must contain the following:

a. A name for the threatening process
b. Name of any species or ecological communities listed as threatened under the EPBC Act that are considered to be adversely affected by the threatening process
c. Name of any species or ecological community, other than those that are listed under the EPBC Act, that could become eligible for listing in one of those categories because of the threatening process

Thus, to assess whether the application of 1080 during vertebrate pest control campaigns is a key threatening process the above criteria must be applied.

3.0 HOW 1080 WORKS

Sodium monofluoroacetate is absorbed into the body through the gut where the fluoroacetic acid is a potent inhibitor of succinate and citrate metabolism in the tri-carboxylic acid cycle (Krebs cycle). The toxicity of 1080 may also be due to an affect on the permeability of the mitochondrial membrane. Both mechanisms ultimately result in the impairment of energy metabolism and cellular function, resulting in the depletion of energy resources leading to gross organ dysfunction (Marks *et al*, 2000[1]).

In carnivores, 1080 toxicosis results in severe central nervous system disturbances, convulsions and ultimately respiratory failure. In herbivores, 1080 toxicosis appears to affect the cardiac system or both the cardiac and the nervous system. Either cardiac or respiratory failure can be the terminal event in some and, in others, respiratory arrest following disruption of the central nervous system and severe convulsions (McIlroy, 1982).

The symptoms of 1080 poisoning have been described by many authors, particularly J.C. McIlroy (see McIlroy, 1981-1986, in Appendix 1). A summary of some of the results from assessments of comparative toxicology are:

- Mammals tend to be more sensitive to 1080 than birds, and birds are more sensitive than reptiles and amphibians (McIlroy, 1986)
- Herbivores tend to be more sensitive to 1080 than granivores, carnivores, insectivores and omnivores (NSW Agriculture, 1992)
- Eutherian mammals are equally or more sensitive to 1080 than marsupials (NSW Agriculture, 1992)
- The young of marsupials appear to be more susceptible to 1080 (through their mother's milk) than adults (McIlroy, 1981)
- There is a wide range of times before the signs of poisoning are observed e.g. birds, 1 hr to 60 hrs (McIlroy, 1984)
- There is a wide range of times before an animal dies from 1080 poisoning e.g. bandicoots 4 hours to 9 days, birds 1 hour to 11 days, herbivores 1 hr to 7 days (McIlroy, 1984, McIlroy, 1983, McIlroy, 1982)
- Although studies show that animals are apparently unconscious and insensible to pain, there is evidence that pain and distress could be experienced at some time during the progression of the toxicosis (Marks *et al*, 2000)

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[1] References used in this review are given in Appendix 1

- Native animals from Western Australia appear to be less susceptible to 1080, than those from eastern Australia. This is possibly due to a long exposure to plants with high levels of 1080 (e.g. Twigg and King, 1989, King *et al*, 1981).

4.0 APPLICATION OF 1080 IN VERTEBRATE PEST CONTROL

1080 is presented to pest vertebrate species[2] in a variety of baits. Baits for herbivores, granivores and omnivores are usually grain (e.g. wheat, oats), carrots or pellets prepared from pollard and bran. These baits are usually laid as a trail, or are hand broadcast in inaccessible areas, or are laid by aerial distribution. The amount of 1080 within each bait varies, but the concentration of 1080 on pellets is usually about 0.5 mg per bait (McIlroy and Gifford, 1991). The amount of 1080 in carrot baits can be about 0.33 mg per gm (McIlroy and Gifford, 1992). Baits can be coloured either blue or green, to identify them and to reduce the risk of birds taking them. However, studies have shown that birds are not discouraged from eating dyed baits (Hone *et al*, 1985; Jongman *et al*, 2000).

Baits for carnivores and omnivores (feral pig) are meat based, with either fresh meat or dried meat. These are presented by means of aerial, ground or bait station distribution. Although there is some variation in the size of the bait (e.g. 400-500 g in Northern Territory and 150 g in South Australia), the amount of 1080 contained in each bait is usually 6 mg (Eldridge *et al*, 2000). Other baits used are Crackle bait[3] and a manufactured sausage bait containing 1080 in a purple enteric-coated pellet. These baits contain 5-6 mg of 1080. A manufactured meat-based bait, called Foxoff, is also available commercially and contains 3 mg of 1080. Meat-based baits, particularly those used for foxes, are often buried to prevent non-target animals from taking the baits (this aspect will be discussed in Section 6.0).

Other methods of application, such as spraying plants with 1080 (for goats, deer and possums), using 1080 in jam baits (for possums) or sardine baits (for wasps) and using 1080 in collars on domestic stock (for coyote control) are not used in Australia.

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[2] In Australia, the following are considered to be vertebrate pest species: feral pig, feral cat, fox, rabbit, feral goat, feral/wild dog. In Tasmania, the brushtail possum, Tasmanian pademelon and Bennett's wallaby are also considered to be pest species.

[3] Crackle bait comprise tissue remaining after fat rendering, as well as glycerine and whale oil.

5.0 PROBLEMS ASSOCIATED WITH THE APPLICATION OF 1080

Although 1080 poison baiting has been undertaken in Australia for more than 20 years, there are still several problems associated with the mode of application. These are:

i. Displacement of baits.

There are numerous reports of non-target species taking 1080 baits (e.g. Thomson and Algar, 2000; Eldridge *et al*, 2000; Fleming *et al*, 2000; McIlroy *et al*, 1986; Allan *et al*, 1989; McIlroy, 1981). McIlroy (1981) states that "For example, up to 90-100% of dingo baits can be removed from an area within 24 h, particularly by foxes *Vulpes vulpes*, pied currawongs *Strepera graculina*, and ravens *Corvus* spp. (unpublished data)". Apart from the loss of potency of the baiting campaign, there is the problem of the baits taken being deposited away from the baited area. There are anecdotal reports of 1080 meat-baits being found in people's yards, where they have been dropped by passing birds or other non-target species.

Another problem encountered during baiting campaigns is the caching of baits by foxes. In a study of fox baiting by Saunders *et al* (1999), it was found that an average of 34% of baits were taken and 10% were cached by foxes. The mean distance from the bait station was 156 m, with some baits being cached up to 800 m away.

The authors state:

"In the broader, State-wide context, the findings presented here become significant. Of the 1 million fox baits laid in New South Wales each year, about 100 000 of these will be cached by foxes. About 56 000 baits will not have been retrieved at the completion of the baiting. Many of these will constitute a non-target threat in the sense that they may have been moved some distance away from the original bait line to areas previously thought to be free of bait" (p.339).

ii. Longevity of baits.

Although it is usually stated that 1080 baits are not long-lasting in the environment, there are reports of baits lasting far longer than expected in a variety of environments. A study by Saunders *et al* (2000) on the degradation of 1080 in buried Foxoff baits showed that baits became non-lethal to dogs at 2.2 weeks and foxes at 2.8 weeks. However, some baits, even after 11 weeks in the soil, still contained enough 1080 to kill a fox or dog (this was taken to be 0.65mg 1080 for foxes and 1.05mg per bait for dogs). The authors state:

"This would suggest that at any time of the year when drought conditions occur or in arid to semi-arid regions where negligible rainfall can be common, buried baits should be treated with caution in respect of potential, long-term, non-target losses."

Other studies show that fox baits remain toxic for at least six weeks (Thomson *et al*, 2000), 1080 meat baits remained toxic for at least 8 months, whether protected from rain or not (in central Australia, Twigg *et al*, 2000; in NSW, Fleming and Parker, 1991), and meat baits in north-western Australia remained intact for at least three months (Thomson, 1986). Twigg *et al* (2000) state the following:

"Thus, untaken baits will remain a potential hazard to non-target species, particularly farm dogs, for a considerable period."

"In fact, the regression equations (decay curves) presented in Table 2 predict that meat baits in arid Australia could remain toxic for at least 14, 18, 20 and 21 months for dingoes, domestic dogs, foxes and feral cats respectively."

iii. Bait type and attractiveness.

Studies have shown that some non-target species prefer one type of bait and not others. Soderquist and Serena (1993) found that quolls prefer fresh meat to dried meat, whilst Calver *et al* (1989) found that a range of small to medium sized dasyurids and rodents ate meat and crackle baits, particularly if there was no alternative food available. Crackle baits are softer than dried meat baits and their sharp corners are easier for gnawing. They also hold a greater concentration of 1080. The authors stated "Crackle baits are therefore potentially far more hazardous to non-target fauna than are meat baits, especially during periods of food shortage".

iv. Burying of baits.

Studies of the behaviour of non-target species, particularly quolls, have shown that meat type baits should be buried at least 10cm deep (Belcher, 1998; Murray, 1996). However, it has been found that birds and rats will remove baits that were buried as deep as 15 cm (Dexter and Meek, 1998). The authors state:

"The bait taken by non-target species, while only a fraction of that taken by foxes, is cause for concern. ..... where endangered native rodents are known to be present baiting should be undertaken very carefully."

"Currawongs and ravens at Beecroft may also have learnt to identify areas at which foxes have been digging as good sources of buried food and so be preconditioned to digging up baits. If bandicoots or potoroos are to be reintroduced to Beecroft Peninsula then extreme care will have to be exercised in the placement and monitoring of baits..."

Although baits are removed if buried as deep as 15 cm, instructions for the use of baits do not state that baits must be buried greater than 15 cm. The instructions for Foxoff state that the baits are to be buried 'just under surface'.

v. Discourage non-target species.

Apart from burying baits, some baits are coloured with blue or green dye, as early studies concluded that birds were discouraged from eating coloured baits (Bryant *et al*, 1984; Brunner and Coman, 1983). However, later research has shown that birds are not discouraged from eating coloured grain or meat baits (Jongman *et al*, 2000; Hone *et al*, 1985; McIlroy and Gifford, 1991; McIlroy, 1984).

Another aspect of bird behaviour that is believed to protect some species from eating 1080 is the 'husking' of whole grains by parrots. As 1080 coats the outside of whole grains the removal of the outside husk will reduce the amount of 1080 eaten. However, according to Jongman *et al* (2000), there are several bird species that will eat whole grains and also may be able to 'learn' to accept whole grains in field conditions. It is also possible that birds husking sufficient quantities of whole bait over time may be exposed to poison.

vi. Aerial versus trail baiting.

In large and/or inaccessible areas of land 1080 baits can be distributed from aircraft (aerial baiting). Although this allows for a greater coverage than presentation of baits by hand e.g. trail baiting, locating of baits is less precise and there is less control over the baiting programme, less opportunity to track changes in non-target populations and less opportunity to remove unused baits.

Concerns have been expressed by several researchers concerning the use of aerial baiting. McIlroy (1982a) states:

"..it is evident from the results that the higher density of baiting and/or higher concentration of 1080 involved in the simulated aerial baiting had a greater reducing effect on Brown Antechinus numbers than those associated with trail baiting (p.270)".

Fleming *et al* (2000) conclude from their studies that "Pigs require a large 1080 dosage to kill them and so aerially-distributed 1080-meat baits for pigs may be hazardous to birds".

6.0 EFFECTS ON NON-TARGET SPECIES

Although most publications describing the use of 1080 state that non-target species are not affected by the use of poison baits, there is a considerable body of information within the research literature that provides evidence to the contrary. From observations taken during experiments undertaken in enclosures and in the field, it is known that at least 61 native vertebrate species take 1080 poison baits, and at least 24 native vertebrate species are known to have been killed by 1080 poison baits. A list of these species, together with the type of bait eaten, the type of experiment and the reference is given in Appendix 2.

Table 1 lists those native species where there is evidence that they will take baits containing 1080.

Table 1: Non-Target Species Known To Take Baits Containing 1080

Mammals and Reptiles	**Avifauna**
Brown Antechinus	Crimson Rosella
Tiger Quoll*	Galah
Ningaui spp.+	Sulphur-crested Cockatoo
Dasyurus hallucatus+	Wonga Pigeon
Planigale maculata+	Common Bronzewing
Sminthopsis dolichura+	Maned Duck
Sminthopsis crassicaudata+	Wedge-tailed Eagle
Sminthopsis hirtipes+	Whistling Kite
Common Brushtail Possum	Little Eagle
Mountain Brushtail Possum	Brown Falcon
Grey Kangaroo	Nankeen Kestrel
Swamp Wallaby	Brown Goshawk
Long-nosed Potoroo*	Pink Robin
Common Wombat	Eastern Yellow Robin
Bush Rat	Olive Whistler
Swamp Rat	Grey Shrike-thrush
Pseudomys hermannsbergensis+	Superb Fairy-wren
Leggadina forresti+	White-browed Scrub-wren
Zyzomys argurus+	Red-browed Firetail
Rattus tunneyi+	White-winged Chough
Notomys mitchelli	Grey Currawong
Mastacomys fuscus	Pied Currawong
'rats'	Australian Magpie
	Little Raven
'goannas'	Australian Raven
	'corvids'

* Listed as Vulnerable in the EPBC Act 1999

\+ From enclosure experiments, remainder from field studies

There is a problem with relating the observation of an animal eating a bait with the actual death of that animal. The amount of 1080 in a single bait, or that part of a bait that has been eaten, may not be a lethal dose for the species, or the animal may drop the bait before eating it. There are instances of animals vomiting a bait before the 1080 is absorbed e.g. *Sminthopsis crassicaudata* (Sinclair and Bird, 1984).

However, the main difficulty in relating the taking of a bait with the death of the animal is the long time interval between the ingestion of a poison bait and the onset of any signs of toxicity. In the case of avifauna, the onset of symptoms can be as long as 60 hours, and death may not occur for 11 days (McIlroy, 1984). Such delays in the onset of symptoms may lead to incorrectly concluding that the taking of a bait by an animal does not lead to death. A quote by R.Sinclair (in NSW Agriculture, 1992) illustrates this point:

"Large numbers of wild dog baits are taken by corvids and raptors but no mortality has been recorded. Wedge-tailed Eagles take many baits. One individual in South Australia was seen to take 6 baits (6 mg 1080 each) and was observed for several hours with no apparent affect (R. Sinclair, pers. comm.)".

As pointed out above, it may take up to 60 hours before the signs of any apparent affect are noticed, and in that time period a Wedge-tailed Eagle could be many kilometres away from the baited area.

Table 1 gives a list of species that are known to take poisoned baits and have the **potential** of being killed by the application of 1080. Two of these species are listed as Vulnerable in the EPBC Act (tiger quoll, long-nosed potoroo), whilst others are listed in different States as threatened e.g. *Planigale maculata, Pseudomys hermannsbergensis*, *Mastacomys fuscus* in New South Wales.

Studies of lethal dosage rates have shown that there are other species that are vulnerable to the eating of 1080 poison baits. McIlroy (1982a and 1982b) makes the following observations:

"In theory, Fat-tailed Dunnarts, *Sminthopsis crassicaudata*, Striped-faced Dunnarts, *S. macroura*, Brown Antechinus, *Antechinus stuartii*, Dusky Antechinus, *Antechinus swainsoni*, and Kowari, *Dasyuroides byrnei*, could all eat sufficient bait containing 0.015mg/g of commercial 1080 (a relatively low concentration advocated for some campaigns) during a poisoning campaign for them to face a 73-100% chance of being killed. The overall situation would be far worse were much higher concentrations of 1080 used (p.270)".

"The first group consists of macropodids such as the long-nosed potoroo and red-bellied pademelon, which are more sensitive to 1080 than the rabbit and which may also be lighter and thus require less 1080 for an LD_{50}. The western pygmy-possum also belongs to this group despite its much higher tolerance to

1080 than rabbits, because of its very small size. Other small marsupial herbivores in eastern Australia also probably belong to this group. Because of the far greater susceptibility to 1080 of this group than of rabbits, rabbit-poisoning campaigns should be avoided in areas which contain these non-target species."

Thus, there is a list of potential non-target species that could be killed by the application of 1080 poison baits, together with those species that are known to take baits (Table 1) and could be killed by 1080.

The finding of dead animals, or a recorded decline in population numbers of a species after 1080 poisoning campaigns are definite indications of impacts from 1080 upon non-target species. Some results from experiments using 1080 baits are from enclosures, but the majority are from observations in the field and relate to 'natural' conditions. Table 2 gives the list of native species known to be killed as non-target animals during 1080 baiting programmes.

Table 2: Non-Target Species Known To Be Killed By 1080 Baiting

Mammals
Tiger Quoll*
Brown Antechinus
Fat-tailed Dunnart+
Common Wombat
Common Brushtail Possum
Long-nosed Potoroo*
Tasmanian Bettong
Red-necked Wallaby
'wallaby' sp
'kangaroo' sp
Bush Rat
Swamp Rat+
Silky Mouse
Long-tailed Mouse+
Avifauna
Black Kite
Masked Lapwing
Wood Duck
Green Rosella
Crimson Rosella
Silver Gull
Australian Magpie
Magpie-lark
Little Crow
'corvids'
* Listed as Vulnerable in the EPBC Act 1999
+ From enclosure experiments, remainder from field studies

It can be seen from Table 2 that there are many native species that are known to be affected by the application of 1080 during pest control programmes. Of these species, two (tiger quoll and long-nosed potoroo) are listed as Vulnerable in the EPBC Act.

In some cases, only individuals are known to have died, but in other cases whole populations have been affected. In a study of the effects from simulated aerial dog baiting in the Brindabella Ranges, it was found that at least 73% of a brown antechinus population had been affected by 1080 baits (McIlroy, 1982a). Other cases of populations being affected are the silky mouse (*Pseudomys apodemoides*) and the bush rat (*Rattus fuscipes*), as described by McIlroy (1982c):

"There is evidence (McIlroy, unpublished data) that a substantial proportion of *Rattus fuscipes* populations do so with carrot baits meant for rabbits and meat baits meant for dingoes, and are poisoned. Pellet baits for rabbits also appear to have killed all adult residents in a marked populations of *Pseudomys apodemoides* on the southern fringe of the Big Desert region in Victoria (A. Cockburn, personal communication 1979)."

Tiger Quoll populations also appear to have been affected by 1080 poison baiting programmes. Belcher (1998) relates the following:

"The results of the free-feed trail undertaken at Suggan Buggan (S.McPhee, personal communication) also confirm that tiger quolls will take buried baits during a normal bait programme and that even when foxes are abundant, tiger quolls are put at risk by poison baiting. The taking of baits by tiger quolls was inferred from tracks and hairs left in hairtubes adjacent to the bait stations (S.McPhee, personal communication) and from the presence of coloured plastic marker beads in a tiger quoll scat collected after the trail (C.Belcher, unpublished data)."

"In 1492 free-feed bait-nights during a predator-control programme to protect a colony of brush-tailed rock wallabies in southern New South Wales, a large number of non-target species was recorded, including 26 instances of tiger quolls taking baits (L. Dovey, New South Wales NPWS, personal communication)."

A report in the Sydney Morning Herald (dated 5th July, 1997) states:

"He (Chris Belcher) has moved his quoll research work to the Queanbeyan forestry district after aerial baiting of feral animals wiped out his target quoll population at Suggan Buggan in the Upper Snowy Mountains,.."

The problem discussed above i.e. difficulty finding dead animals after eating baits, as it takes a long time for the poisoned animal to die, is illustrated in the results of a search for carcasses after an aerial-poisoning campaign. McIlroy and Gifford (1992) describe how it took five days to find three poisoned birds and seven poisoned marsupials in Bondo State Forest after a poisoning campaign.

Studies of radio-collared marsupials poisoned during a 1080 baiting campaign in Tasmania found the following (le Mar and McArthur, 2000). The fate of 26 radio-collared individuals from three marsupial species were followed during a 1080 poisoning operation. Fifteen of the 26 animals died from the poison. Radio-collared carcasses were found between 8 m and 83 m from the bait-line. 75% of the carcasses were found inside windrows, hollow logs, dens, fallen vegetation i.e. were hidden. Three carcasses were not found, but the collars were and these showed carnivores teeth marks (Tasmanian devils, spotted-tailed quolls), It is assumed that they had been moved and consumed. The authors concluded:

"A major implication of this research is that animal carcasses are extremely difficult to locate following a poisoning operation. Therefore, routine carcass collection operations following 1080 poisoning are unlikely to be effective at removing most carcasses".

There is also evidence of at least nine invertebrate orders being prone to 1080 poisoning. Invertebrates have been observed eating baits, and their habitats are contaminated by residues leaching from baits, and from animal by-products and carcasses. According to a review by Notman (1989), the groups of invertebrates where there is evidence of effects from 1080 are:

Acari
Collembola
Blattodea
Hemiptera (aphids killed from systemic activity of 1080)
Coleoptera
Lepidoptera (dead moths found beside baits)
Diptera
Siphonaptera (fleas killed by feeding on poisoned rats)
Hymenoptera (16 000 dead and dying bees after feeding on 1080 jam bait)
Mollusca

Poisoned insects could provide a means of secondary poisoning for insectivores, and it was recommended by Notman (1989) that 1080 should not be used where susceptible invertebrate species or rare insectivores are found. Insectivorous birds have been found dead after poison operations, and it was concluded that they must have eaten either poisoned insects or baits (Spurr 1979).

Australian studies have shown that ants, termites and blow-fly larvae will attack and eat 1080 poison meat-baits (Risbey *et al*, 1997; Merks and Calver, 1989; Thomson, 1986; McIlroy *et al*, 1988). The study by McIlroy *et al* (1988) provides information about the amounts of 1080 taken from meat baits by blowfly larvae (maggots).

In the study by McIlroy *et al* (1988) meat baits began to lose their toxicity from the moment of preparation onwards, particularly after different rainfall treatments and when inhabited by blowflies (Calliphoridae) larvae (maggots). The main reasons for the loss of 1080 were consumption by maggots and their subsequent disappearance from the baits, leaching by rain and defluorination by micro-organisms. Baits remained toxic to dogs for over 32 days, but toxic to an average sized tiger quoll for 4-15 days in winter and 2-4 days in summer (due to differences in maggot activity).

The number of maggots found in each bait are shown in the following table:

	Number of maggots per bait	Amount of 1080 in the maggots	Amount of 1080 in each maggot
Day 4	253	0.18 mg	0.49 microgram
Day 6	280	0.13 mg	0.3 microgram
Day 10	8	nm	nm

There are many birds, mammals and reptiles that will feed upon fly larvae, ants and termites. Within the non-passerine birds there are at least 46 species that are known to eat ants and 18 species that eat fly larvae (Barker and Vestjens, no date), There are another nine non-passerine bird species that eat carrion, including herons (Klapste, 1991).

A white-browed scrubwren weighs 0.011-0.012 kg i.e. about 12 g, and has a LD_{50} of 4.5 mg/kg (McIlroy, 1984). If this species were to eat maggots from a bait, then it would need to ingest about 0.054 mg of 1080 to be 50% lethal. As the maggots on the meat bait at day 4 contain 0.18 mg 1080, then the white-browed scrubwren would need to eat about 30% i.e. about 1/3 rd of the maggots on one bait to be affected.

The brown antechinus has a LD_{50} of 0.07 mg. This species would need to eat less than half of the maggots in one bait. The stripe-faced dunnart (LD_{50}=0.02 mg) would need to eat about 10% of the maggots.

Thus, there is the potential for a range of non-target species to be secondarily affected by 1080 poison baits. Added to this are the species that will eat the carcasses of animals poisoned by 1080. Although many species would need to eat large quantities of a poisoned carcass to be killed by the 1080, studies have shown that secondary poisoning hazards can be associated with 1080-treated carrot-baiting campaigns for rabbits (McIlroy and Gifford, 1992). The study by McIlroy and Gifford (1992) showed that the following species could eat sufficient muscle or viscera from one poisoned rabbit to ingest a LD_{50}: fat-tailed dunnart, brown antechinus, bush rat, little raven, dusky antechinus, swamp rat, magpie-lark and grey shrike-thrush.

Another aspect of secondary poisoning is from the ingestion of vomitus from feral pigs. O'Brien *et al* (1986) compared the estimated LD_{50} for non-target species with the amount of poison (1080) in vomitus of penned feral pigs after the pigs had eaten poison. The level of poison was higher than the LD_{50} for 14 non-target species. Hence the vomitus, if eaten, posed some hazard to those non-target species. Vomitus from feral pigs is frequently observed near bait stations during poisoning operations. The concentration of 1080 in vomitus ranges from 11.9 to 19.6 microgram1080/g depending upon the dosage of 1080 in the bait. The 14 species included the fat-tailed dunnart, grassland melomys and dusky antechinus.

The authors point out:

"Thus, in terms of its 1080 concentration and content, feral pig vomitus has the potential to kill a number of nontarget species".

"because pigs vomited repeatedly and for a number of hours after 1080 intoxication, it is likely that vomitus would be distributed over a wide area, in some cases remote from the site of poison placement. Where nontarget species have small home ranges, this effect may enhance the impact of feral pig poisoning programs on nontarget populations".

"We have no data concerning the palatability of fresh or desiccated feral pig vomitus to nontarget species. However, we consider that the vomitus produced after poisoning with wheat bait, which contains a mixture of whole and fragmented grain in viscous suspension, may be palatable to many nontarget species".

The results of a search of the research literature shows that at least 61 non-target native species are definitely known to take 1080 baits, and at least 24 of these species are definitely known to be killed by the application of 1080. Of the 24 species known to be affected by the application of 1080, two are listed as Vulnerable on the EPBC Act. There is evidence of populations of native species being affected by the application of 1080 during pest control campaigns. There are reports from studies that show that there may be many more species affected by secondary poisoning (from eating carrion, ants, maggots or vomitus) during the application of 1080.

7.0 CONCLUSIONS

Using the criteria set out in Sub-Section 188 of the EPBC Act (see Section 2.0), it is clear that "The Application of 1080 during pest control campaigns" could be considered a Key Threatened Process. There are at least two species listed as Vulnerable under the EPBC Act that are affected by the process (Tiger Quoll, Long-nosed Potoroo), and it is likely that there would be other threatened species affected.

However, there are certain aspects of the use of 1080 as a poison that must be considered if a nomination is to developed. First, it is apparent that the effects from 1080 upon native fauna is much less in Western Australia than in the eastern parts of Australia. This appears to be due to the evolution of native fauna in the presence of plants that naturally contain higher amounts of 1080 than plants in eastern Australia.

If the application of 1080 is listed as a key threatening process, then it may be necessary to provide some form of exclusion for the use of 1080 in Western Australia.

Although the use of 1080 does appear to adversely affect some non-target native species, the use of this poison over the last twenty years has been a revolution in conservation biology. Control, and even eradication of introduced predators (e.g. fox, feral cat) and competitors (rabbit) has resulted in increased populations of species once considered 'on the brink' of extinction.

However, there are certain negative aspects to the use of 1080 that need to be recognised and, where possible, neutralised. There appears to be reluctance by many researchers to acknowledge the effects on non-target species from the application of 1080 in pest control programmes. This is illustrated by the exclusion of any clear description of the death of non-target animals in scientific papers. Rather, many descriptions of the effects from 1080 on non-target species are given as 'personal communications', embedded in the methods or results sections of a publication. There are methods that can be applied to minimize the impacts from 1080 upon non-target species e.g. use of dried meat rather than fresh meat, alternative methods of control, better management of stock. Many such alternatives are listed in the publication by NSW Agriculture (1992) and in Fleming *et al* (2001).

The balance between the minimization of threat from introduced species and the loss of non-target fauna needs to be better explored and it is hoped that this review of the use of 1080 will assist in such a debate.

Dr Martin Denny
7th September, 2001

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APPENDIX 2: SPECIES KNOWN TO BE AFFECTED BY THE APPLICATION OF 1080

Common Name	***Scientific Name***	**Ate bait**	**Killed by bait**	**Bait type**	**Field experiment**	**Enclosure experiment**	**Reference**
Brown Antechinus	*Antechinus stuartii*		X	Meat	X		McIlroy, 1982a
Brown Antechinus	*Antechinus stuartii*	X		Meat	X		McIlroy, 1981
Brown Antechinus	*Antechinus stuartii*	X		Foxoff	X		Kortner and Gresser, 2000
Black Kite	*Milvus migrans*		X	Meat	X		NSW Agriculture, 1992
Black Kite	*Milvus migrans*		X	?	X		McIlroy, 1986
Black Kite	*Milvus migrans*	X	X	Meat	X		McIlroy, 1983
Magpie-lark	*Grallina cyanoleuca*		X	Meat	X		NSW Agriculture, 1992
Magpie-lark	*Grallina cyanoleuca*	X	X	Meat	X		McIlroy, 1983
Little Crow	*Corvus bennetti*		X	Meat	X		McIlroy, 1983
Little Crow	*Corvus bennetti*		X	Meat	X		NSW Agriculture, 1992
'corvids'	*Corvus* sp.		X	Meat	X		NSW Agriculture, 1992
'corvids'	*Corvus* sp		X	Meat	X		McIlroy, 1983
'corvids'	*Corvus* sp	X		Meat	X		McIlroy, 1982a
'corvids'	*Corvus* sp	X		Meat	X		Eldridge *et al*, 2000
'corvids'	*Corvus* sp	X		Meat	X		McIlroy, 1983
'corvids'	*Corvus* sp	X		Meat	X		Fleming, 1996
'corvids'	*Corvus* sp	X		Meat	X		McIlroy, 1981
'wallaby' sp	?		X	Carrot	X		NSW Agriculture, 1992
'kangaroo' sp	*Macropus* sp.		X	Carrot	X		NSW Agriculture, 1992
Common Brushtail Possum	*Trichosaurus vulpecula*		X	?	X		NSW Agriculture, 1992
Common Brushtail Possum	*Trichosaurus vulpecula*		X	Meat	X		Fleming, 1996
Common Brushtail Possum	*Trichosaurus vulpecula*		X	Carrot	X		McIlroy and Gifford, 1992
Common Brushtail Possum	*Trichosaurus vulpecula*	X		Rabbit baits	X		Brunner, 1983
Common Brushtail Possum	*Trichosaurus vulpecula*	X		Wheat	X		McIlroy *et al*, 1993

Common Name	*Scientific Name*	Ate bait	Killed by bait	Bait type	Field experiment	Enclosure experiment	Reference
Mountain Brushtail Possum	*Trichosaurus caninus*	X		Rabbit baits	X		Brunner, 1983
Common Ringtail Possum	*Pseudocheirus peregrinus*	X		Rabbit baits	X		Brunner, 1983
Magpie	*Gymnorhina tibicen*		X	?	X		NSW Agriculture, 1992
Magpie	*Gymnorhina tibicen*		X	Grain	X		Bryant *et al.* 1984
Magpie	*Gymnorhina tibicen*		X	Carrot	X		McIlroy and Gifford, 1992
Magpie	*Gymnorhina tibicen*	X		Meat	X		McIlroy *et al*, 1986
Magpie	*Gymnorhina tibicen*	X		Pellet/ carrot	X		McIlroy and Gifford, 1991
Magpie	*Gymnorhina tibicen*	X		Wheat	X		McIlroy *et al*, 1993
Magpie	*Gymnorhina tibicen*	X		Oats	X		Statham, 1983
Silver Gull	*Larus novaehollandiae*		X	?	X		NSW Agriculture, 1992
Tasmanian Bettong	*Bettongia gaimardi*		X	Carrot	X	X	Statham, 1983
Bush Rat	*Rattus fuscipes*		X	Carrot	X		McIlroy, 1983c
Bush Rat	*Rattus fuscipes*	X		Rabbit baits	X		Brunner, 1983
Bush Rat	*Rattus fuscipes*	X		Foxoff	X		Kortner and Gresser, 2000
Silky Mouse	*Pseudomys apodemoides*		X	Pellet	X		McIlroy, 1983c
Long-nosed Potoroo	*Potorous tridactylus*		X	Carrot	X		McIlroy, 1982
Long-nosed Potoroo	*Potorous tridactylus*		X	Carrot		X	Statham, 1983
Long-nosed Potoroo	*Potorous tridactylus*	X		Rabbit baits	X		Brunner, 1983
Common Wombat	*Vombatus ursinus*		X	Carrot ?	X		McIlroy, 1982
Common Wombat	*Vombatus ursinus*		X	Pellet	X		McIlroy and Gifford, 1991
Common Wombat	*Vombatus ursinus*		X	Carrot	X		McIlroy and Gifford, 1992
Common Wombat	*Vombatus ursinus*	X		Rabbit baits	X		Brunner, 1983
Common Wombat	*Vombatus ursinus*	X		Wheat	X		McIlroy *et al*, 1993
Tiger Quoll	*Dasyurus maculatus*		X	Meat	X		Belcher, 1998

Common Name	*Scientific Name*	Ate bait	Killed by bait	Bait type	Field experiment	Enclosure experiment	Reference
Tiger Quoll	*Dasyurus maculatus*		X	Meat	X		Fleming, 1996
Tiger Quoll	*Dasyurus maculatus*	X		Meat	X	X	Belcher, 1998
Tiger Quoll	*Dasyurus maculatus*	X		Foxoff	X		Kortner and Gresser, 2000
Tiger Quoll	*Dasyurus maculatus*	X		Meat	X		Murray, 1996
Fat-tailed Dunnart	*Sminthopsis crassicaudata*		X	Meat		X	Sinclair and Bird, 1984
Fat-tailed Dunnart	*Sminthopsis crassicaudata*	X		Meat/ crackle		X	Calver *et al*, 1989
Wood Duck	*Chenonetta jubata*		X	Grain	X		Bryant *et al*, 1984
Wood Duck	*Chenonetta jubata*	X		Wheat	X		McIlroy *et al*, 1993
Crimson Rosella	*Platycercus elegans*		X	Carrot	X		McIlroy and Gifford, 1991
Crimson Rosella	*Platycercus elegans*		X	Carrot	X		McIlroy and Gifford, 1992
Crimson Rosella	*Platycercus elegans*	X		Wheat	X		McIlroy *et al*, 1993
Crimson Rosella	*Platycercus elegans*	X		Oat	X		Brunner and Browne, 1979
Red-necked Wallaby	*Macropus rufigriseus*		X	Carrot	X		McIlroy and Gifford, 1992
Green Rosella	*Platycercus caledonicus*		X	Carrot	X		Statham, 1983
Masked Lapwing	*Vanellus miles*		X	Carrot	X		Statham, 1983
Long-tailed Mouse	*Pseudomys higginsi*		X	Carrot		X	Statham, 1983
Swamp Rat	*Rattus leucopus*		X	Carrot		X	Statham, 1983
Swamp Rat	*Rattus leucopus*	X		Rabbit baits	X		Brunner, 1983
Pied Currawong	*Strepera graculina*	X		Meat	X		McIlroy, 1982a
Pied Currawong	*Strepera graculina*	X		Meat	X		McIlroy *et al*, 1986
Pied Currawong	*Strepera graculina*	X		Meat	X		McIlroy, 1981
Pied Currawong	*Strepera graculina*	X		Pellets/ carrot	X		McIlroy and Gifford, 1991
Pied Currawong	*Strepera graculina*	X		Wheat	X		McIlroy *et al*, 1993
'goannas'	*Varanus* sp.	X		Meat	X		Eldridge *et al*, 2000
'goannas'	*Varanus* sp.	X		Meat	X		Allan *et al*, 1989

Common Name	*Scientific Name*	Ate bait	Killed by bait	Bait type	Field experiment	Enclosure experiment	Reference
Wedge-tailed Eagle	*Aquila audax*	X		Meat	X		NSW Agriculture, 1992
Wedge-tailed Eagle	*Aquila audax*	X		Meat	X		McIlroy *et al*, 1986
Wedge-tailed Eagle	*Aquila audax*	X		Meat	X		McIlroy, 1983
Australian Raven	*Corvus coronoides*	X		Meat	X		McIlroy *et al*, 1986
Australian Raven	*Corvus coronoides*	X		Meat	X		McIlroy, 1983
Australian Raven	*Corvus coronoides*	X		Oats	X		Statham, 1983
Ningaui	*Ningaui* spp.	X		Meat/ crackle		X	Calver *et al*, 1989
Northern Quoll	*Dasyurus hallucatus*	X		Meat/ crackle		X	Calver *et al*, 1989
Sandy Inland Mouse	*Pseudomys hermannsberg ensis*	X		Meat/ crackle		X	Calver *et al*, 1989
Forrest's Mouse	*Leggadina forresti*	X		Meat/ crackle		X	Calver *et al*, 1989
Common Rock-rat	*Zyzomys argurus*	X		Meat/ crackle		X	Calver *et al*, 1989
Pale Field Rat	*Rattus tunneyi*	X		Meat/ crackle		X	Calver *et al*, 1989
Mitchell's Hopping-mouse	*Notomys mitchelli*	X		Meat/ crackle		X	Calver *et al*, 1989
Mitchell's Hopping-mouse	*Notomys mitchelli*	X		Rabbit baits	X		Brunner, 1983
Common Planigale	*Planigale maculata*	X		Meat/cr ackle		X	Calver *et al*, 1989
Little Long-tailed Dunnart	*Sminthopsis dolichura*	X		Meat/ crackle		X	Calver *et al*, 1989
Hairy-footed Dunnart	*Sminthopsis hirtipes*	X		Meat/ crackle		X	Calver *et al*, 1989
'rats'	*?*	X		Foxoff	X		Dexter and Meek, 1998
Grey Kangaroo	*Macropus giganteus*	X		Rabbit baits	X		Brunner, 1983
Swamp Wallaby	*Wallabia bicolor*	X		Rabbit baits	X		Brunner, 1983
Broad-toothed Rat	*Mastacomys fuscus*	X		Rabbit baits	X		Brunner, 1983
Whistling Kite	*Haliastur sphenurus*	X		Meat	X		McIlroy, 1983
Little Eagle	*Hieraaetus morphnoides*	X		Meat	X		McIlroy, 1983

Common Name	*Scientific Name*	Ate bait	Killed by bait	Bait type	Field experiment	Enclosure experiment	Reference
Brown Falcon	*Falco berigora*	X		Meat	X		McIlroy, 1983
Nankeen Kestrel	*Falco cenchroides*	X		Meat	X		McIlroy, 1983
Brown Goshawk	*Accipiter fasciatus*	X		Meat	X		McIlroy, 1983
Galah	*Cacatua roseicappilla*	X		Pellets/ carrot	X		McIlroy and Gifford, 1991
Grey Currawong	*Strepera versicolor*	X		Pellets/ carrot	X		McIlroy and Gifford, 1991
Little Raven	*Corvus mellori*	X		Wheat	X		McIlroy *et al*, 1993
Wonga Pigeon	*Leucosarcia melanoleuca*	X		Wheat	X		McIlroy *et al*, 1993
Common Bronzewing	*Phaps chalcoptera*	X		Wheat	X		McIlroy *et al*, 1993
Sulphur-crested Cockatoo	*Cacatua galerita*	X		Wheat	X		McIlroy *et al*, 1993
White-winged Chough	*Corcorax melanorhamphos*	X		Wheat	X		McIlroy *et al*, 1993
Pink Robin	*Petroica rodinogaster*	X		Oat	X		Brunner and Browne, 1979
Eastern Yellow Robin	*Eopsaltria australis*	X		Oat	X		Brunner and Browne, 1979
Olive Whistler	*Pachycephala olivacea*	X		Oat	X		Brunner and Browne, 1979
Grey Shrike-thrush	*Colluricincla harmonica*	X		Oat	X		Brunner and Browne, 1979
Superb Fairy-wren	*Malurus cyaneus*	X		Oat	X		Brunner and Browne, 1979
White-browed Scrub-wren	*Sericornis frontalis*	X		Oat	X		Brunner and Browne, 1979
Red-browed Firetail	*Emblema temporalis*	X		Oat	X		Brunner and Browne, 1979