



NSW NATIONAL PARKS & WILDLIFE SERVICE

Conservation Risk Assessment

**Aerial baiting with sodium fluoroacetate (1080)
for wild dog and fox control – 2020–2022**

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Environment, Energy and Science
Department of Planning, Industry and Environment
4 Parramatta Square, 12 Darcy Street, Parramatta NSW 2150
Phone: +61 2 9995 5000 (switchboard)
Phone: 1300 361 967 (Environment, Energy and Science enquiries)
TTY users: phone 133 677, then ask for 1300 361 967
Speak and listen users: phone 1300 555 727, then ask for 1300 361 967
Email: info@environment.nsw.gov.au
Website: www.environment.nsw.gov.au

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Executive summary

Wild dogs and foxes are listed as priority pests in all regions of New South Wales, which places a duty on private landholders and public land managers under the *Biosecurity Act 2015* to minimise the negative impacts of these species on their land and neighbouring lands (LLS 2018a–k).

The effective control of foxes is also imperative because foxes have been one of the major drivers of mammal extinctions in Australia and have been identified as having an ongoing impact on more than 100 threatened species in New South Wales. Failure to control foxes will result in ongoing declines, and potentially local extinctions, of native fauna. The impact of foxes is likely to be exacerbated by the effect of the 2019–20 bushfires.

This Conservation Risk Assessment (CRA) evaluates the proposed aerial baiting of wild dog and fox populations using sodium fluoroacetate (1080). The proposed aerial baiting program will be implemented over a two-year period from May 2020 by the NSW National Parks and Wildlife Service (NPWS), across all NPWS estate and landowner approved neighbouring public and private lands.

The use of 1080 reflects the fact that wild dogs and foxes are significantly more susceptible to sodium fluoroacetate (1080) than native wildlife (McIlroy 1986). Aerial baiting with 1080 is currently the only cost-effective method for landscape control of foxes and wild dogs.

This risk assessment concludes that the proposed aerial baiting program:

- will be carried out in a manner consistent with all relevant legislation
- involves an increase in overall baiting effort across New South Wales because it will occur across a broader geographic area; however, the available baiting prescriptions remain unchanged (up to 40 baits per kilometre for wild dogs and up to 10 baits per kilometre for foxes)
- is the only viable method for landscape-scale control of foxes and wild dogs
- gives effect to the statutory obligation on NPWS under the Biosecurity Act in relation to the control of wild dogs and foxes
- is consistent with all relevant legislation
- delivers 1080 baits in a manner that will not have an adverse impact on native wildlife populations
- will reduce fox densities and improve the prospects for survival of native wildlife including threatened species
- will reduce the economic impact of wild dogs and foxes on landholders
- will avoid impacts on wild dogs in selected parts of national parks where baiting will not occur, to allow wild dogs to fulfil the ecological role of the dingo in those locations
- is unlikely to lead to any increase in feral cat impacts.

The CRA has been prepared to review the potential impacts on native wildlife and to identify appropriate risk controls to avoid or minimise these impacts. It replaces the previous CRA prepared in 2015. It includes consideration of enhanced large-scale pest control operations following the major bushfires of 2019–20.

Implementation of the baiting program is subject to ongoing review and, if required, revision. This will be reflected as necessary with updates to this CRA.

This CRA should be read in conjunction with the NPWS Guidelines for undertaking wild dog and fox aerial baiting on NPWS estate (NPWS 2020). Each aerial baiting operation must be preceded by a specific risk assessment, of the form given in Appendix A of this CRA, which must be reviewed and approved by an Authorised Control Officer (ACO) employed by NPWS.

1. Introduction

1.1 Background

Under the *Biosecurity Act 2015*, the NSW National Parks and Wildlife Service (NPWS) has a general biosecurity duty to manage pest animals such as foxes and dogs. This duty requires the occupier of land (both public and private) to ensure that, so far as is reasonably practicable, the biosecurity risk is prevented, eliminated or minimised.

As a public land manager with responsibility for the care and control of approximately 9% of New South Wales, NPWS carries out control programs for these pests – often with the cooperation of neighbours including wild dog associations, Local Land Services (LLS) and other land management agencies. The methods used include baiting using sodium fluoroacetate (1080) as the toxin.

1080 is an odourless, tasteless white powder that is diluted with water to concentrations specific for the species being targeted. Many Australian native animals have a high tolerance to 1080 because the chemical used in baits is synthetically manufactured and identical to the natural sodium fluoroacetate poison found in over 30 Australian native plants. It is highly soluble and biodegradable, breaking down in soil and carcasses. All Australian states and territories endorse 1080 baiting as part of an integrated approach to pest animal management. In Australia, 1080 supply and use is highly regulated. It is a restricted chemical product and can only be supplied to persons who are authorised to use the product under the laws of a state or territory (PestSmart 2017).

Aerial baiting with 1080 is one of a range of methods employed to meet the objectives of NPWS wild dog and fox control programs. It is currently the most safe, efficient and cost-effective technique available to reduce wild dog and fox abundance, particularly in areas where vehicle access is limited. Baiting operations can be conducted over multiple tenures to achieve effective control across the landscape.

The term ‘wild dog’ refers to dingoes, feral dogs and their hybrids. Most wild dogs in New South Wales are hybrids. The NSW *Wild Dog Management Strategy* (DPI 2017) promotes a balance between managing wild dogs in areas where they have negative impacts and preserving the ecological role of the dingo. Consistent with the *Wild Dog Management Strategy*, NPWS aerial baiting operations that target wild dogs focus on reducing negative impacts to neighbours’ livestock and are not generally undertaken in parts of the reserve system away from livestock production, to allow wild dogs to fulfil the natural ecological role of the dingo in these locations.

This Conservation Risk Assessment (CRA) has been prepared to review any potential risks to native wildlife from NPWS aerial baiting programs and to identify appropriate risk controls to avoid or minimise impacts. It replaces a CRA prepared in 2015 and includes updated information from recent research and the monitoring of baiting operations conducted during the past five years.

The use of pesticides, including aerial baiting, is not considered an ‘activity’ for the purposes of Division 5.1 of the *Environmental Planning and Assessment Act 1979* and, in some circumstances, may be considered ‘exempt development’. This means a statutory environmental impact assessment under NSW legislation is not required. Pesticide use in New South Wales is extensively regulated by the Australian Pesticides and Veterinary Medicines Authority (APVMA) and the *NSW Pesticides Act 1999* (including relevant Pesticide Control Orders issued by the NSW Environment Protection Authority).

Under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), approval from the Australian Minister for the Environment is required if an action has, will have, or is likely to have a ‘significant impact’ on a matter of national environmental

significance. The south-eastern mainland population of the spotted-tailed quoll (*Dasyurus maculatus maculatus*) is listed as endangered under the EPBC Act and, as such, is a matter of national environmental significance. In determining that NPWS aerial baiting programs do not require Ministerial approval, i.e. because they are not likely to have a significant impact on the spotted-tailed quoll, the Australian Government relied on such operations being undertaken in compliance with the state's best practice guidelines, the preparation of a risk assessment, and clear documentation of appropriate mitigation measures to avoid impacts on spotted-tailed quoll populations. Relevant documents include the NPWS Vertebrate Pesticide Standard Operating Procedures (NPWS 2019) and this CRA.

The implementation of the aerial baiting program as set out in this CRA is not likely to have a significant impact on a matter of national environmental significance.

1.2 Scope of Conservation Risk Assessment

This Conservation Risk Assessment has been prepared in accordance with NPWS policy. Its purpose is to define and communicate the NPWS aerial baiting program and address the requirements of applicable legislation, as well as identify the mitigation measures that will apply to avoid or minimise environmental impacts.

The scope of activities covered by this CRA is:

- aerial baiting activities undertaken by NPWS
- targeting wild dogs and foxes
- utilising both fixed wing aircraft and helicopters
- using the legally prescribed dose of sodium fluoroacetate (1080) in meat baits
- at a pre-determined rate
- across all NPWS estate and neighbouring public and private lands (with agreement from the respective adjoining land manager where part of a cooperative, cross-tenure baiting program)
- in both burnt areas and unburnt areas (refuges)
- at any time of the year, for a period of two years from 2020

in accordance with the framework of legislation, procedures and guidelines that direct the conduct of aerial baiting programs by NPWS.

1.3 Supporting documents

This CRA forms part of the framework of legislation, procedures and guidelines that direct the conduct of aerial baiting programs by NPWS. These include:

- NSW [Pesticides Act 1999](#) and [Pesticides Regulation 2017](#)
- [Pesticide Control \(1080 Bait Products\) Order \(PDF 552KB\)](#) as issued under section 38 of the Pesticides Act (as updated from time to time)
- [Off-label wild dog aerial baiting permit \(PDF 97KB\)](#) issued by the Australian Pesticides and Veterinary Medicines Authority (APVMA 2018)
- NPWS Vertebrate Pesticide Standard Operating Procedures (NPWS 2019)
- [NPWS Pesticide Use Notification Plan](#) (OEH 2015)
- [NPWS Guidelines for undertaking wild dog and fox aerial baiting on NPWS estate](#) (NPWS 2020).

This CRA will be reviewed and revised as necessary following any changes to the above documents. NPWS baiting operations must adhere to both the 1080 Pesticide Control Order current at the time and current permits from the APVMA.

2. Description of the program

Wild dog and fox control on NPWS parks and reserves is part of a strategic and integrated approach to reduce the negative impacts of these pests. The primary impact of wild dogs is their effect on agricultural productivity. Foxes have negative impacts on both agriculture and the environment.

Thus, the objectives of the aerial baiting program are:

- broadscale reduction in the fox population
- targeted reduction in the wild dog population
- maintenance of, or an increase in the relative abundance of native fauna due to a reduction in predation
- no negative impact on native fauna populations
- improved ecosystem condition
- a reduction in the economic costs to primary producers as a result of stock losses caused by wild dogs and foxes.

Wild dog control operations are normally undertaken cooperatively over multiple tenures in accordance with the relevant wild dog management plans. Fox control for the protection of agriculture can be undertaken concurrently with wild dog control as part of wild dog management plans, as the same techniques can be used to achieve control of both species at the same time.

The primary reason NPWS undertakes fox-specific control programs is to protect native wildlife; however, NPWS does undertake some dedicated fox control programs to protect livestock on neighbouring properties.

Aerial baiting is a well-refined technique widely employed by NPWS and other land management agencies for more than 20 years. The NPWS aerial baiting program, using helicopters and/or fixed wing aircraft, involves operations using the following prescriptions:

- aerial baiting with fox baits at up to 10 baits per linear kilometre
- aerial baiting with fox baits at up to 10 baits per linear kilometre and lines approximately 1 kilometre apart
- aerial baiting with wild dog baits at up to 10 baits per linear kilometre and lines approximately 1 kilometre apart
- aerial baiting with wild dog baits at up to 40 baits per linear kilometre in strategic areas such as known wild dog paths in those regions included in the AVMPA off-label permit.

Following the unprecedented extent of the 2019–20 fire season, NPWS will significantly increase the geographic scope of aerial baiting conducted on land it manages to reduce post-fire predation of native fauna. The program will be conducted using the same techniques (including the same bait densities) employed in previous years, but across a broader area. As a result, more baits will be deployed in total (on an annual basis); however, the available baiting prescriptions remain unchanged (up to 40 baits per kilometre for wild dogs and up to 10 baits per kilometre for foxes).

The precise areas to be baited, and the baiting prescription in each area, is determined by NPWS specialist staff, often in consultation with relevant wild dog control groups and neighbours. A risk assessment on the proposal is assessed by an Authorised Control Officer (ACO), confirming it is consistent with all requirements including this CRA.

It is estimated that the aerial baiting program will involve up to 60,000 kilometres of baiting in the 12 months from May 2020. The level of baiting in 2021 will be determined after an assessment of this year's baiting program but is not expected to exceed the proposed level of baiting in 2020.

The expansion in the geographic scope of the program as defined in this CRA does not raise any new or additional risks to the environment.

Aerial baiting is often one element of an integrated pest control program that includes ground baiting, trapping and shooting. Although aerial baiting can remove over 90% of wild dogs and foxes in the landscape (Fleming et al. 2014), the remaining pest animals can still cause significant problems and often need to be removed by these other techniques.

All NPWS aerial baiting operations are preceded by the completion of an operation-specific risk assessment, to be reviewed and approved by an ACO employed by NPWS. An example of the pro-forma used for this risk assessment is included as **Appendix A**. The risk matrix is used as per the NSW DPI Vertebrate Pesticide Manual (DPI 2020).

Following completion of the risk assessment the relevant NPWS Park Operations Director must then approve the aerial baiting operation before it can proceed, as per the NPWS aerial baiting guidelines for wild dogs and foxes (NPWS 2020) and the NPWS Pesticide Use Notification Plan (OEH 2015).

3. Justification for the program

3.1 The need for wild dog and fox control

Wild dogs and foxes have been identified as priority pest animals by all 11 Regional Pest Animal Committees (RPACs) in New South Wales (LLS 2018a–k). NPWS is represented on all 11 RPACs and conducts wild dog and fox control for the following reasons:

- **To address our biosecurity duty**

Under section 22 of the *Biosecurity Act 2015*, NPWS has a general biosecurity duty to manage pest animals such as foxes and wild dogs. This duty requires the occupier of land (both public and private) to ensure that, so far as is reasonably practicable, the biosecurity risk is prevented, eliminated or minimised.

Wild dogs and foxes meet the definition of ‘pest’ as defined in the Act (section 15) and have the potential to give rise to an adverse effect on the economy, the environment or the community (section 13).

Accordingly, NPWS is required to minimise the impact of wild dogs and foxes. Aerial baiting as defined in this CRA is a key element of the NPWS response to the duty imposed under the Biosecurity Act.

- **To reduce the economic impact of wild dogs and foxes**

Across New South Wales, wild dogs and foxes regularly prey on livestock. This results in significant financial loss for individuals and communities. It has been estimated that the statewide annual production losses associated with wild dogs is \$17.16 million and foxes \$11.66 million (in 2013–14 dollar terms), excluding control costs (McLeod 2016).

This impact can also take an (incalculable) emotional toll on individuals, families and communities. NPWS works closely with Local Land Services, other public land managers and neighbouring private landholders to implement appropriate control programs to minimise the economic impact, and the social impact, of wild dogs and foxes.

- **To conserve native biodiversity**

A fundamental objective of the NSW system of national parks and reserves is the conservation of native biodiversity. In New South Wales, introduced pests, especially foxes and cats, have the greatest negative impact on native fauna (Cresswell & Murphy 2017), and it is critical that actions are taken to reduce the impact of these predators.

Predation by the European red fox is listed as a key threatening process (KTP) under Schedule 4 of the *Biodiversity Conservation Act 2016*. The NSW Scientific Committee final determination of the KTP listing noted predation by the fox is a major threat to the survival of native Australian fauna, with non-flying mammals weighing between 35 and 500 grams and ground-nesting birds thought to be at greatest risk. Foxes impact on at least 110 threatened species in New South Wales (Coutts-Smith et al. 2007). They inhabit more than 98% of the state and are abundant in all regions (West & Saunders 2006). Their density varies greatly across vegetation types and locations, with published estimates in different locations ranging from as low as 0.2 foxes per square kilometre to as high as 7.2 per square kilometre (Saunders et al. 1995).

Priorities and actions for the control of foxes to protect threatened species are documented in the NPWS Regional Pest Management Strategies, which are consistent with the statewide approach outlined in the NSW *Saving our Species* (SOS) program.

The SoS program has been established to maximise the long-term security of threatened species and threatened ecological communities and to minimise the impacts of key threatening processes on biodiversity and ecological integrity. Priorities for fox management are included within individual SoS threatened species projects as well as the KTP strategy addressing predation by the European red fox.

- ***To manage NPWS estate effectively***

Under the *National Parks and Wildlife Act 1974*, plans of management for parks must consider the identification and mitigation of threatening processes such as pest animals and weeds. These plans must also consider the social and economic context of the park to ensure, for example, that the impacts of pest species in the park do not impact neighbouring lands, and that control programs are coordinated across different tenures.

- ***To respond appropriately following the 2019-20 wildfires***

There is a heightened need for pest animal control following the 2019–20 bushfires, which affected 37% of the total NPWS estate, and 63% of the reserved area in the heavily forested and biodiverse landscapes east of the Great Dividing Range. Foxes and cats have been implicated in numerous species extinctions (Doherty et al. 2015) and the impacts of these predators on small mammals is greatly increased after fire (Leahy et al. 2015), with the edges of burnt areas being at most risk of predation occurring (Nimmo et al. 2018). In order to support the persistence of wildlife species after fire, post-fire responses should prioritise management to control introduced predators at key sites (Dickman et al. 2020) at least until suitable vegetation cover re-grows.

Of the 29 species in New South Wales identified by the Federal Wildlife and Threatened Species Bushfire Recovery Expert Panel as requiring urgent management intervention following the 2019–20 bushfires, 15 species are thought to be vulnerable to predation by foxes (DAWE 2020b). This includes iconic species listed in Table 1. The Expert Panel has therefore identified feral predator control as a priority activity to prevent extinction and limit declines of native species, and maximise the chances for long-term recovery of native species and communities (DAWE 2020a).

Although some researchers have suggested that lethal control of wild dogs could lead to increases in foxes and cats through mesopredator release (Brook et al. 2012; Colman et al. 2014; Colman et al. 2015; Johnson & Ritchie 2012), manipulative experimental studies in Australian systems have found this to not be the case (Allen et al. 2013; Allen 2014; Fancourt et al. 2019; Fleming et al. 2012a, 2012b; Stobo-Wilson et al. 2020). Indeed, research has shown that aerial baiting programs for wild dogs at 10 baits per kilometre will remove over 90% of foxes (Fleming et al. 2014).

Table 1 Iconic species at risk without predator control

| Species | Without predator control, what's at risk? |
|---------------------------|--|
| Spotted-tailed quoll | <p>The average weight of an adult male is about 3500 g and an adult female about 2000 g. It has rich-rust to dark-brown fur above, with irregular white spots on the back and tail, and a pale belly. The range of the spotted-tailed quoll has contracted considerably since European settlement. It is now found in eastern New South Wales, eastern Victoria, south-east and north-eastern Queensland, and Tasmania. Only in Tasmania is it still considered relatively common.</p> <p>Conservation status in NSW: Vulnerable</p> |
| Brush-tailed rock-wallaby | <p>The brush-tailed rock-wallaby has a characteristic, long and bushy, dark rufous-brown tail that is bushier towards its tip. This wallaby is highly agile and can move swiftly and confidently through rugged and precipitous areas. The average weight of this species is about 8 kg for males and 6 kg for females. The range of the brush-tailed rock-wallaby extends from south-east Queensland to the Grampians in western Victoria, roughly following the line of the Great Dividing Range; however, the distribution of the species across its original range has declined significantly in the west and south and has become more fragmented.</p> <p>Conservation status in NSW: Endangered</p> |
| Long-nosed potoroo | <p>Adult long-nosed potoroos weigh up to 1.6 kg and have a head and body length of about 360 mm and a tail length between 200 and 260 mm. Its fur is greyish-brown above and light grey below. The long-nosed potoroo is found on the south-eastern coast of Australia, from Queensland to eastern Victoria and Tasmania, including some of the Bass Strait islands. In New South Wales it is generally restricted to coastal heaths and forests east of the Great Dividing Range.</p> <p>Conservation status in NSW: Vulnerable</p> |
| Mountain pygmy-possum | <p>Mountain pygmy-possum adults average 40 g. Of the total length of 250 mm, over half is tail. The fur is dense and fine, grey-brown above and creamy to bright fawn under the body. The mountain pygmy-possum lives only in alpine and subalpine areas on the highest mountains of Victoria and New South Wales. In New South Wales, the entire range is in a 30 km by 8 km area of Kosciuszko National Park between Thredbo and Kerries Ridge, where it occupies less than 4 km² of habitat. The total population size is fewer than 500 adults.</p> <p>Conservation status in NSW: Endangered</p> |
| Broad-toothed rat | <p>A tubby, compact rodent, chubby-cheeked, with a short, wide face and ears, and long, dense, fine fur. It is brown above, with attractive, rufous highlights. In New South Wales, the broad-toothed rat occurs in two widely separated areas: the wet alpine and subalpine heaths and woodlands in Kosciuszko National Park, and on the Barrington Tops, north-west of Newcastle.</p> <p>Conservation status in NSW: Vulnerable</p> |
| Smoky mouse | <p>The smoky mouse is similar in size to a small rat, with a head and body length averaging about 90 mm and a tail averaging 140 mm. The average adult weight is 52 g. The fur is fine, soft, pale-grey to bluish-grey above, with a grey to white belly and a ring of dark hairs around the eye. The smoky mouse is currently limited to a small number of sites, including in south-east New South Wales and the ACT.</p> <p>Conservation status in NSW: Critically Endangered</p> |

| Species | Without predator control, what's at risk? |
|---------------------|---|
| Lyrebird | <p>There are two species in the family of lyrebirds – the superb lyrebird and Albert's lyrebird. The male superb lyrebird is 80–100 cm long, including his 55 cm long tail. He is dark brown on the upper part of his body and lighter brown below, with red-brown markings on his throat. His tail feathers are dark brown above and silver-grey below. Females of the species are smaller than the males, with similar colouring but without the lyre-shaped tail. The Albert's lyrebird is similar in appearance to the superb lyrebird, but is smaller and darker, with a rich chestnut colour. The male does not have the outer lyre-shaped tail feathers of the superb lyrebird.</p> <p>Conservation status in NSW: Vulnerable (Albert's lyrebird)</p> |
| Eastern bristlebird | <p>Eastern bristlebirds are medium-sized, long-tailed, brown and rufous birds. They are shy and cryptic and mostly occur in dense, coastal vegetation. The plumage of the eastern bristlebird is dull brownish above and lighter grey below, with rufous wings. The distribution of the eastern bristlebird has contracted to three disjunct areas of south-eastern Australia. There are three main populations in New South Wales: northern New South Wales, around Jervis Bay National Park, and in the south, at Nadgee Nature Reserve. The estimated population is fewer than 2000 individuals occupying a total area of about 120 km².</p> <p>Conservation status in NSW: Endangered</p> |

3.2 Program design and effectiveness

The most cost-effective method for wild dog and fox control over large and/or inaccessible areas is aerial baiting using 1080. It is often the only way to distribute baits across many of the remote and inaccessible areas of New South Wales, and the only practical landscape-scale control method available. 1080 is currently the optimal choice for baiting of wild dogs and foxes because both species are highly susceptible to the toxin. In contrast, native carnivorous species have a much higher tolerance to 1080 (McIlroy 1999, 2007).

NPWS has considered available literature including recent research and associated reports submitted by the NSW Department of Primary Industries (DPI) to the APVMA, regarding field trials that compare the efficacy of 1080 aerial baiting for wild dogs at 0, 10 and 40 baits per linear kilometre (Ballard et al. 2020; DPI 2018; Fleming & Ballard 2014). This research recommends aerial baiting be carried out at rates of 40 baits per kilometre rather than 10 baits per kilometre to maximise wild dog mortality in strategic areas in eastern New South Wales. Baiting at the higher rate is important if the objective is to effectively reduce wild dog numbers and their impacts. In response to this research, the APVMA issued an off-label permit for the use of 40 wild dog baits per kilometre in sections of eastern New South Wales (APVMA 2018).

The current 1080 Pesticide Control Order and the APVMA permit for aerial baiting only refers to **baits per linear kilometre**, i.e. there is no specified limit on the distance between baiting lines and thus the density of baiting per square kilometre. However, the relevant documents limit ground baiting to **10 baits per linear kilometre** or **20 baits per square kilometre**.

NPWS has chosen to adopt the density requirements of ground baiting in designing its aerial baiting program. As a result, NPWS will implement grid pattern baiting at 10 baits per kilometre along parallel lines approximately 1 kilometre apart, to ensure the aerial baiting rate does not exceed the allowable ground baiting density.

Similarly, the spacing of 40 baits per kilometre strategic baiting lines targeting areas such as known wild dog paths (e.g. ridge lines), will be designed to not exceed the ground baiting density requirements.

The various aerial baiting options and relevant prescriptions are as set out in Table 2.

Table 2 Prescriptions for fresh meat baits for aerial baiting of foxes and wild dogs

| Target | Bait weight* / 1080 dose | Rate | Application |
|----------------|--------------------------|---|--|
| Fox | 80 g / 3 mg | 10 baits per km | The locations of bait lines will target areas where they will have the maximum impact on reducing livestock attacks and/or reducing impacts on wildlife from foxes. |
| Fox | 80 g / 3 mg | 10 baits per km (linear) and lines 1 km apart | The locations of bait lines will target areas where they will have the maximum impact on reducing livestock attacks and/or reducing impacts on wildlife from foxes. |
| Wild Dog / Fox | 200 g / 6 mg | 10 baits per km (linear) and lines 1 km apart | The locations of bait lines will target areas where they will have the maximum impact on reducing livestock attacks from dogs, reducing livestock attacks from foxes and/or reducing impacts on wildlife from foxes. |
| Wild Dog | 200 g / 6 mg | 40 baits per km | Targeted areas of focused wild dog control along linear routes such as known wild dog paths, e.g. ridge lines. These programs will be designed to not exceed the allowable ground baiting density in those regions included in the AVMPA off-label permit. Primarily used for areas interfacing with agricultural production or neighbouring public and private lands (with agreement from respective adjoining land manager where part of a cooperative, cross-tenure baiting program). |

* Minimum post-drying weight

Supporting documents (see section 1.3) provide detailed advice about requirements relating to planning and approvals, notification, bait type, aircraft operations and post-baiting activities.

For the purpose of this CRA, it is noted that:

- aerial baiting will be undertaken in accordance with the current Pesticide Control (1080 Baits Products) Order, the NSW Vertebrate Pesticide Control Manual, the NPWS Pesticide Use Notification Plan and the guidelines for undertaking wild dog and fox aerial baiting on NPWS estate
- aerial bait lines will be developed in consultation with Operations Branch staff and be mapped on a geographic information system (GIS), consistent with the prescriptions outlined in Table 2
- each baiting program must have its own, individual application approved by the relevant Park Operations Director
- only fresh meat baits will be used by NPWS for aerial wild dog control. Fresh baits are preferred for foxes; however, other baits allowed by the current Pesticide Control (1080 Baits Products) Order or Department of Primary Industries vertebrate pesticide manual may be used for aerial baiting of foxes by NPWS, as per the guidelines for undertaking wild dog and fox aerial baiting on NPWS estate.

- In relation to wild dogs, the rate identified in Table 2 will be modified to a lower bait rate where one or more of the following applies:
 - the ACO risk assessment determines there is an unacceptable level of risk at the maximum rate and the ACO prescribes an alternative, lower rate
 - an efficient, integrated control program is already providing effective results
 - a more efficient aerial bait rate provides greater spatial coverage within the control area. For example, for the same cost, a program can cover a larger area by aerial baiting 100 kilometres at 30 baits per kilometre as opposed to 75 kilometres at 40 baits per kilometre.

Where possible, the NPWS ACO's risk assessment of the on-park baiting rate will consider the desirability of bait rates consistent with those being applied on other adjacent tenure/s as part of any cooperative baiting program. Where the bait rates are not consistent across tenure boundaries, the reasons will be stated in the application to be considered by the NPWS Park Operations Director.

Case study – Aerial baiting in Wollemi-Yengo and Mudgee areas in May and June 2020

In May and June 2020, aerial baiting will be undertaken across the national parks and reserves of the Wollemi-Yengo and Mudgee NPWS management areas, generally between Mudgee and Bucketty, encompassing most of Wollemi and Yengo national parks and nearby smaller reserves. Most of this area was burnt in the 2019–20 bushfires.

Of the 564,670 hectares to be aerially baited, 22 kilometres of wild dog baiting will occur adjacent to adjoining agricultural properties, using 200 gram/6 milligram baits at a rate of 40 baits per kilometre. These transects coincide with lines used annually as part of a broader cooperative wild dog program. An additional 131 kilometres of fox baiting will be undertaken around the Wolgan Valley brush-tailed rock-wallaby colonies, using 80 gram/3 milligram baits at a rate of 10 baits per kilometre. These transects coincide with lines used annually as part of the *Saving our Species* program. A further 3596 kilometres will be baited targeting both wild dogs and foxes using 200 gram/6 milligram baits at a rate of 10 baits per kilometre in a line transect pattern (1 kilometre apart) as part of the post-bushfire recovery program.

Almost 205,000 hectares of the combined areas of the parks and reserves in the Wollemi-Yengo and Mudgee management areas will not be baited. In these locations, wild dogs will continue to perform the ecological role of the dingo. This area largely coincides with remote areas that are also declared wilderness.

4. Consideration of impacts

4.1 Impacts on susceptible wildlife

After an extensive series of targeted research projects, Mcllroy (1999) found there is no definite evidence of any populations of common native animals in New South Wales at population-level risk from 1080 meat baiting programs. The susceptibility of a species to 1080 baiting with fresh meat baits varies according to a combination of their susceptibility to 1080, their ability to locate and consume sufficient poisoned bait material, and their ecological characteristics. For example, although carnivorous native species such as goannas and raptors are known to consume fresh meat baits, they are highly tolerant to 1080. Wedge-tailed eagles are at least 85 times more tolerant than wild dogs (Mcllroy 1984), and lace monitors are at least 900 times more tolerant of 1080 than wild dogs (Mcllroy et al. 1985).

Spotted-tailed quolls were the only species identified by Mcllroy (1999) as being potentially at risk from aerial baiting in selected NSW national parks. This species is 17 times more tolerant to 1080 than wild dogs (Mcllroy 1981b).

The impact of aerial baiting with 1080 meat dog baits on spotted-tailed quolls has been investigated in four separate studies in New South Wales: Claridge & Mills (2007), Körtner (2007), Körtner and Watson (2005), and Claridge et al. (in prep). In a study in a rainshadow woodland in southern New South Wales, aerial baiting at a rate of 10 baits per kilometre had no observable impact on local quolls that had been radio-collared and monitored (Claridge & Mills 2007). During this study, it was found that several quolls were exposed to 1080 baits but none succumbed to the toxicant. Similar results were found by Körtner and Watson (2005) and Körtner (2007) in northern New South Wales, where baiting rates varied from 10 baits per kilometre up to 40 baits per kilometre. In both studies, quolls were again found to encounter and ingest baits, and survived after the program. Although a small number of individual quolls died during these studies, no mortalities could be directly attributed to 1080, whereas a number of observed quoll deaths were directly attributed to predation.

A recent synthesis of quoll research suggests that lethal control of wild dogs and foxes through baiting programs has likely benefited the persistence of quoll populations in New South Wales and south-east Queensland (Fleming & Ballard 2019).

In his independent review for the Australian Government on the effect of large-scale 1080 baiting programs for wild dogs and foxes on the spotted-tailed quoll, Mcllroy (2007) concluded that aerial baiting up to 40 baits per kilometre is unlikely to have a significant impact on most spotted-tailed quoll populations, but noted the viability of small fragmented populations was uncertain. However, improved knowledge of quoll distribution has since identified that there are no known small fragmented populations of quolls on NPWS estate in New South Wales. As shown in Figure 1, there are a large number of records of the species in the eastern third of the state, and the contiguous nature of those records in geographic space represents a single closely linked interbreeding meta-population.

In spring of 2016, Claridge et al. (in prep.) live-trapped, radio-tracked and followed the fate of adult female quolls and their pouch young through aerial baiting programs in northern and southern New South Wales. Despite being exposed to aerially delivered 1080 injected meat baits at a rate of 40 baits per kilometre, no collared adults died and juvenile recruitment was normal. The implication of this work is that aerial baiting can also be safely carried out during spring months without concern for negative impacts on quolls.

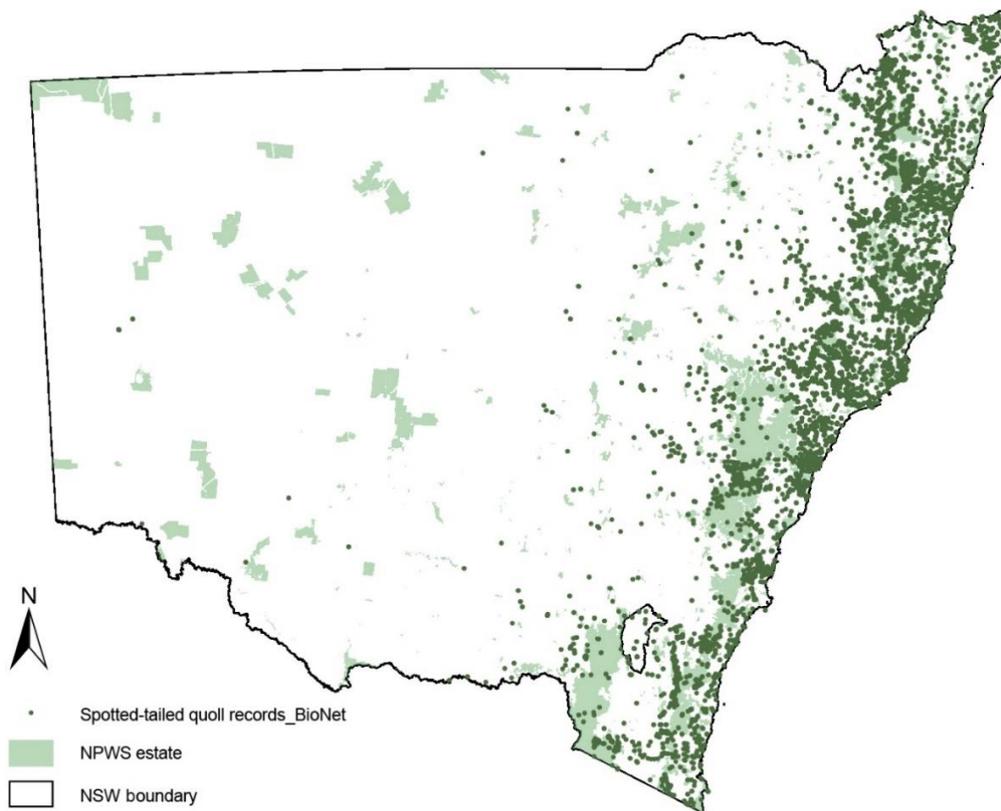


Figure 1 NSW BioNET Atlas records of the spotted-tailed quoll (*Dasyurus maculatus*) across New South Wales

The distribution of the records highlights the widespread occurrence of the species across the eastern third of the state, with concentrations of records either side of the Great Dividing Range and Coastal Escarpment.

4.2 Other approaches considered

A range of alternative approaches to the aerial baiting with 1080 as it has been recommended in this CRA have been considered (Table 3).

Table 3 Other approaches considered

| Alternative | Assessed likely outcome |
|--|--|
| Do nothing | Fox populations will increase, resulting in increased predation of native fauna and localised declines and possible extinctions. NPWS may be in breach of the <i>Biosecurity Act 2015</i> |
| Do not bait for wild dogs | Wild dog populations will increase. Neighbouring stock losses will increase, resulting in increased financial and social costs to the agricultural sector and rural communities. NPWS may be in breach of the <i>Biosecurity Act 2015</i> |
| Reduce geographic coverage of fox baiting | Fox populations will increase, resulting in increased predation of native fauna and localised declines and possible extinctions. |
| Reduce geographic coverage of wild dog baiting | Consistent with the <i>NSW Wild Dog Management Strategy</i> (DPI 2017) this technique is already being employed. NPWS aerial dog baiting operations will focus on areas adjacent to livestock production, leaving wild dogs to fulfil the natural ecological role of the dingo in the more remote parts of parks and reserves. |

| Alternative | Assessed likely outcome |
|-------------------|--|
| Alternative toxin | <p>Para-aminopropiophenone (PAPP) is another toxin registered for wild dog and fox control. Commercially available wild dog baits contain 1000 mg of PAPP. A range of native fauna are susceptible to PAPP at this dose rate. Lace monitors <i>Varanus varius</i> have an LD₅₀* of 12.9 mg (Frappell 2007), southern brown bandicoots <i>Isoodon obesulus</i> 5.4 mg and spotted-tailed quolls <i>Dasyurus maculatus</i> 124 mg (NWR 2006). As a result, PAPP poses an unacceptable risk to native species and cannot be considered as an alternative to 1080 for wild dog and fox aerial baiting programs.</p> <p>* The LD₅₀ is the lethal dose of a toxin required to kill 50% of a test population.</p> |
| Ground bait only | <p>Due to the inaccessible nature of much of the NPWS estate ground baiting on its own cannot achieve the landscape coverage required for effective control.</p> <p>Ground baiting is used in conjunction with other pest control techniques to complement aerial bating and optimise results.</p> |

4.3 Identification of other hazards and risks

The relevant NPWS guidelines and standard operating procedures (NPWS 2019, 2020) require strict compliance with the Pesticide Control Order and legislated restrictions on the use of 1080. An ACO risk assessment template is provided in Appendix A.

5. Monitoring and research

5.1 Forecast outcomes

The success of the 1080 aerial baiting program in meeting its key objectives will be assessed by monitoring and evaluation. The results of previous broadscale baiting programs guide the application of current baiting programs and provide an indication of likely outcomes.

Dexter and Murray (2009) examined the impact of poisoning foxes on the relative abundance of a group of medium-sized mammals in an experiment conducted in three large forest blocks in south-eastern Australia. They found a higher abundance of all mammals, including long-nosed potoroos, southern brown bandicoots and common brushtail possums at all treatment sites. The increase in abundance of native mammals was most likely due to lower predation as a result of fox control. The study also demonstrated that the influence of fox control on fox abundance can extend well beyond the perimeter of the area baited.

Claridge et al. (2010) monitored the relative activity of ground-dwelling vertebrates for 10 consecutive years using tracks in sand plots across three nearby study areas in south-eastern mainland Australia. Two areas were subject to intensive 1080 poison baiting for foxes, while one unbaited area acted as a control. At the two 1080 baited sites there was a demonstrable decline in the reporting rate of fox tracks. At the unbaited site the reporting rate of foxes remained stable. Among the native omnivorous mammals that ordinarily fall prey to foxes, bandicoots, brushtail possums and lyrebirds increased in activity against a background of diminishing fox activity, although these effects were not uniform at both baited sites. In contrast, at the study area where foxes were not baited, the activity of bandicoots, brushtail possums and lyrebirds either did not change or diminished.

5.2 Monitoring

A monitoring program will be implemented to provide, to the greatest extent practicable, data that can inform the design of future baiting programs. In particular, monitoring programs will be designed to generate data to understand the impact of baiting on:

- wild dog, fox and feral cat presence and activity over time, and
- native species presence and activity over time.

Initial monitoring will utilise and build on existing monitoring sites and programs; however, a review will be conducted to identify how monitoring can be expanded to generate more comprehensive and improved data, noting the severity of impacts on native fauna from foxes and feral cats.

6. Conclusion

There is a compelling conservation imperative for landscape-scale aerial baiting. It is an essential component of post-bushfire recovery if localised species declines and extinctions are to be prevented. Currently, there are no viable alternatives to aerial baiting.

This CRA has determined that it is possible to implement the proposed aerial baiting program for the control of wild dogs and foxes while avoiding impacts on non-target native species.

Based on the information contained in this CRA, and the additional references provided below, the proposed aerial baiting program may proceed subject to the following conditions:

- All aerial baiting for wild dogs and foxes on NPWS estate will adhere to the conditions of the NPWS 1080 aerial baiting guidelines for wild dogs and foxes and the Pesticide Control (1080 Bait Products) Order current at the time.
- An ACO risk assessment of the form included in Appendix A will be completed, reviewed and approved by an ACO employed by NPWS.
- Where the guidelines are met, rates up to 40 baits per kilometre can be used for wild dogs.
- Where the guidelines are met, rates up to 10 baits per kilometre can be used for foxes.
- When undertaking grid pattern baiting, bait rates should be at a maximum of 10 baits per kilometre.
- Monitoring and evaluation will be carried out to determine the effectiveness of the operations.

7. References and additional sources

- Allen BL, Allen LR, Engeman RM and Leung LKP 2013, Intraguild relationships between sympatric predators exposed to lethal control: predator manipulation experiments, *Frontiers in Zoology*, vol.10, art.39, www.frontiersinzoology.com/content/10/1/39
- Allen BL 2015, Top-predator control-induced trophic cascades: an alternative hypothesis to the conclusion of Colman et al., *Proceedings of the Royal Society B*, vol.282, no.1799, DOI: [dx.doi.org/10.1098/rspb.2014.1251](https://doi.org/10.1098/rspb.2014.1251)
- APVMA 2018, *Permit to allow the use of baits containing 1080 at a rate higher than that specified by the label instructions for aerial baiting of wild dogs*, Permit number PER83516, Version 2, Australian Pesticides and Veterinary Medicines Authority, Canberra, permits.apvma.gov.au/PER83516.PDF (PDF 97KB).
- Ballard G, Fleming PJS, Meek PD and Doak S 2020, Aerial baiting and wild dog mortality in south-eastern Australia, *Wildlife Research*, vol.47, no.2, pp.99–105, DOI: doi.org/10.1071/WR18188.
- Brook LA, Johnson CN and Ritche EG 2012, Effects of predator control on behaviour of an apex predator and indirect consequences for mesopredator suppression, *Journal of Applied Ecology*, vol.49, pp.1278–1286.
- Claridge AW and Mills DJ 2007, Aerial baiting for wild dogs has no observable impact on spotted-tailed quolls (*Dasyurus maculatus*) in a rainshadow woodland, *Wildlife Research*, vol.34, pp.116–124.
- Claridge AW, Cunningham RB, Catling PC and Reid AM 2010, Trends in the activity levels of forest-dwelling vertebrate fauna against a background of intensive baiting for foxes, *Forest Ecology and Management*, vol.260, no.5, pp.822–832.
- Claridge AW, Ballard G, Körtner G, Forge T, Russell BR, Fleming PJS and Gigliotti F in prep., Monitoring impacts of aerial baiting for wild dogs on female spotted-tailed quolls (*Dasyurus maculatus*) during the breeding season.
- Colman NJ, Gordon CE, Crowther MS and Letnic M 2014, Lethal control of an apex predator has unintended cascading effects on forest mammal assemblages, *Proceedings of the Royal Society B*, vol.281, no.1782, DOI: doi.org/10.1098/rspb.2013.3094.
- Colman NJ, Gordon CE, Crowther MS and Letnic M 2015, Response to Allen 'An alternative hypothesis to the conclusion of Colman et al. (2014)', *Proceedings of the Royal Society B*, vol.282, no.1799, 20141845, DOI: [dx.doi.org/10.1098/rspb.2014.1845](https://doi.org/10.1098/rspb.2014.1845).
- Coutts-Smith AJ, Mahon PS, Letnic M and Downey PO 2007, *The threat posed by pest animals to biodiversity in New South Wales*, Invasive Animals Cooperative Research Centre, Canberra, www.pestsmart.org.au/wp-content/uploads/2010/03/NSWBiodiversity.pdf (PDF 1.8MB).
- Cresswell ID and Murphy HT 2017, *Australia State of the Environment 2016: biodiversity*, independent report to the Australian Government Minister for the Environment and Energy, Australian Government Department of the Environment and Energy, Canberra.
- DELWP 2016, *National Recovery Plan for the Spotted-tailed Quoll Dasyurus maculatus*, prepared by the Victorian Department of Environment, Land, Water and Planning, Australian Government Department of the Environment, Canberra, www.environment.gov.au/biodiversity/threatened/recovery-plans/spotted-tailed-quoll.

DAWE 2020a, *Wildlife and Threatened Species Bushfire Recovery Expert Panel Communique 15 January 2020*, Department of Agriculture, Water and Environment, Canberra, www.environment.gov.au/system/files/pages/effd94e2-00fc-4e4b-8692-941f90f5ad8c/files/communique-15jan2020.pdf (PDF 134KB).

DAWE 2020b, *Provisional list of animals requiring urgent management intervention identified by the Wildlife and Threatened Species Bushfire Recovery Expert Panel*, Department of Agriculture, Water, and Environment, Canberra, www.environment.gov.au/biodiversity/bushfire-recovery/priority-animals

Dexter D and Murray AJ 2009, The impact of fox control on the relative abundance of forest mammals in East Gippsland, Victoria, *Wildlife research*, vol. 36, no.3, pp.252–261, DOI: [dx.doi.org/10.1071/WR08135](https://doi.org/10.1071/WR08135).

Dickman C, Driscoll D, Garnett S, Keith D, Legge S, Lindenmayer D, Maron M, Reside A, Ritchie E, Watson J, Wintle B and Woinarski J 2020, *After the catastrophe: a blueprint for a conservation response to large-scale ecological disaster*, Threatened Species Recovery Hub, January 2020.

Doherty TS, Dickman CR, Nimmo DG and Ritchie EG 2015, Multiple threats, or multiplying the threats? Interaction between invasive predators and other ecological disturbances, *Biological Conservation*, vol.190, pp.60–68.

DPI 2017, *NSW Wild Dog Management Strategy 2017–2021*, Department of Primary Industries, Department of Industry, Sydney, www.dpi.nsw.gov.au/_data/assets/pdf_file/0004/445234/NSW-Wild-Dog-Management-Strategy-2017-2021.pdf (PDF 872KB).

DPI 2018, 'Optimal control of wild dogs using aerial baiting: Technical update and environmental assessment', unpublished submission to the Australian Pesticides and Veterinary Medicine Authority, NSW Department of Primary Industries.

DPI 2020, *NSW DPI Vertebrate Pesticide Manual*, 11th edition, Department of Primary Industries, Orange, www.dpi.nsw.gov.au/biosecurity/vertebrate-pests/publications/nsw-vertebrate-pesticide-manual.

EPA 2019, *Pesticide Control (1080 Bait Products) Order*, Environment Protection Authority, www.epa.nsw.gov.au/your-environment/pesticides/pesticides-nsw-overview/pesticide-control-orders/guidance-for-using-1080.

Fancourt BA, Cremasco P, Wilson C, and Gentle MN 2019, Do introduced apex predators suppress introduced mesopredators? A multiscale spatiotemporal study of dingoes and feral cats in Australia suggests not, *Journal of Applied Ecology*, vol.56, pp.2584–2595, DOI: [dx.doi.org/10.1111/1365-2664.13514](https://doi.org/10.1111/1365-2664.13514)

Fleming PJS, Allen BL and Ballard GA 2012a, Seven considerations about dingoes as biodiversity engineers: the socioecological niches of dogs in Australia, *Australian Mammalogy*, vol.34, pp.119–131

Fleming PJS, Allen BL, and Ballard GA 2012b, Cautionary considerations for positive dingo management: a response to the Johnson and Ritchie critique of Fleming et al. (2012), *Australian Mammalogy*, vol.35, pp.15–22.

Fleming PJS, Ballard G and Tarrant M 2014, *Aerial Baiting for Wild Dogs*, project ON-00047 (ex AWI WP477), final report to Australian Wool Innovation Ltd, Sydney.

Fleming PJS and Ballard G 2014, *An investigation of aerial baiting rates for strategic control of wild dogs: Final report to Biosecurity NSW, Local Lands Services and Australian Pesticides and Veterinary Medicines Authority*, Department of Primary Industries, Orange, www.pestsmart.org.au/wp-content/uploads/2015/04/FlemingBallard_AerialBaitingRept_APVMA.pdf (PDF 640KB).

Fleming PJS and Ballard G 2019, Yes, killing is sometimes essential for conservation, *Australian Zoologist*, vol.40, no.1, pp.5–12, DOI: doi.org/10.7882/AZ.2018.037.

Fleming PJS, Thompson JA and Nicol HI 1996, Indices for measuring the efficacy of aerial baiting for wild dog control in north-eastern New South Wales, *Wildlife Research*, vol.23, no.6, pp.665–674.

Frappell P 2007, 'The effect of para-aminopropiophenone (PAPP) on methemoglobin levels in the Lace monitor, *Varanus varius*', Addendum for submission to Pestat Ltd, Adaptational and Evolutionary, Respiratory Physiology Laboratory, Department of Zoology, La Trobe University.

Gentle M and Cother E 2013, Biodegradation of 1080: Testing soils in south-eastern Australia for sodium fluoroacetate-degrading micro-organisms, *Ecological Management and Restoration*, vol.15, pp.52–57.

Johnson CN and Ritchie EG 2012, The dingo and biodiversity conservation: response to Fleming et al. (2012), *Australian Mammalogy*, vol.35, pp.8–14.

Körtner G 2004, 'Conservation Risk Assessment for an aerial baiting trial in Cunnawarra National Park and surrounding areas to measure the impact of aerial baiting for wild dogs on spotted-tailed quolls', unpublished report for the Department of Environment and Conservation (NSW).

Körtner G 2007, 1080 aerial baiting for the control of wild dogs and its impact on spotted-tailed quoll (*Dasyurus maculatus*) populations in Eastern Australia, *Wildlife Research*, vol.34, no.1, pp.48–53.

Körtner G and Watson P 2005, The immediate impact of 1080 aerial baiting to control wild dogs on a spotted-tailed quoll population, *Australian Wildlife Research*, vol.32, no.8, pp.673–680.

Leahy L, Legge MS, Tuft K, McGregor HW, Barmuta LA, Jones ME and Johnson CN 2015, Amplified predation after fire suppresses rodent populations in Australia's tropical savannas, *Wildlife Research*, vol.42, no.8, pp.705–716.

LLS 2018a, *Central Tablelands Regional Strategic Pest Animal Management Plan 2018–2023*, Local Land Services, Dubbo, NSW, www.ils.nsw.gov.au/help-and-advice/pests,-weeds-and-diseases/pest-control/regional-strategic-pest-animal-management.

LLS 2018b, *Central West Regional Strategic Pest Animal Management Plan 2018–2023*, , Local Land Services, Dubbo, NSW, www.ils.nsw.gov.au/help-and-advice/pests,-weeds-and-diseases/pest-control/regional-strategic-pest-animal-management.

LLS 2018c, *Greater Sydney Regional Strategic Pest Animal Plan 2018–2023*, Local Land Services, Dubbo, NSW, www.ils.nsw.gov.au/help-and-advice/pests,-weeds-and-diseases/pest-control/regional-strategic-pest-animal-management.

LLS 2018d, *Hunter Regional Strategic Pest Animal Management Plan 2018–2023*, Local Land Services, Dubbo, NSW, www.ils.nsw.gov.au/help-and-advice/pests,-weeds-and-diseases/pest-control/regional-strategic-pest-animal-management.

LLS 2018e, *Murray Regional Strategic Pest Animal Plan 2018–2023*, Local Land Services, Dubbo, NSW, www.ils.nsw.gov.au/help-and-advice/pests,-weeds-and-diseases/pest-control/regional-strategic-pest-animal-management.

LLS 2018f, *North Coast Regional Strategic Pest Animal Management Plan 2018–2023*, Local Land Services, Dubbo, NSW, www.ils.nsw.gov.au/help-and-advice/pests,-weeds-and-diseases/pest-control/regional-strategic-pest-animal-management.

LLS 2018g, *North West Regional Strategic Pest Animal Management Plan 2018–2023*, Local Land Services, Dubbo, NSW, www.ils.nsw.gov.au/help-and-advice/pests,-weeds-and-diseases/pest-control/regional-strategic-pest-animal-management.

LLS 2018h, *Northern Tablelands Regional Strategic Pest Animal Management Plan 2018–2023*, Local Land Services, Dubbo, NSW, www.ils.nsw.gov.au/help-and-advice/pests,-weeds-and-diseases/pest-control/regional-strategic-pest-animal-management.

LLS 2018i, *Riverina Regional Strategic Pest Animal Management Plan 2018–2023*, Local Land Services, Dubbo, NSW, www.ils.nsw.gov.au/help-and-advice/pests,-weeds-and-diseases/pest-control/regional-strategic-pest-animal-management.

LLS 2018j, *South East Regional Strategic Pest Animal Management Plan 2018–2023*, Local Land Services, Dubbo, NSW, www.ils.nsw.gov.au/help-and-advice/pests,-weeds-and-diseases/pest-control/regional-strategic-pest-animal-management.

LLS 2018k, *Western Regional Strategic Pest Animal Management Plan 2018–2023*, Local Land Services, Dubbo, NSW, www.ils.nsw.gov.au/help-and-advice/pests,-weeds-and-diseases/pest-control/regional-strategic-pest-animal-management.

McIlroy JC 1981a, The sensitivity of Australian animals to 1080 poison, I. Intraspecific variation and factors affecting acute toxicity, *Australian Wildlife Research*, vol.8, no.2, pp.369–383.

McIlroy JC 1981b, The sensitivity of Australian animals to 1080 poison, II. Marsupials and eutherian carnivores, *Australian Wildlife Research*, vol.8, no.2, pp.385–399.

McIlroy JC 1982a, The sensitivity of Australian animals to 1080 poison, III. Marsupial and eutherian herbivores, *Australian Wildlife Research*, vol.9, no.3, pp.487–503.

McIlroy JC 1982b, The sensitivity of Australian animals to 1080 poison, IV. Native and introduced rodents, *Australian Wildlife Research*, vol.9, no.3, pp.505–517, DOI: doi.org/10.1071/WR9820505.

McIlroy JC 1984, The sensitivity of Australian animals to 1080 poison, VII. Native and introduced birds. *Australian Wildlife Research*, vol.11, no.2, pp.373–385, DOI: doi.org/10.1071/WR9840373.

McIlroy JC 1986, The sensitivity of Australian animals to 1080 poison. IX. Comparisons between the major groups of animals, and the potential danger nontarget species face from 1080 poisoning campaigns, *Australian Wildlife Research*, vol.13, no.1, pp.39–48, DOI: doi.org/10.1071/WR9860039.

McIlroy JC 1999, 'Species Impact Statement: Aerial Baiting with 1080 poison for wild dog control in New South Wales', unpublished report prepared for the NSW National Parks and Wildlife Service, Hurstville.

McIlroy JC 2007, *A review of the effect of large-scale 1080 baiting for fox and wild dog control on the spotted-tailed quoll, *Dasyurus maculatus maculatus**, Department of the Environment and Water Resources, Canberra.

McIlroy JC, King DR and Oliver AJ 1985, The sensitivity of Australian animals to 1080 poison, VIII. Amphibians and Reptiles, *Australian Wildlife Research*, vol.12, no.1, pp.113–118, DOI: doi.org/10.1071/WR9850113.

McLeod R 2016, *Cost of Pest Animals in NSW and Australia, 2013–14*, eSYS Development Pty Ltd, report prepared for the NSW Natural Resources Commission.

Nelson JL, Scroggie MP and Belcher C 2014, 'Developing a camera trap survey protocol to detect a rare marsupial carnivore, the spotted-tailed quoll (*Dasyurus maculatus*)', in P Meek, P Fleming, G Ballard, P Banks, A Claridge, J Sanderson and D Swann (eds), *Camera Trapping: Wildlife research and management*, CSIRO Publishing, Australia, pp.271–280.

Nimmo DG, Avitabile S, Banks SC, Bird RB, Callister K, Clarke MF, Dickman CR, Doherty TS, Driscoll DA, Greenville AC, Haslem A, Kelly LT, Kenny SA, Lahoz-Monfort JJ, Lee C, Leonard S, Moore H, Newsome TM, Parr CL, Ritchie EG, Schneider K, Turner JM, Watson S, Westbrooke M, Wouters M, White M and Bennett AF 2018, Animal movements in fire-prone landscapes, *Biological Reviews*, vol.94, pp.981–998, DOI: doi.org/10.1111/brv.12486.

NPWS 2018, *Wild Dog Policy*, NSW National Parks and Wildlife Service, Department of Planning, Industry and Environment, Sydney, www.environment.nsw.gov.au/topics/parks-reserves-and-protected-areas/park-policies/wild-dogs/.

NPWS 2019, *NPWS Vertebrate Pesticide Standard Operating Procedures*, Version 2.1, NSW National Parks and Wildlife Service, Department of Planning, Industry and Environment, Sydney.

NPWS 2020, 'Guidelines for undertaking wild dog and fox aerial baiting on NPWS estate', unpublished internal report, NSW National Parks and Wildlife Service, Sydney.

NWR 2006, *New Canid Toxicant, PAPP non-target hazard assessment: Data summary and interpretation* (Volume 1 of 3), *Progress Report 4: EC470*, Nocturnal Wildlife Research Pty Ltd.

OEH 2015, *Pesticide Use Notification Plan for NSW National Parks and Wildlife Service*, Office of Environment and Heritage NSW, www.environment.nsw.gov.au/topics/animals-and-plants/pest-animals-and-weeds/managing-pest-animals-and-weeds/pesticide-use-notification-plan.

PestSmart 2017, *1080 poison baiting – the facts*, Connect, Powered by the Centre for Invasive Species Solutions, PestSmart, pestsmart.org.au/1080-poison-baiting-facts.

Saunders G, Coman B, Kinnear J, and Braysher M 1995, *Managing Vertebrate Pests: Foxes*, Bureau of Rural Sciences, Canberra, ACT

Soderquist T 1995, 'Brush-tailed phascogale', in R Strahan (ed.), *The Mammals of Australia*, Australian Museum, Reed Books, Australia, pp.104–106.

Spurr EB 1994, Review of the impacts on non-target species of sodium monofluoroacetate (1080) in baits used for brushtail possum control in New Zealand, in AA Seawright and CT Eason (eds), *Proceedings of the Science Workshop on 1080*, the Royal Society of New Zealand, pp.124–133.

Stobo-Wilson AM, Stokeld D, Einoder LD, Davies HF, Fisher A, Hill BM, Mahney T, Murphy BP, Stevens A, Woinarski JCZ, Rangers D, Rangers W and Gillespie GR 2020, Habitat structural complexity explains patterns of feral cat and dingo occurrence in monsoonal Australia, *Biodiversity Research*, DOI: doi.org/10.1111/ddi.13065.

Twigg LE 2001, '1080 predator baits: Just how safe are they?', in *Proceedings of the 12th Australian Vertebrate Pest Conference*, Department of Natural Resources and Environment, East Melbourne, Victoria, pp.136–140.

West P and Saunders G 2006, *Pest Animal Survey: A review of the distribution, impacts and control of invasive animals throughout NSW and the ACT*, Department of Primary Industries, Orange, NSW.

Appendix A: ACO risk assessment pro-forma for aerial baiting operations

Note: With proposed controls and restrictions, all residual risks should be rated low for an aerial baiting operation to commence. The NPWS guidelines (NPWS 2020) for aerial baiting provide procedures for these controls, including specific accountabilities of Branch Directors and Authorised Control Officers under the Pesticide Control Order.

|  ACO RISK ASSESSMENT FOR AERIAL BAITING PROGRAMS | | | | | |
|--|-----------------------|----------------------------|------------|-------------------|--|
| Reserve(s) | | Authorised Control Officer | | Assessment date | |
| Program name | | | | Equipment ID | |
| Pesticide | 1080 | Target species | Foxes/Dogs | CM9 ref. | |
| Bait type | Fresh meat – red meat | | | | |
| Disposal | | | | Disposal CM9 ref. | |

| Hazards / risks | Yes | No | N/A | Risk level | Description of hazard or risk | Recommended control measures | New risk level | Detail how control measures will be implemented and any additional controls |
|--|-------------------------------------|--------------------------|--------------------------|------------|---|---|----------------|---|
| Not complying with distance restrictions | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | M | Risk to neighbour's working dogs Risk of domestic waterpoint contamination Risk of human poisoning from 1080 exposure | Baiting location to be mapped and attached to this risk assessment. Bait lines to be mapped and establish all distance restrictions are met as per current PCO. Neighbours to be notified of the presence of baits as per notification requirements in the PCO, and signs placed at all entry points. Operation staff to be aware of distance restrictions required. | L | Staff to review this risk assessment and map during operation briefing. Baiting transects are planned with buffers of xx metres, exceeding the 100 metre PCO requirement. A qualified air observer (or equivalent) will be used for navigation. Two systems of GPS will be used for navigation, and track log of bait deployment must be recorded, including start and finish points. Baiting will cease if environmental conditions are marginal. Staff to maintain current AQF3 and 1080 awareness for operation duration and utilise PPE as outlined in the JSA. |

Conservation Risk Assessment: Aerial baiting with sodium fluoroacetate (1080) for wild dog and fox control – 2020–2022

| Hazards / risks | Yes | No | N/A | Risk level | Description of hazard or risk | Recommended control measures | New risk level | Detail how control measures will be implemented and any additional controls |
|--|-------------------------------------|-------------------------------------|--------------------------|------------|--|--|----------------|---|
| Presence of domestic pets | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | M | Death of domestic dogs from neighbouring properties entering the park, or neighbours bringing working dogs on to park as part of grazing management, or illegal hunters using dogs on park | Bait lines to be mapped and establish all distance restrictions are met as per the current PCO. Baits not to be laid within 1000 m of habitation (if by fixed wing). Warning signs indicate risk to domestic animals. Unused baits to be disposed of as per PCO | L | No domestic animals permitted within these parks, and signage indicates no domestic animals allowed on park. Warning signs to be mapped and checked prior to baiting commencement. Conduct neighbour notification as per PCO, and record in program CM9 location. Baits are not to be laid within xxx m of points where high illegal visitation by domestic animals may be likely. These points are mapped with these buffers applied. Musterers are to be given specific warnings not to operate on park during and immediately after 1080 delivery. Warnings must include advice that 1080 can kill their working dog, and working dogs must be muzzled when operating on park. |
| Presence of livestock | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | L | Livestock may enter due to fencing failure | Pesticide concentration will not be at levels that could affect livestock. Bait form is unpalatable to livestock. Dose rate will not affect livestock. | L | Neighbours will be notified of baiting program and briefed on removal of stock if required. Regular checks of boundary fencing where required. |
| Presence of susceptible native animals | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | M | Death of non-target species | Amount of 1080 and bait matrix will rarely affect native animals. 1080 solution injected into centre of baits. Follow PCO and NPWS guidelines for aerial baiting on park estate. Follow recommended application rates in NPWS guidelines. | L | Monitor for non-target impacts and amend baiting strategy to further reduce off-target consumption. Unused baits to be collected and disposed of as per disposal instructions above. Quolls have been recorded in this area and may occur on park. An NPWS Conservation Risk Assessment for this activity has concluded that there is no significant risk to quolls when using bait rates of less than 40 baits/km. The bait rate used for this operation will be 10 baits/km. |
| Proximity to urban areas and townships | <input type="checkbox"/> | <input checked="" type="checkbox"/> | <input type="checkbox"/> | | Baiting site is more than 4 km from closest township | | | Baiting transects exceed PCO requirement for boundary buffers and are at considerable distance from nearest township. |

Conservation Risk Assessment: Aerial baiting with sodium fluoroacetate (1080) for wild dog and fox control – 2020–2022

| Hazards / risks | Yes | No | N/A | Risk level | Description of hazard or risk | Recommended control measures | New risk level | Detail how control measures will be implemented and any additional controls |
|---|-------------------------------------|--------------------------|--------------------------|------------|--|--|----------------|---|
| Risk to domestic or town water supplies | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | M | Contamination of domestic water supply with 1080 | Waterpoints to be identified on map. Bait transects to be placed no closer than xx m to waterpoint (exceeds PCO). | L | Waterpoints within the baiting location have been identified and mapped. Baits not to be dropped within xx metres from a waterpoint, exceeding PCO requirements. |
| Contamination of waterways from 1080 baits | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | M | 1080 contaminating waterways | Bait transects to be placed no closer than 100 m to any non-ephemeral waterway. | L | Ephemeral creeks have been mapped as part of planning process, and map attached to this risk assessment. Baiting transects have been planned via GIS to ensure baits will not to be dropped within xxx m of waterways. A qualified air observer (or equivalent) will be used for navigation. Two systems of GPS will be used for navigational accuracy. Unused bait will be disposed as per disposal instructions above. |
| Researchers, special interest groups visiting the reserve | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | L | Human poisoning from 1080 | Visitors to be briefed by park ranger or delegate prior to arrival. Signs placed as per PCO. | L | Briefing to be provided to all groups for four weeks after bait application. Unused bait will be disposed as per disposal instructions above. |
| Illegal access – exposure to 1080 by hunters and their dogs | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | M | Death of non-target animals, human poisoning from 1080 | Monitor for illegal access. Notification and signs as per PCO. | L | Conduct compliance programs where illegal dog access is suspected prior to commencement of baiting program. Signs to be placed / checked prior to program commencement. Media notification to be undertaken prior to this operation. |
| Disposal of baits | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | M | Death of non-target animal, human poisoning from 1080 and contamination of the environment | All unused baits must be disposed of as per the PCO. | L | The bait disposal location for this program is within XXXX NP and is identified on attached map. OIC to confirm with ACO that all baits have been appropriately disposed of. |

Conservation Risk Assessment: Aerial baiting with sodium fluoroacetate (1080) for wild dog and fox control – 2020–2022

| Hazards / risks | Yes | No | N/A | Risk level | Description of hazard or risk | Recommended control measures | New risk level | Detail how control measures will be implemented and any additional controls |
|--|-------------------------------------|--------------------------|--------------------------|------------|-------------------------------|--|----------------|---|
| Human poisoning from injecting and/or deploying 1080 | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | M | Human poisoning from 1080 | Staff preparing 1080 bait must be a currently accredited ACO. Baits to be prepared in an approved 1080 preparation facility. Operational staff to be trained to NPWS requirements and undertake JSB before commencing operation. All staff are to use appropriate PPE for the preparation and/or placement of 1080 baits. | L | All staff handling 1080 baits must have current AQF3 training and be current in 1080 awareness. All operational staff to comply with this risk assessment, JSA for this program, PPE and first aid requirements. All containers used for storing and transporting 1080 baits must be clearly labelled with '1080 Poison' in red lettering. |
| Compliance risk | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | L | Breach of legislation | Program manager is responsible for ensuring compliance and record keeping. | L | Program manager to use 1080 planning checklist during program planning and record in program CM9 location. All staff must have an AQF3 chemical accreditation and attended a 1080 awareness day. |
| Human contact with 1080 | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | L | Human poisoning from 1080 | Warning signs to be mapped and checked prior to baiting commencement. Wild dog and fox baits are unpalatable to humans and contain an insufficient amount to poison a human. | L | All thoroughfares to be mapped as part of planning process, with buffers in place on main thoroughfares, and map attached to this risk assessment. Points of higher visitation within the park have been mapped, and baits are not to be laid within xxx m. These points are mapped with these buffers applied. Baiting program to be recorded in xxx Area Pesticide Use Register per Pesticide Use Notification Plan and identified on Elements. |

| Hazards / risks | Yes | No | N/A | Risk level | Description of hazard or risk | Recommended control measures | New risk level | Detail how control measures will be implemented and any additional controls |
|---|-------------------------------------|--------------------------|--------------------------|------------|--|--|----------------|---|
| 1080 poison poses an increased risk to native predators such as quolls and varanids, where food is scarce post fire event | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | L | Carnivores and varanids consuming 1080 baits | Appropriate bait rate will be used as endorsed by the APVMA and PCO and outlined in the vertebrate pesticide manual. Red meat baits will be used. | L | Extensive research has shown there is minimal threat of 1080 to native wildlife populations when conducting aerial baiting with red meat baits at rates of up to 40 baits/km. Varanids have a tolerance to 1080 that is significantly higher than foxes. Although spotted-tailed quolls have a tolerance that is only 17 times higher than foxes, research conducted in both the Northern Tablelands and Southern Ranges of NSW found that quolls that did ingest 1080 baits did not suffer a fatal outcome. One quoll that was trapped had encountered and at least partially consumed six wild dog baits, with no observable impact. The program will be implemented using the same bait rates as used in this research; up to 10 baits/km and up to 40 baits/km. |
| Risk of baiting to dingoes/wild dogs | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | M | Wild dogs which are not currently having a negative impact are controlled as part of the program | Wild dogs will be targeted in areas where they are negatively impacting upon livestock, at a rate of up to 40 baits/km. Foxes will be targeted where they are having negative impacts on native wildlife species, with fox baits at a rate of up to 10 baits/km. Aerial baiting will only be undertaken where there is a risk of negative impacts from wild dogs and or foxes. Where there is no risk, aerial baiting will not occur, to allow wild dogs to fulfil the natural ecological role of the dingo. | L | Baiting transects have been carefully planned to identify areas where wild dogs will be targeted, areas where foxes will be targeted and areas where no aerial baiting will be undertaken to allow wild dogs to fulfil the natural ecological role of the dingo. |

Conservation Risk Assessment: Aerial baiting with sodium fluoroacetate (1080) for wild dog and fox control – 2020–2022

| Hazards / risks | Yes | No | N/A | Risk level | Description of hazard or risk | Recommended control measures | New risk level | Detail how control measures will be implemented and any additional controls |
|--|-------------------------------------|--------------------------|--------------------------|------------|---|--|----------------|--|
| Increased level of 1080 baits in the environment | <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> | L | Consumption of 1080 baits by non-target species | Baiting operations at each location will be undertaken at the rate allowed by the PCO. The number of locations will be greater than in previous programs, and therefore the total number of baits statewide will be greater, the rate at any location will be the standard rates of either up to 10 baits/km or up to 40 baits/km. | L | Baiting transects have been carefully planned such that bait rates are consistent with previous programs, at either up to 10 baits/km or up to 40 baits/km with 1080 meat baits. At these rates, previous research has clearly demonstrated that there is no risk to non-target species and they are permitted by the PCO. 1080 breaks down quickly, by microbial action in the environment. |