Australian Government

Australian Pesticides and Veterinary Medicines Authority

ENVIRONMENTAL TECHNICAL REPORT

Approved: 17/04/2023

APPLICATION DETAILS

Application number:	136442
Permit number:	92722
Product name:	PESTOFF RODENT BAIT 20R
Formulation type:	BA – bait
Active constituent:	0.02 g ac/kg brodifacoum
Applicant:	Department of Environment Land Water and Planning (Victoria)
Purpose of application:	To permit minor use of an unregistered product for eradication of European rabbits (*Oryctolagus cuniculus*) on Deen Maar Island

EXECUTIVE SUMMARY

The purpose of the application is to permit minor use of use of an unregistered cereal-based rodenticide bait, PESTOFF RODENT BAIT 20R containing 0.02 g/kg brodifacoum for eradication of European rabbits (*Oryctolagus cuniculus*) on Deen Maar Island (also known as Lady Julia Percy Island) of Victoria.

Baits pellets will be distributed by air throughout the island on two separate events in a 7 to 21 day interval, totalling the nominal rate of 20 kg/ha (0.40 g ac/ha). The first application will be 12 kg/ha (0.24 g ac/ha) and the second application will be 8 kg/ha (0.16 g ac/ha).

Brodifacoum has high toxicity to aquatic species and a protection statement is required on the permit to identify the hazard. However, the use of this product as directed is not expected to have adverse effects on aquatic species. Standard precautionary measures are required to minimise contamination of aquatic habitat.

No data are available on the toxicity of brodifacoum to bees, other arthropods or terrestrial plants; however, exposure of these non-target taxa are expected to be negligible under the proposed conditions of use. Many years of use in a wide range of situations globally have shown no effects, and there is no evidence in the literature that brodifacoum is toxic to these organisms.

Brodifacoum is not hazardous to soil organisms such as earthworms and soil microflora. Furthermore, brodifacoum has no adverse impacts on snails or slugs that might consume the bait. Therefore, risks of brodifacoum to soil organisms from the proposed off-label use are considered to be acceptable.

The bait is based on cereals, thus granivorous and omnivorous bird species can potentially consume the bait (primary poisoning). Predatory and scavenging vertebrates may consume poisoned rats or invertebrates that consume the bait (secondary poisoning). Focal species were therefore identified to assess risks of primary and secondary poisoning based on island surveys going back to 1959. The overall protection goal within two years of baiting is populations must be at least 100% of the baseline or post-baiting populations be at least 50% of pre-baiting populations estimates and increasing.

High risks (RQ >10) of the following were identified:

- Primary poisoning of parrots
- Secondary poisoning to small (<50 g) invertebrate-eating birds, such as the little grassbird, white-fronted chat, and various shorebirds

To mitigate risks to these types of birds, an island-wide survey must be conducted to estimate populations sizes of resident species at risk. An annual survey must be conducted to ensure the overall protection goal is met. For affected populations, if recovery is not evident within two years of baiting program, translocation from the mainland must be employed to assist in re-colonisation.

Medium risks (RQ >1 ≤ 10) of the following were identified:

- Secondary poisoning of white’s skink
- Secondary poisoning of silver gull and grey-headed albatross (scavengers)
- Secondary poisoning of larger (>50 g) invertebrate-eating birds, such as the sooty oystercatcher

No specific risk mitigation measures are required for these species; however, adequate monitoring is required to ensure resident populations remain stable. To reduce risks to migratory bird species, the planned timing of the operation should be conducted when migratory birds are not present in high numbers on the island. In addition, frequent searches and removal of dead rabbits are required to mitigate risks of secondary poisoning.

In considering the environmental safety of the proposed minor use, the APVMA had regard to the toxicity of the active constituent and its residues, including metabolites and degradation products, in relation to relevant organisms and ecosystems. Based on the outcome of the risk assessment, the APVMA can be satisfied under s14 of the Agricultural and Veterinary Chemicals Code Act 1994 that the proposed minor use meets the environmental safety criteria with respect to s5A(1)(c) and s112(2)(d) provided the recommended permit conditions are applied.

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ENVIRONMENTAL ASSESSMENT

1. Information on the product and its uses

The purpose of the application is to permit minor use of use of an unregistered cereal-based rodenticide bait, PESTOFF RODENT BAIT 20R containing 0.02 g/kg brodifacoum for eradication of European rabbits (*Oryctolagus cuniculus*) on Deen Maar Island (also known as Lady Julia Percy Island) of Victoria.

Bait pellets of 10 mm diameter will be distributed by air throughout the island on two separate events in a 7-to-21-day interval, totalling the nominal rate of 20 kg/ha (0.40 g ac/ha). The first application will be 12 kg/ha (0.24 g ac/ha) and the second application will be 8 kg/ha (0.16 g ac/ha), approximately 7-21 days after.

Spreader buckets will be calibrated to spread bait at half the rate required to the prescribed kg/ha, while allowing for a 50% overlap between parallel swaths across the main landmass of the island. To ensure there are no gaps in coverage, particularly in coastal areas, some areas will be subject to greater overlap. The maximum application rate applied to the island is expected to reach 24 kg/ha (0.48 g ac/ha).

The total area that will be treated is 459 ha (229.5 ha baited twice). Applications will be during the winter months (from March to August) at the end of the summer season when breeding has reduced/ paused and food resources are at a minimum.

Deen Maar Island is an offshore volcano located about 4 km off the south-west coast of Victoria near the town of Yambuk. It is a small, flat island of about 2 km in length and 1 km in width, covering an area of approximately 144 hectares (Figures 1 and 2). The plateau surface of the island averages 30 to 40 metres above sea level and surrounded by cliffs, rock platforms, sea caves and reefs on all sides. Shore platforms and reefs prevent boat landings apart from one site on the north-east corner, called Dinghy Cove, from which boulder-strewn slopes lead to a narrow route through cliffs to access the top of the island. The island is built of submarine pillow larvas and hyalocastite deposits overlain by sub-aerial basalt flows. The dominate vegetation communities are grasslands and closed bracken (*Pteridium esculentum*) fernland. There are no permanent natural freshwater bodies on the island. During wet periods, freshwater collects in small, shallow ephemeral swamps and pours over the cliffs in to the sea, or percolates through joints in the upper larva flows to emerge as springs in the cliff faces. The plateau soils have been described as acidic, loam soil and is generally less than 500 mm deep and contain volcanic rock fragments and limonitic pisolites (Edwards et al. 2004).

Deen Maar Island is home to one of Australia's largest established Australian fur seal (*Arctocephalus pusillus doriferus*) colonies (representing 26% of the breeding population)[1]. There are also nesting colonies of little penguins (*Eudypltula minor*), common diving-petrels (*Pelecanoides urinatrix*), fairy prions (*Pachyptila turtur*) and short-tailed shearwaters (*Ardenna tenuirostris*). Other bird species reported to have resident breeding populations (or individuals) on the island include, sooty oystercatcher, kelp gull, Pacific gull, white-bellied sea-eagle, swamp harrier, nankeen kestrel, white-fronted chat, and little grassbird. Most other bird species recorded on the island are considered seasonal marine migrants, or uncommon or rare visitors (with last records dating back to 1959) (see Appendix 3).

The majority of approved active constituents for the use in rodenticides, including brodifacoum, belong to the anticoagulants which either belong to the class of 4-hydroxocoumarines or to 1,3-

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[1] https://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=21#:~:text=There%20are%2010%20established%20breeding,of%20Tasmania%20(Kirkwood%20et%20al.

indandione derivates. Anticoagulant rodenticides are grouped by their mode of action to act as vitamin K antagonists thereby inhibiting blood-clotting (Buckle & Eason 2015). Rodents will eventually die as late as 3-7 days after bait uptake from internal or external bleeding. Due to this delayed mode of action, rodents are unable to associate the toxic effect with the poisoned bait (bait shyness). With reference to the date of their introduction on the market, anticoagulant rodenticides are subdivided into first- and second-generation anticoagulant rodenticides, abbreviated by FGARs and SGARs, respectively. After oral administration, the major route of elimination in various species is through the faeces. The metabolic degradation of warfarin and indandiones in rats mainly involves hydroxylation. However, some second-generation anticoagulants are mainly eliminated as unchanged compounds (Larsen 2003).

First-generation anticoagulants (such as warfarin) need to be consumed repeatedly by rodents to cause death. Second-generation anticoagulants (such as brodifacoum) have been developed in response to resistance to FGARs. They are more toxic and more persistent in biota and the environment. A single feeding of baits is often sufficient to achieve a lethal dose.

The proposed minor use would be to allow broadcast application of loose bait in open areas. The rationale for use in an 'open area' scenario is typically the protection of a landscape area, which is the case for this permit. The intended eradication of rabbits from Deen Maar Island is part of a larger effort to restore natural habitat on the island. Habitation of the rodent or rabbit is in burrows and nesting sites, and foraging takes place in open terrain. Emissions to soils are therefore predominantly attributed to direct emissions, with indirect emissions being negligible.

SGARs such as brodifacoum are best applied using a 'pulsed baiting' technique. Pulsed baiting is a time-limited baiting technique where small quantities of baits are applied, and baiting points are visited at daily intervals until baits are consumed. During each visit, it has to be ensured that fresh bait is available, possible spillage of bait is eliminated and dead or dying rodents are removed. The primary purpose of the pulsed baiting technique is to permit effective rodent control while reducing the quantities of rodenticide used and, thereby, the quantity of the active substance released into the environment (Berny et al. 2014). This application technique is applied for the most potent, single-feed second-generation anticoagulant rodenticides (i.e. brodifacoum). It has been observed that dominant or less neophobic rodents consume the baits completely when they are first put out. These animals die before the next pulse of baits is applied where more neophobic or less dominant rodents encounter and consume the baits (Buckle & Eason 2015). Aerial application of SGARs is a relatively extreme control measure.

The territory or home range of rabbits varies from approximately 0.2 to 2 ha depending on rabbit density, food availability, sex, age, and surface cover. Rabbits require a high-quality diet to maintain condition and for reproduction. As such, they are highly selective grazers, with a preference for plants or parts of plants with the highest nutritional content. Rabbits generally obtain water from green vegetation but will travel to drink if they can't obtain enough water from their diet. Adult rabbits weigh 1–2.3 kg and range in length from 35 to 45 cm. With an average body weight of 1.6 kg, a rabbit can consume up to one-third of its own weight daily, with the average daily intake 100 to 150 g (equivalent to approximately 6.3-9.4% of the animal's body weight)[2].

[2] https://www.dpi.nsw.gov.au/biosecurity/vertebrate-pests/pest-animals-in-nsw/rabbits/rabbit-biology

Figure 1 Map of Deen Maar Island, South-west Victoria

Figure 2 Aerial view of Deen Maar Island, South-west Victoria

2. Fate and behaviour in the environment

Brodifacoum is stable to hydrolysis and is persistent and immobile in soil. However, contamination of surface and ground waters is expected to be negligible based on its use pattern and immobility in soil, provided there are precautionary measures to minimise entry into neighbouring aquatic habitat.

Table 1 Brodifacoum – Key regulatory endpoints for exposure assessment

Compartment	Value	Comment
Foliage	—	Not relevant to baits
Soil	DT_{50} 157 d K_F 91 mL/g	Value at 20°C laboratory soil predicted for 1% OC based on 0.01 × average K_{oc}
Water	DT_{50} 1000 d	default for persistent substances
Sediment	DT_{50} 1000 d	default for persistent substances
Air	—	Not relevant. Not volatile.

3. Effects and associated risks to non-target species

3.1 Terrestrial vertebrates

3.1.1 Toxicity

The use of rodenticides intended for killing selected pest mammals has to be considered a general hazard to non-target vertebrates as well. Since birds, mammals and other vertebrates share the same blood clotting mechanism as rodents, they are all vulnerable to the toxic effects of anticoagulants (Smith & Shore 2015). Regulatory acceptable doses are summarised in Table 2 based on available data on brodifacoum.

Table 2 Brodifacoum – Regulatory acceptable doses for terrestrial vertebrates

Taxonomic group	Endpoint	Assessment factor	RAD
Mammals	LD_{50} 0.44 mg ac/kg bw/d	10	0.044 mg ac/kg bw/d
Reptiles	LD_{50} >3.0 mg ac/kg bw/d	10	0.30 mg ac/kg bw/d
Birds – Charadriiformes Double-banded Plover Hooded Plover Kelp Gull Masked Lapwing Pacific Gull Red-capped Plover Red-necked Stint Silver Gull Sooty Oystercatcher	LD_{50} 0.70 mg ac/kg bw/d	10	0.070 mg ac/kg bw/d
Birds – Anseriformes Grey Teal Pacific Black Duck	LD_{50} 0.28 mg ac/kg bw/d	10	0.028 mg ac/kg bw/d

Taxonomic group	Endpoint	Assessment factor	RAD
Birds – Passeriformes Australian Magpie Australian Pipit European goldfinch Grey shrike-thrush Little grassbird Magpie-lark Silvereye Willie wagtail White-fronted chat Yellow-rumped thornbill	LD_{50} >3.0 mg ac/kg bw/d	10	0.30 mg ac/kg bw/d
Bird – Raptors and owls Barn Owl Brown Falcon Brown Goshawk Peregrine Falcon Swamp Harrier Wedge-tailed Eagle White-bellied Sea-Eagle	LD_{50} 10 mg ac/kg bw	10	1.0 mg ac/kg bw/d
Birds – other Australasian swamphen Australian white ibis Blue-winged parrot Crimson rosella Fan-tailed cuckoo Grey-headed albatross Laughing kookaburra Southern giant-Petrel Wandering albatross White-faced heron	LD_{50} 0.28 mg ac/kg bw/d	10	0.028 mg ac/kg bw/d

Endpoints from Appendix 2
RAD = regulatory acceptable dose = endpoint/assessment factor

3.1.2 Risks of primary poisoning

The bait is based on cereals, thus granivorous and omnivorous species are the potentially affected non-target species from primary poisoning (EFSA 2009).

Mammals

There are no granivorous or omnivorous mammals on Deen Maar Island. Therefore, risks of primary poisoning to non-target mammals are considered acceptable.

Reptiles

White's skink is the only reptile reportedly present on the island. White's skink has an omnivorous diet consisting largely of invertebrates, meat and some plant material, and therefore, primary poisoning risks were considered.

Reptiles are generally thought to have a high tolerance to brodifacoum (Lohr & Davis 2018; Mauldin et al 2020). In oral dose exposure studies, Mauldin et al (2020) found boa constrictors and wood turtles to be relatively insensitive to brodifacoum, while green iguanas and giant ameivas appeared somewhat sensitive (with mortality of 3/9 ameivas and 1/9 iguanas occurring following oral doses of 0.13-0.18 mg/kg bw and 0.24-0.32 mg/kg bw, respectively, noting no hemorrhaging was observed in the ameivas).

Of the reptiles, skinks have been observed to directly ingest brodifacoum baits, even when applied in bait stations. Lohr & Davis (2018) report that, in Australia, the single documented account of lethal toxicity in reptiles involved the direct ingestion of brodifacoum baits by King's skinks (*Egernia kingii*) during a rat eradication using 63625 X-VERMINATOR SINGLE FEED LETHAL DOSE RODENT PELLETS on Penguin Island in Western Australia (Bettink 2015; PER13612). Eight of the skinks were found dead and exhibited haemorrhage associated with anticoagulant toxicity and several others were treated with vitamin K and released. Subsequent analysis revealed a concentration of 1.3 mg/kg in the liver of one of the dead skinks. This liver concentration is well above minimum lethal thresholds suggested for many bird and mammal species, so it is difficult to infer relative susceptibility of King's skinks from this event.

Direct consumption of brodifacoum baits by shore skinks (*Oligosoma smithi*) in the wild has been observed in New Zealand (Wedding et al. 2010). Wedding et al. (2010) cites records of five other skink species eating cereal baits, some of which contained rodenticides. Telfair's skink (*Leiolopisma telfairii*) was observed eating rain-softened brodifacoum pellets 3 weeks after baits had been laid on Round Island (near Mauritius), and one skink was found dead (Merton 1987). Two species of New Zealand gecko, common gecko (*H. maculatus*) on Mana Island and Duvaucel's gecko (*Hoplodactylylus duvaucelii*) on Lady Alice Island were also observed consuming brodifacoum supplied in bait stations (Christmas 1995, Hoare & Hare 2006a, 2006b). Bennison et al. (2016) used dye tracers to prove that the large carnivorous King's Skink (*Egernia kingii*) had ingested non-toxic baits laid out on islands off the West Australian coast. King Skinks were also observed consuming baits from bait containers intended to exclude the skinks on Penguin Island, WA (Bettink 2015). Others have observed bobtails (*Tiliqua rugosa*) – another large omnivorous skink – inside bait boxes in urban areas (Lohr & Davis 2018).

It is most likely the skinks are feeding on the invertebrates within the bait boxes rather than the baits themselves (ie, secondary exposure route). Based on high tolerance and low incidence of adverse effects reported in the literature, overall risks of primary poisoning to reptiles are considered to be acceptable.

Birds

On Deen Maar Island, there are reports of several ground-feeding granivorous and omnivorous birds that could consume bait. Of most concern are gulls (which have resident populations on the island and can flock in large numbers). Of next most concern include, blue-winged parrot, European goldfinch, Australian pipit, double-banded plover, grey teal, pacific black duck, Australian magpie, crimson rosella, and Australian swamphen, which may occasionally visit the island.

The assessment for primary poisoning assumed that the whole day's food requirement of the non-target species consists of the consumption of the rodenticide. A default avoidance factor of 0.90 was assumed as a realistic worst-case (ECHA 2018). It was also assumed that occasional visitors spend 20% of their time feeding on the island (PT 0.20). In addition, it was assumed that the bait comprised no more than 20% of the diet of omnivorous species (PD 0.20).

Based on these assumptions, a high risk (RQ >10) of primary poisoning to blue-winged parrots was identified (Table 3). The overall protection goal for broad-scale eradication efforts such as this is 'no long-term impact on any species at the population level'. Key outcomes in achieving this goal are considered to be:

- Within two years of the baiting program, the population must be at least 100% of the baseline or
- Post-baiting populations be at least 50% of pre-baiting populations estimates and increasing within two years of baiting.

Although the last sighting of blue-winged parrots on Deen Maar Island was in 1959, there may be other parrot populations on the island that were not recorded since the last survey of the island. As such, an island-wide survey must be conducted to estimate sizes of any parrot populations. For any populations that have been identified, annual surveys must be conducted to ensure the overall protection goal is met. For affected populations, if recovery is not evident within two years of baiting program, translocation from the mainland must be employed to assist in re-colonisation.

Medium risks (RQ >1 ≤ 10) of primary poisoning were identified for all other species, except Australasian pipit and Australian magpie for which acceptable risks were concluded (Table 3). To reduce risks to migratory bird species, the planned timing of the operation should be conducted when migratory birds are not present in high numbers on the island. No other specific mitigation measures are therefore required for these species.

Table 3 Brodifacoum – Assessment of risks of primary poisoning

Focal group	Focal species	BW (g)	FIR (g/d)	ETE (mg ac/kg bw/d)	RAD (mg ac/kg bw/d)	RQ
Bait-eating birds	Blue-winged parrot (V, G)	55	8.6	0.56	0.028	**20**
	European goldfinch (V, G)	16	6.2	1.4	0.30	**4.7**
	Silver gull (R, O)	313	28	0.32	0.070	**4.6**
	Kelp gull (R, O)	940	58	0.22	0.070	**3.2**
	Pacific gull (R, O)	1000	61	0.22	0.070	**3.1**
	Crimson rosella (V, O)	129	15	0.085	0.028	**3.0**
	Grey teal (V, O)	554	41	0.053	0.028	**1.9**
	Australasian swamphen (V, O)	988	64	0.047	0.028	**1.7**
	Pacific black duck (V, O)	980	60	0.044	0.028	**1.6**
	Double-banded plover (V, O)	70	10	0.11	0.070	**1.5**
	Australasian pipit (V, O)	26	8.6	0.24	0.30	0.80
	Australian magpie (V, O)	300	45	0.11	0.30	0.36

G = granivorous species; O = omnivorous species; R = resident; V = occasional visitor
BW = body weight (from Appendix 3)
FIR = DEE / (FE * (1-MC/100) * (AE/100)), where:
DEE = daily energy expenditure (from Appendix 3)
FE = food energy of 18 kJ/g dw for cereals on average (Table 3 in Appendix G in EFSA 2009)
MC = moisture content = 13% on average for PESTOFF RODENT BAIT 20R according to product specifications
AE = assimilation efficiency, which is
72% for Passerines (European goldfinch, Australasian pipit, Australian magpie) on artificial diet from Table 2 in Appendix L in EFSA 2009
74% for Anseriformes (grey teal, Pacific black duck) on artificial diet from Table 2 in Appendix L in EFSA 2009
74% for Charadriiformes (silver gull, Pacific gull, kelp gull, double-banded plover) on artificial diet from Table 2 in Appendix L in EFSA 2009
75% default for remaining species (blue-winged parrot, crimson rosella)
ETE = estimated theoretical exposure = FIR/BW * PEC * AV * PT * PD, where:
PEC =predicted environmental concentration = concentration of the active constituent in the bait = 20 mg ac/kg food
AV = avoidance factor = 0.90 (ECHA 2018 default for realistic worst case)
PT = fraction of diet obtained in treated area = 0.20 (occasional visitors) or 1.0 (residents)
PD = fraction of food type in diet = 0.20 (omnivorous species) or 1.0 (granivorous species)
RAD = regulatory acceptable dose from Table 2
RQ = risk quotient = ETE/RAD, where acceptable RQ ≤1

3.1.3 Risks of secondary poisoning

Second-generation anticoagulants, such as brodifacoum, tend to be more acutely toxic than are the first-generation anticoagulants, and they are retained much longer in body tissues of primary consumers. They generally provide a lethal dose after a single feeding, although death is usually delayed by 5 to 10 days and animals continue feeding. Since severe symptoms or death occur only after many days. During this time, rats and mice will behave normally (feeding and behaviour), allowing toxicant to build-up in the organism. Consequently, highly contaminated rodents will still represent a food item for predators; more, they might represent an even easier prey due to predictable slower reactions towards predators. In a situation of repeated exposure for several days or more, anticoagulant may circulate in the blood at higher levels and for a longer time than suggested by studies in which only a single, sublethal dose was administered.

Based on the calculated log K_{ow} 6.12 and the estimated BCF_{fish} and $BCF_{earthworm}$, there is concern for the bioaccumulative nature of brodifacoum. Furthermore, brodifacoum has also a low solubility in water, is hydrolytically stable, and it is not readily or inherently biodegradable.

There is a risk for secondary poisoning for broadcast application of brodifacoum baits. Predators may consume poisoned rodents or poisoned invertebrates, so the risk for secondary poisoning must be assessed, including slugs and snail-eating species.

Invertebrates (particularly slugs and snails, however also cockroaches, ants, beetles and weta) are known to consume rodenticide baits. Thus, animals feeding on contaminated invertebrates can accumulate anticoagulant rodenticides in their tissues (Dowding et al. 2010). In a New Zealand field study, weta, cockroaches, beetles and other ‘miscellaneous’ species were monitored for residues before, during and after application of brodifacoum baits in stations at Tawharanui (Craddock 2003, Fischer 2010). While background ‘trace’ concentrations of brodifacoum were apparently present in some invertebrates before baiting started, some invertebrates contained much higher residues of brodifacoum (up to 7.47 µg/g) during the baiting period, which were dependent on the amount of toxic bait available in stations. After baits were removed from stations, brodifacoum residues in invertebrates took more than 4 weeks to return to ‘background’ levels (Craddock 2003, Fisher 2010).

Similarly, following aerial broadcast application of brodifacoum pellets on Palmyra Atoll (located in the tropical pacific region), brodifacoum residues were detected at levels of up to 2.3 µg/g in cockroaches and 0.18 µg/g in ants 2 to 3 weeks following application (Pitt et al. 2015).

Alomar et al. 2018 have investigated the accumulation of three anticoagulant active substances (chlorophacinone, bromadiolone or brodifacoum) in the slug *Deroceras reticulatum* exposed for a period of 5 days followed by a depuration time of 4 days in the laboratory. Furthermore, they studied the exposure of slugs to brodifacoum baits placed in bait boxes in the field. In the laboratory trial, all slugs consumed baits and all three anticoagulant rodenticides could be detected in snails from the first day of exposure. Mortality could not be observed. The decrease of bromadiolone and brodifacoum concentrations in slugs was significant during the post exposure period but not significant for chlorophacinone. The estimated elimination half-lives were 1.9 days, 2.5 days and 4.0 days for bromadiolone, brodifacoum and chlorophacinone, respectively. In the field study part, brodifacoum was detected in more than 90% of the analysed slugs. Based on a toxicity-exposure ratio approach, the authors judged that slug consumption represents a risk of secondary poisoning for hedgehogs, shrew and European starling, with shrews being affected most seriously. Hence, this exposure route is relevant and will be considered in the risk assessment for secondary poisoning.

The concentration of the rodenticide within the slug immediately after a last meal on day 5 was calculated. Slugs have a body weight of 40–1000 mg (Frank & Barone 1999, Alomar et al. 2018). Slugs are quite voracious and can consume between 25% (Rheinland Pfalz 2010) and 40%[3] of their body weight per night. Sometimes, even 50% is reported. For the risk assessment, it is assumed that slugs consume rodent baits corresponding to 40% of their body weight. It is also assumed that the invertebrate-eating species consume 100% of their daily intake on poisoned slugs.

Mammals

On Deen Maar island, there are large established Australian fur seal (*Arctocephalus pusillus doriferus*) colonies. Australian sea lions (*Neophoca cinerea*), long nosed fur seals (*Arctocephalus forsteri*) and southern elephant seals (*Mirounga leonine*) are also occasional visitors. Considering the foraging behaviour (marine benthic and pelagic feeders) and typical diet (fish, cephalopods and occasionally seabirds), secondary poisoning is unlikely to be a concern for seals and sea lions, and therefore, risks are considered acceptable.

Reptiles

White's skink is the only reptile reported on Deen Maar island. Based on the species typical diet of invertebrates, meat and plant matter, risks of secondary poisoning were considered.

There is limited information on secondary poisoning in reptiles. In one baiting program, Bungarras (or sand goanna) (*Varanus gouldii)* were observed eating dead or dying rats with evidence of green dye from the bait in the droppings of the bungarras following brodifacoum baiting on the Montebello Islands, WA; however, no dead or moribund Varanus were observed (Burbridge 2004). Considering the paucity of toxicity data on reptiles (one non-sensitive endpoint) and adverse incidents reported under field conditions, it was considered most appropriate to utilise bird toxicity data in the risk assessment. It was assumed that the skinks fed entirely within the treatment area (PT 1.0) and poisoned slugs comprised 100% of the diet (PD 1.0). Data on insectivorous passerine species were considered most representative of toxicity to skinks (Table 2).

Based on these assumptions, a medium risk (RQ $>1 \leq 10$) to white's skink was identified (Table 4). No specific mitigation measures are required for species at medium risk. It is noted in a non-toxic baiting trial on Lord Howe Island (Wilkinson 2007), a single delicate skink did not show any evidence of primary or secondary exposure.

Birds

Raptors and owls are bird species that would prey on living rabbits. Though such birds of prey do not eat rodenticides, their risk of being victims of secondary poisoning through poisoned prey animals has to be evaluated. Also, scavenging and slug-eating birds may be at risk of secondary poisoning.

On Deen Maar Island, there are numerous carnivorous, scavenging and insectivorous bird species that may be vulnerable to secondary poisoning from consuming live rabbits or carcasses (see Appendix 3). Species of most concern include gulls, white-bellied sea eagle (which listed as an endangered species in Victoria), swamp harrier, sooty oystercatcher, white-fronted chat and little grassbird, which are reported to have resident breeding populations (or individuals) on island. Of next most concern include large marine migratory birds such as petrels and albatrosses (several of which are listed as vulnerable or endangered under the EPBC Act), and other occasional or rare visitors to the island such as barn owls, falcons, goshawks, and wedge-tailed eagles, which are known to predate on rabbits or feed on carrion. In addition, scavenging birds (such as Australian white ibis and grey-shrike thrush)

[3] http://www.hortipendium.de/Schnecken

and slug-eating birds (such as silvereyes, wrens, thornbills, willie wagtails, Australian magpie, herons, stints, plovers and oystercatchers) may be at risk of secondary poisoning.

The assessment of secondary poisoning is based on the concentration in the food of predators or scavengers, i.e. poisoned rabbits and slugs. It is assumed that rabbits consume food equivalent to ~10% of their body weight (F_{rabbit} 0.1) and slugs consumed 40% of their body weight (F_{slug} 0.4). It was also assumed that migratory species and occasional visitors spend 20% of their time feeding on the island (PT 0.20). In addition, it was assumed that carrion-eating species <500 g in size and omnivores would not consume more than 20% rabbit carrion in their diet (PD 0.20), while invertebrate-eating species >50 g would not consume more than 20% poisoned slugs in their diet (PD 0.20).

Based on these assumptions, high risks (RQ >10) were concluded for small invertebrate-eating species that may feed on contaminated slugs or other insects, including little grassbird and white-fronted chat, which likely have resident populations on the island (Table 4). As such, an island-wide survey must be conducted to estimate populations sizes of resident species at risk. An annual survey must be conducted to ensure the overall protection goal is met. For affected populations, if recovery is not evident within two years of baiting program, translocation from the mainland must be employed to assist in re-colonisation.

Medium risks (RQ >1 ≤ 10) of secondary poisoning were concluded for larger species, including the silver gull (scavenger) and sooty oystercatcher, which likely have resident populations on the island (Table 4). Medium risks to the grey-headed albatross were also concluded; however, it is noted that this species has not been sited on the island since 1959. To reduce risks to migratory bird species, the planned timing of the operation should be conducted when migratory birds are not present in high numbers on the island.

It is noted that, in similar baiting operations, lethal doses of residues were detected in eagles and gulls (Ebbert & Burek-Huntington 2010), shorebirds (Dowding et al. 2006), while non-lethal residues of brodifacoum were detected in owls in Britain (Walker et al. 2008). Clearly secondary poisoning of predatory and scavenging birds is of concern and must be mitigated. As such, monitoring of non-target species and frequent searches and removal of dead rabbits is recommended as a condition of the permit.

Table 4 Brodifacoum – Assessment of risks of secondary poisoning

Focal group	Focal species	Prey	BW (g)	FIR (g/d)	PEC (mg/kg)	ETE (mg/kg/d)	RAD (mg/kg/d)	RQ
Slug-eating reptile	White's skink (R, SS)	Slug	26	1.5	8.0	0.46	0.30	**1.5**
Carrion-eating birds	Silver gull (R, O)	Rabbit	313	66	2.0	0.085	0.070	**1.2**
	Grey-headed albatross (V, LC)	Rabbit	3350	257	2.0	0.031	0.028	**1.1**
	Southern giant petrel (V, LC)	Rabbit	4400	308	2.0	0.028	0.028	1.0
	Kelp gull (R, O)	Rabbit	940	138	2.0	0.059	0.070	0.84
	Pacific gull (R, O)	Rabbit	1000	144	2.0	0.058	0.070	0.82
	Wandering albatross (V, LC)	Rabbit	9315	509	2.0	0.022	0.028	0.78
	Australian white ibis (V, SC)	Rabbit	1950	194	2.0	0.0080	0.028	0.28
	Swamp harrier (R, LC)	Rabbit	740	99	2.0	0.27	1.0	0.27
	White-bellied sea eagle (R, LC)	Rabbit	2630	232	2.0	0.18	1.0	0.18
	Wedge-tailed eagle (R, LC)	Rabbit	4025	308	2.0	0.15	1.0	0.15
	Grey shrike-thrush (V, SC)	Rabbit	63	33	2.0	0.042	0.30	0.14
	Barn owl (V, LC)	Rabbit	520	83	2.0	0.064	1.0	0.06

Focal group	Focal species	Prey	BW (g)	FIR (g/d)	PEC (mg/kg)	ETE (mg/kg/d)	RAD (mg/kg/d)	RQ
	Brown goshawk (V, LC)	Rabbit	544	81	2.0	0.059	1.0	0.06
	Brown falcon (V, LC)	Rabbit	530	77	2.0	0.058	1.0	0.06
	Peregrine falcon (V, LC)	Rabbit	765	99	2.0	0.052	1.0	0.05
Slug-eating birds	Little grassbird (R, SS)	Slug	12	26	8.0	17	0.30	**57**
	White-fronted chat (R, SS)	Slug	13	27	8.0	17	0.30	**55**
	Red-necked stint (V, SS)	Slug	25	29	8.0	1.9	0.070	**27**
	Red-capped plover (V, SS)	Slug	37	38	8.0	1.6	0.070	**23**
	Hooded plover (V, SS)	Slug	95	71	8.0	1.2	0.070	**17**
	Yellow-rumped thornbill (V, SS)	Slug	9.0	21	8.0	3.7	0.30	**12**
	Silvereye (V, SS)	Slug	11	24	8.0	3.5	0.30	**12**
	Willie wagtail (V, SS)	Slug	20	36	8.0	2.9	0.30	**9.6**
	Fan-tailed cuckoo (V, LS)	Slug	58	46	8.0	0.26	0.028	**9.1**
	Sooty oystercatcher (R, LS)	Slug	819	299	8.0	0.58	0.070	**8.4**
	Laughing kookaburra (V, LS)	Slug	340	151	8.0	0.14	0.028	**5.1**
	White-faced heron (V, LS)	Slug	525	192	8.0	0.12	0.028	**4.2**
	Masked lapwing (V, LS)	Slug	315	158	8.0	0.16	0.070	**2.3**
	Magpie-lark (V, LS)	Slug	92	101	8.0	0.35	0.30	**1.2**
	Australian magpie (V, LS)	Slug	300	225	8.0	0.24	0.30	0.80

C = large carnivore; O = omnivorous; R = resident; LS = large slug-eater; SC = small carnivore; SS, = small slug-eater; V = occasional visitor
BW = body weight (from Appendix 3)
FIR = DEE / (FE * (1-MC/100) * (AE/100)), where:
- DEE = daily energy expenditure (from Appendix 3)
- FE = food energy = 22.6 kJ/g for carrion and 19.3 kJ/g for slugs (Table 1 in Appendix L in EFSA 2009)
- MC = moisture content = 68.8% for carrion and 84.6% for slugs (Table 1 in Appendix L in EFSA 2009)
- AE = assimilation efficiency for birds eating animals from Table 2 in Appendix L in EFSA 2009, which is:
  - 69% for Charadriiformes (gulls, stint, plovers, osytercacher, masked lapwing)
  - 76% for Passerines (grey shrike-thrush, grassbird, cat, thornbill, silverye, wagtail, magpie-lark, magpie; surrogate for kokkaburra, cuckoo)
  - 77% for Strigiformes (barn owl)
  - 80% for Pelecaniformes (herons, ibis)
  - 82% for Acciptriformes (goshawk, swamp harrier, eagles)
  - 84% for Falconiformes (falcons)
  - 87% for Procellariformes (petrel, albatross)
- AE = 85% for skinks (Xu and Zhang 2004)

PEC = predicted environmental concentration in prey = 20 mg/kg bait * F_{rodent} (0.1) or F_{slug} (0.4)
$ETE_{non\text{-}target}$ = estimated theoretical exposure = FIR/BW * PEC * PT * PD, where:
- PEC =predicted environmental concentration = concentration of the active constituent in the bait = 20 mg ac/kg food
- PT = fraction of diet obtained in treated area = 0.20 (occasional visitors) or 1.0 (residents)
- PD = fraction of food type in diet = 0.20 (small carnivores; large slug-eaters, omnivores) or 1.0 (large carnivores, small slug-eaters)

RAD = regulatory acceptable dose from Table 2
RQ = risk quotient = ETE/RAD, where acceptable RQ ≤1

3.2 Aquatic species

Brodifacoum is considered to be very toxic to aquatic organisms based on LC_{50} values 0.015 to 0.042 mg ac/L for fish, EC_{50} values 0.25 to 0.98 mg ac/L for aquatic invertebrates, and E_rC_{50} 0.040 mg ac/L for algae (Appendix 2). Therefore, the following protection statement is required on the permit.

> Very toxic to aquatic life. DO NOT contaminate wetlands or watercourses with this product or used containers.

Despite the high toxicity, the proposed use in a pelleted formulation is considered to have negligible exposure to the aquatic environment. There are no permanent freshwater bodies on Deen Maar Island.

Precautionary measures are necessary, however, to avoid entry to the marine environment, noting marine life can be contaminated if applied in intertidal areas (Primus et al. 2005). It is noted that aerial broadcasting of the pellets will be targeted in vegetated areas of the island and deflector buckets (allowing bait to be thrown out one side) will be used along the coastal margin, which will be limit the potential for active ingredient in the pellets to wash out during rain and into the marine environment. Therefore, risks of brodifacoum to aquatic species from the proposed minor use are considered to be acceptable. The following restraints are therefore required as a condition of the permit.

> DO NOT apply if heavy rains or storms are imminent.
>
> DO NOT apply in marine and intertidal zones and other aquatic areas (i.e. swamps and springs). Deflector buckets must be used in areas along the coastal margin to limit bait from entering the marine environment.

3.3 Bees and other non-target arthropods

No data are available on the toxicity of brodifacoum to bees and other non-target arthropods. Brodifacoum is of very low water solubility and vapour pressure. Based on the properties and its use as a solid formulation, it is not expected to contaminate plants or other habitat that are attractive to bees and other non-target arthropods. Many years of use in a wide range of situations globally have shown no effects, and there is no evidence in the literature that brodifacoum is toxic to bees and other non-target arthropods. Therefore, risks of brodifacoum to bees and other non-target arthropods from the proposed minor use are considered to be acceptable.

3.4 Soil organisms

Earthworms were not affected after acute exposure to brodifacoum at concentrations up to 944 mg ac/kg dry soil (Appendix 2). Similarly, no adverse effects were observed in soil bacteria or activated sludge at the limit of solubility in water. Therefore, risks of brodifacoum to soil organisms from the proposed minor use are considered to be acceptable.

3.5 Non-target terrestrial plants

No data are available on the toxicity of brodifacoum to non-target terrestrial plants. Brodifacoum has a very high K_{oc} indicative of very strong adherence to soil particles. It also has a very low water solubility. These two factors suggest that brodifacoum available in solution to be taken up by the roots of plants will be extremely low. Many years of use in a wide range of situations globally have shown no effects on plants, and there is no evidence in the literature that brodifacoum is toxic to plants. Therefore, risks of brodifacoum to non-target terrestrial plants from the proposed minor use are considered to be acceptable.

4. Conclusions

Brodifacoum has high toxicity to aquatic species and a protection statement is required on the permit to identify the hazard. However, the use of this product as directed is not expected to have adverse effects on aquatic species. Standard precautionary measures are required to minimise contamination of aquatic habitat.

No data are available on the toxicity of brodifacoum to bees, other arthropods or terrestrial plants; however, exposure of these non-target taxa are expected to be negligible under the proposed conditions of use. Many years of use in a wide range of situations globally have shown no effects, and there is no evidence in the literature that brodifacoum is toxic to these organisms.

Brodifacoum is not hazardous to soil organisms such as earthworms and soil microflora. Furthermore, brodifacoum has no adverse impacts on snails or slugs that might consume the bait. Therefore, risks of brodifacoum to soil organisms from the proposed off-label use are considered to be acceptable.

The bait is based on cereals, thus granivorous and omnivorous bird species can potentially consume the bait (primary poisoning). Predatory and scavenging vertebrates may consume poisoned rats or invertebrates that consume the bait (secondary poisoning). Focal species were therefore identified to assess risks of primary and secondary poisoning based on island surveys going back to 1959. The overall protection goal within two years of baiting is populations must be at least 100% of the baseline or post-baiting populations be at least 50% of pre-baiting populations estimates and increasing.

High risks (RQ >10) of the following were identified:

- Primary poisoning of parrots
- Secondary poisoning to small (<50 g) invertebrate-eating birds, such as the little grassbird, white-fronted chat, and various shorebirds

To mitigate risks to these types of birds, an island-wide survey must be conducted to estimate populations sizes of resident species at risk. An annual survey must be conducted to ensure the overall protection goal is met. For affected populations, if recovery is not evident within two years of baiting program, translocation from the mainland must be employed to assist in re-colonisation.

Medium risks (RQ >1 ≤ 10) of the following were identified:

- Secondary poisoning of white's skink
- Secondary poisoning of silver gull and grey-headed albatross (scavengers)
- Secondary poisoning of larger (>50 g) invertebrate-eating birds, such as the sooty oystercatcher

No specific risk mitigation measures are required for these species; however, adequate monitoring is required to ensure resident populations remain stable. To reduce risks to migratory bird species, the planned timing of the operation should be conducted when migratory birds are not present in high numbers on the island. In addition, frequent searches and removal of dead rabbits are required to mitigate risks of secondary poisoning.

In considering the environmental safety of the proposed minor use, the APVMA had regard to the toxicity of the active constituent and its residues, including metabolites and degradation products, in relation to relevant organisms and ecosystems. Based on the outcome of the risk assessment, the APVMA can be satisfied under s14 of the Agricultural and Veterinary Chemicals Code Act 1994 that the proposed minor use meets the environmental safety criteria with respect to s5A(1)(c) and s112(2)(d) provided the recommended permit conditions are applied.

5. Permit conditions

The following mitigation/labelling statements are recommended based on the outcome of the risk assessment. Please note the environmental assessment does not consider storage conditions of the product. Standard precautionary measures are required to minimise contamination of aquatic habitat.

> Very toxic to birds. To protect birds, remove spillages.
>
> Monitoring of the effects in target and non-target animals of the treatment is required in order to guide renewal applications. Every 48 hours for at least 2 weeks following baiting, mortality must be

monitored and cause of death determined for any non-target species. Ill individuals must be treated with Vitamin K where possible.

Every year for a period of at least two years, a whole-of-island survey must be conducted. Within two years of the baiting program, bird populations must be at least 100% of baseline or at least 50% of baseline and increasing. If recovery is not evident within two years of baiting program, translocation from the mainland must be employed to assist in re-colonisation.

To mitigate secondary poisoning risks, search for and remove dead rabbits at 48 hour intervals for at least 2 weeks following baiting, and at least as often as when baits are checked and/or replenished. Dispose of dead rabbits in accordance with local requirements.

To reduce risks to migratory bird species, the planned timing of baiting should be when migratory birds are not present in high numbers on the island.

Very toxic to aquatic life. DO NOT contaminate wetlands or watercourses with this product or used containers.

DO NOT apply if heavy rains or storms are imminent.

DO NOT apply in marine and intertidal zones and other aquatic areas (i.e. swamps and springs). Deflector buckets must be used in areas along the coastal margin to limit bait from entering the marine environment.

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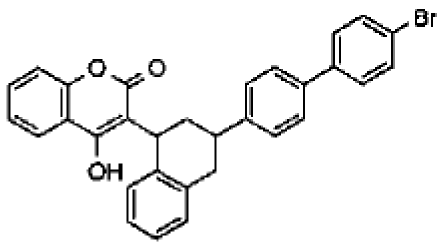
APPENDIX 1 Abbreviations

ac	active constituent
AE	assimilation efficiency
APVMA	Australian Pesticide and Veterinary Medicines Authority
AV	avoidance factor
BCF	bioconcentration factor
bw	body weight
C	concentration of compound in diet
d	day(s)
DEE	daily energy expenditure
DT_{50}	period required for 50 percent dissipation
DT_{90}	period required for 90 percent dissipation
EC_{50}	effective concentration, median
E_rC_{50}	effective concentration, median, growth rate
E_bC_{50}	effective concentration, median, biomass
ECHA	European chemicals agency
EFSA	European Food Safety Authority
El	fraction of daily uptake eliminated
ETE	estimated theoretical exposure
FE	food energy
FIR	food intake rate
FGAR	first generation anticoagulant rodenticide
g	gram(s)
ha	hectare(s)
kg	kilogram(s)
K_d	adsorption constant
K_{oc}	organic carbon absorption coefficient
K_{ow}	octanol-water partition coefficient
L	litre(s)
LC_{50}	lethal concentration, median
LD_{50}	lethal dose, median
LOEC	lowest observable effect concentration
LR_{50}	lethal rate, median
mg	milligram(s)
NOEC	no observable effect concentration
PD	composition of diet obtained from treated area
PEC	predicted environmental concentration
pKa	negative logarithm (to the base 10) of the dissociation constant
PT	proportion of diet obtained from treated area
RAC	regulatory acceptable concentration
RQ	risk quotient
RUD	residue unit dose
SGAR	second generation anticoagulant rodenticide
µg	microgram(s)
USEPA	United States Environmental Protection Agency

APPENDIX 2 Listing of endpoints

Identity

Active constituent	Brodifacoum
Molecular formula	C31H23BrO3
Molecular mass	523.4
Structural formula	

Fate and behaviour in the environment

	Value	Reference
Vapour pressure	2.6×10^{-22} Pa at 20°C 1.9×10^{-21} Pa at 25°C	ECHA 2010
Henry's law constant	2.4×10^{-18} Pa m^3 mol^{-1} at pH7 and 20°C	ECHA 2010
Solubility in water	pH 5.2: 3.8×10^{-6} Pa at 20°C pH 7.4: 2.4×10^{-4} Pa at 20°C pH 9.3: 1.0×10^{-2} Pa at 20°C	ECHA 2010
log Kow	pH 5: log K_{ow} 6.1 at 20°C pH 7: log K_{ow} 4.9 at 20°C pH 9: log K_{ow} 4.8 at 20°C	ECHA 2010
Dissociation constant	Not applicable	ECHA 2010
UV/VIS absorption (max)	Solution — λ_{max} (nm) — ε (l mol^{-1} cm^{-1}) methanol — 308 — 14089 HCl — 308 — 15629 NaOH — 312 — 16677	ECHA 2010
Hydrolysis	pH 5: DT_{50} 173 d pH 7: DT_{50} 300 d pH 9: stable	ECHA 2010
Aqueous photolysis	DT_{50} 0.083 d	ECHA 2010
Photochemical oxidative degradation	DT_{50} 6.61 h (24h 0.5×10^6 OH/cm^3)	ECHA 2010
Aerobic soil degradation	DT_{50} 157 d at 20°C, sandy clay loam DT_{50} 298 d at 12°C 36% mineralisation, 24% bound residues at 365 d No major metabolites	ECHA 2010 USEPA 1998
Degradation in water/sediment	Brodifacoum is expected to partition into sediment due to its high log Kow and poor water solubility.	ECHA 2010
Soil adsorption/ desorption	Average K_{oc} 9155 l/kg (n=3)	ECHA 2010

Effects on non-target species

	Value	Reference
Acute toxicity to mammals Brown rat	LD_{50} 0.40 mg ac/kg bw Technical active *Rattus norvegicus*	ECHA 2010
	LD_{50} 0.42 mg ac/kg bw (males) LD_{50} 0.56 mg ac/kg bw (females) Technical active *Rattus norvegicus*	USEPA 1998
	Geomean LD_{50} 0.44 mg ac/kg bw	
Red-necked wallaby	LD_{50} 1.3 mg ac/kg bw, *Macropus rufogriseus*	Godfrey 1984
Long-term toxicity to mammals	NOAEL 0.0010 mg ac/kg bw/d corresponding to NOEC 0.020 mg ac/kg food Technical active 2-generation reproduction study *Rattus norvegicus*	ECHA 2010
Acute toxicity to birds Anseriformes	LD_{50} 0.31 mg ac/kg bw, *Anas platyrhynchos* LD_{50} 0.26 mg ac/kg bw, *Anas platyrhynchos* **Geomean LD_{50} 0.28 mg ac/kg bw**	ECHA 2010 USEPA 1998
	LD_{50} <0.75 mg ac/kg bw, *Branta canadensis*	Godfrey 1985
	LD_{50} >20 mg ac/kg bw, *Tadorna variegata*	Godfrey 1986
Accipitriformes	LD_{50} 10 mg ac/kg bw, *Circus approximans*	Godfrey 1985
Charadriiformes	LD_{50} <5.0 mg ac/kg bw, *Chroicocephalus bulleri*	Godfrey 1985
	LD_{50} <0.75 mg ac/kg bw, *Larus marinus*	Godfrey 1985
	LD_{50} 0.70 mg ac/kg bw, *Leucophaeus atricilla* LD_{50} 1.6 mg ac/kg bw, *Leucophaeus atricilla* Geomean LD_{50} 1.1 mg ac/kg bw	USEPA 2004
Galliformes	LD_{50} 19 mg ac/kg bw, *Coturnix coturnix japonica*	ECHA 2010
	LD_{50} 3.3 mg ac/kg bw, *Callipepla californica*	Godfrey 1985
	LD_{50} 10 mg ac/kg bw, *Phasianus colchicus*	Godfrey 1985
Gruiformes	LD_{50} 0.95 mg ac/kg bw, *Porphyrio martinicus*	Godfrey 1985
	LD_{50} 0.95 mg ac/kg bw, *Porphyrio melanotus*	Godfrey 1985
Passeriformes	LD_{50} >6.0 mg ac/kg bw, *Passer domesticus*	Godfrey 1985
	LD_{50} >3.0 mg ac/kg bw, *Prunella modularis*	Godfrey 1985
	LD_{50} >3.0 mg ac/kg bw, *Turdus merula*	Godfrey 1985
	LD_{50} >6.0 mg ac/kg bw, *Zosterops lateralis*	Godfrey 1985
Dietary toxicity to birds	**LC_{50} 0.72 mg ac/kg food** Technical active 5-day dietary exposure *Leucophaeus atricilla*	ECHA 2010
	LC_{50} 0.80 mg ac/kg food Technical active 40-day dietary exposure *Colinus virginianus*	USEPA 1998
	LC_{50} 2.0 mg ac/kg food Technical active 40-day dietary exposure *Anas platyrhychos*	USEPA 1998

	Value	Reference
Reproductive toxicity to birds	**NOEL 0.00038 mg ac/kg bw/d** corresponding to NOEC 0.0038 mg ac/kg food[4] Technical difenacoum *Coturnix coturnix japonica*	ECHA 2010
Acute toxicity to reptiles	LD_{50} >1750 mg ac/kg bw, *Sceloporus occidentalis* corresponding to LC_{50} >17,500 mg ac/kg food	Weir et al. 2016
Acute toxicity to fish Rainbow trout	LC_{50} 0.042 mg ac/L Technical active 96h semi-static, mean measured *Oncorhychus mykiss*	ECHA 2010
	LC_{50} 0.015 mg ac/L Technical active 96h flow-through, measured stock *Oncorhychus mykiss*	USEPA 1998
Bluegill sunfish	LC_{50} 0.025 mg ac/L Technical active 96h flow-through, measured stock *Oncorhychus mykiss*	USEPA 1998
Bioconcentration in fish	BCF 35134 (calculated)[5] CT_{50} 8.0 d, CT_{95} 34 d	ECHA 2010
Acute toxicity to aquatic invertebrates	EC_{50} 0.25 mg ac/L Technical active 48h static renewal, mean measured *Daphnia magna*	ECHA 2010
	EC_{50} 0.98 mg ac/L Technical active 48h static, nominal *Daphnia magna*	USEPA 1998
Toxicity to algae	E_rC_{50} 0.040 mg ac/L E_bC_{50} 0.016 mg ac/L Technical active 72h static, mean measured *Selenastrum capricornutum*	ECHA 2010
Acute toxicity to soil macro-organisms	LC_{50} >994 mg ac/kg dry soil Technical active 14d static, nominal *Eisenia foetida*	ECHA 2010
Bioconcentration in earthworms	BCF 15820 (calculated)[6]	ECHA 2010
Effects on micro-organisms	EC_{10} >0.0038 mg ac/L[7] Technical active 6h static *Pseudomonas putida*	ECHA 2010
	EC_{10} >0.058 mg ac/L[8] Technical active 3h static Activated sludge	ECHA 2010

[4] Read across from difenacoum endpoint and extrapolation factor of 26 (based on avian dietary LC_{50} values: 19 mg/kg difenacoum and 0.72 mg ac/kg food)

[5] $\log BCF = -0.20 \cdot \log K_{ow}^2 + 2.74 \cdot \log K_{ow} - 4.72$ where $\log K_{ow}$ 6.1

[6] $\log BCF = 0.84 + 0.012\ K_{ow}$, where $\log K_{ow}$ 6.1

[7] Based on water solubility at pH 5.2 and 20ºC

[8] Based on water solubility at pH 7.0 and 20ºC

APPENDIX 3 Deer Maar Island focal species

The tables below list the bird species that have been recorded on Deen Maar Island (with records dating back to 1959). The yellow highlighted rows represent the 'focal species' that were used in the risk assessment, which were selected based on the likelihood of them ingesting bait, rabbits (or carrion) or slugs based their dietary preferences and likelihood of occurrence on the island.

While there is no record of the species on Deen Maar island, risks to the orange-bellied parrot (*Neophema chrysogaster*) were considered due to species critically endangered status under the Environment Protection and Biodiversity Conservation (EPBC) Act 1999, the close proximity to Yambuck wetlands (which is recognised as a significant site for the species), and considering the timing of application which may coincide with the species occurrence in the south-west region.

Risks to the orange-bellied parrot are considered to be acceptable due to its very low likelihood of occurrence on Deen Maar Island during the baiting period and an overall low exposure risk:

- While the Yambuck area provided important refuge during the millennium drought (2000-2010), orange-bellied parrots have not been sighted in the nearby Yambuck wetlands for over 10 years (despite annual surveys). There is no record of orange-bellied parrots on Deen Maar Island and the last sighting of blue-winged parrots (which are known to forage in flocks with orange-bellied parrots) was in 1959 (64 years ago).

- There is very limited orange-bellied parrot habitat on Deen Maar Island. With current habitat extent being less than 0.25 ha (as recently assessed by DEECA ecologists in ground surveys on the island on February 15th 2023).

- The orange bellied-parrot typically feed on seeds and fruits that are a few millimetres in size, with important food species including glassworts, goosefoot, saltbushes, sea-heath, and seablight, and therefore are unlikely to consume seeds or pellets in the size range of PESTOFF RODENT BAIT 20R (10 mm).

Table 1 Deen Maar Island – Marine and migratory bird species list

Common name	Scientific name	Conservation status	Type of presence	Diet	Last record
Antarctic prion	*Pachyptila desolata*			Fish, invertebrates	1959
Australasian gannet	*Morus serrator*			Pelagic fish	2003
Black-browed albatross	*Thalassarche melanophris*	VU - EPBC Act		Fish, aquatic invertebrates	2017
Cape petrel	*Daption capense*			Fish, invertebrates, scavenger	1959
Common diving-petrel	*Pelecanoides urinatrix*		Breeding pop	Fish, invertebrates	1973
Great skua	*Stercorarius skua*			Fish, invertebrates, scavenger	2001
Grey-headed albatross	*Thalassarche chrysostoma*	EN - EPBC Act & FFG Act		Fish, invertebrates, scavenger	1959
Grey petrel	*Procellaria cinerea*			Fish, invertebrates, fish offal	1959
Great-winged petrel	*Pterodroma macroptera*			Pelagic fish	1959
Fairy prion	*Pachyptila turtur*		Breeding pop (500 pairs)	Fish, invertebrates	2003
Fiordland penguin	*Eudyptes pachyrhynchus*			Fish, invertebrates	1979
Fluttering shearwater	*Puffinus gavia*			Pelagic fish	2001
Indian yellow-nosed albatross	*Thalassarche chlororhynchos*	VU - EPBC Act; EN - FFG Act		Fish, invertebrates, fish offal	2017
Little penguin	*Eudyptula minor*		Breeding site	Fish, invertebrates	2006
Northern giant-petrel	*Macronectes halli*	VU - EPBC Act; EN - FFG Act		Fish, invertebrates, scavenger	2017
Rockhopper penguin	*Eudyptes chrysocome*			Fish, invertebrates	1959
Short-tailed shearwater	*Ardenna tenuirostris*		Breeding pop (80,000 pairs)	Fish, invertebrates	2001
Shy albatross	*Thalassarche cauta*	EN - EPBC Act & FFG Act		Fish, invertebrates, fish offal	2001
Slender-billed prion	*Pachyptila belcheri*			Fish, invertebrates	1959
Sooty shearwater	*Ardenna grisea*			Fish, invertebrates	1959
Southern giant-petrel	*Macronectes giganteus*	EN - EPBC Act & FFG Act		Fish, invertebrates, scavenger	2006
Wandering albatross	*Diomedea exulans*	VU - EPBC Act; Cr EN - FFG Act		Fish, scavenger	1959
White-fronted tern	*Sterna striata*			Pelagic fish	2001
White-headed petrel	*Pterodroma lessonii*			Fish, invertebrates	1959

Highlighted rows are the focal species selected for assessment
EPBC ACT: Environment Protection and Biodiversity Act, 1999
FFG Act: Victorian Flora and Fauna Guarantee Act, 1988
Cr EN – critically endangered, EN – Endangered, VU - vulnerable

Table 2 Deen Maar Island – Aquatic and shorebird species list

Common name	Scientific name	Conservation status	Type of presence	Diet	Last record
Australasian grebe	*Tachybaptus novaehollandiae*			Aquatic invertebrates	1959
Australian ibis	*Threskiornis molucca*			Carnivorous, scavenger	1959
Australasian pelican	*Pelecanus conspicillatus*			Fish, carnivorous	1959
Australian shelduck	*Tadorna tadornoides*			Omnivorous	1978
Australasian shoveler	*Anas rhynchotis*	VU - FFG Act		Aquatic invertebrates	1959
Australasian swamphen	*Porphyrio melanotus*			Omnivorous	1959
Black-faced cormorant	*Phalacrocorax fuscescens*			Fish	2018
Black swan	*Cygnus atratus*			Herbivorous	2001
Crested tern	*Thalasseus bergii*			Fish, invertebrates	2003
Double-banded plover	*Charadrius bicinctus*		Rare visitor	Omnivorous	1959
Great cormorant	*Phalacrocorax carbo*			Fish, invertebrates	1973
Grey teal	*Anas gracilis*			Omnivorous	1959
Hoary-headed grebe	*Poliocephalus poliocephalus*			Aquatic invertebrates	1959
Hooded plover	*Thinornis cucullatus*	VU - FFG Act		Invertebrates	1959
Kelp gull	*Larus dominicanus*		Resident, breeding	Omnivorous, scavenger	2020
Little black cormorant	*Phalacrocorax sulcirostris*			Fish, invertebrates	1959
Little pied cormorant	*Microcarbo melanoleucos*			Fish, invertebrates	1959
Musk duck	*Biziura lobata*	VU - FFG Act		Aquatic invertebrates	1959
Pacific black duck	*Anas superciliosa*			Herbivorous	1959
Pacific gull	*Larus pacificus*		Resident?	Scavenger	2018
Pied cormorant	*Phalacrocorax varius*		Rare visitor	Fish, invertebrates	2001
Pied oystercatcher	*Haematopus longirostris*			Aquatic invertebrates	1978
Red-capped plover	*Charadrius ruficapillus*			Aquatic invertebrates	1959
Red-necked stint	*Callidris ruficollis*			Invertebrates	1959
Silver gull	*Chroicocephalus novaehollandiae*			Omnivorous, scavenger	2003
Sooty oystercatcher	*Haematopus fuliginosus*		Resident?	Aquatic invertebrates	2020
White-bellied sea-eagle	*Haliaeetus leucogaster*	EN - Vic FFG Act	Resident	Carnivorous, scavenger	2000
White-faced heron	*Egretta novaehollandiae*		Rare visitor	Fish, invertebrates	2003

Highlighted rows are the focal species selected for assessment
EPBC ACT: Environment Protection and Biodiversity Act, 1999
FFG Act: Victorian Flora and Fauna Guarantee Act, 1988
Cr EN – critically endangered, EN – Endangered, VU - vulnerable

Table 3 Deen Maar Island – Terrestrial bird species list

Common name	Scientific name	Conservation status	Type of presence	Diet	Last record
Australian magpie	*Cracticus tibicen*			Omnivorous	1959
Australian pipit	*Anthus australis*		Rare visitor	Omnivorous	2003
Barn owl	*Tyto alba*			Carnivorous	1959
Black-faced cuckoo-shrike	*Coracina novaehollandiae*			Insectivorous	1959
Black-shouldered Kite	*Elanus axillaris*			Carnivorous	2003
Blue-winged parrot	*Neophema chrysostoma*			Granivorous	1959
Brown falcon	*Falco berigora*		Rare visitor	Carnivorous	2003
Brown goshawk	*Accipiter fasciatus*			Carnivorous	1959
Brown thornbill	*Acanthiza pusilla*			Insectivorous	1959
Crimson rosella	*Platycercus elegans*			omnivorous	1959
Common starling	*Sturnus vulgaris*	*	Resident?	Omnivorous	2020
European goldfinch	*Carduelis carduelis*	*		Granivorous	2001
European greenfinch	*Chloris chloris*	*		Granivorous	1959
Eurasian skylark	*Alauda arvensis*	*		Omnivorous	2003
Eastern shrike-tit	*Falcunculus frontatus*			Insectivorous	1959
Eastern yellow robin	*Eopsaltria australis*			Insectivorous	1959
Fan-tailed cuckoo	*Cacomantis flabelliformis*			Insectivorous	1959
Golden-headed cisticola	*Cisticola exilis*			Insectivorous	1959
Grey tantail	*Rhipidura albiscapa*			Insectivorous	1959
Grey shrike-thrush	*Colluricincla harmonica*			Carnivorous	1978
House Sparrow	*Passer domesticus*	*		Omnivorous	2003
Jacky Winter	*Microeca fascinans*			Insectivorous	1959
Laughing kookaburra	*Dacelo novaeguineae*			Carnivorous	1959
Little grassbird	*Poodytes gramineus*		Resident?	Insectivorous	2003
Masked lapwing	*Vanellus miles*			Insectivorous	1959
Magpie-lark	*Grallina cyanoleuca*			Insectivorous	1959
Nankeen kestrel	*Falco cenchroides*		Resident (1 pair?)	Carnivorous	2003
New Holland honeyeater	*Phylidonyris novaehollandiae*			Insectivorous	1959
Peregrine falcon	*Falco peregrinus*		Rare visitor	Carnivorous	2003
Rufous bristlebird (Coorong)	*Dasyornis broadbenti*	EN – FFG Act		Insectivorous	1959
Silvereye	*Zosterops lateralis*			Insectivorous	1959
Singing honeyeater	*Lichenostomus virescens*			Insectivorous	1959
Spotted pardalote	*Pardalotus punctatus*			Insectivorous	1959
Striated fieldwren	*Calamanthus fuliginosus*			Insectivorous	1959
Superb Fairy-wren	*Malurus cyaneus*			Insectivorous	1959
Swamp harrier	*Circus approximans*		Seasonal migrant, (1 resident?)	Carnivorous	2003
Wedge-tailed eagle	*Aquila audax*			Carnivorous	1959
Welcome swallow	*Hirundo neoxena*		Rare visitor	Insectivorous	2003
Willie wagtail	*Rhipidura leucophrys*			Insectivorous	1959

Whistling kite	*Haliastur sphenurus*			Carnivorous	1959
White-browed scrubwren	*Sericornis frontalis*			Insectivorous	1959
White-eared honeyeater	*Lichenostomus leucotis*			Insectivorous	1959
White-fronted chat	*Epthianura albifrons*		Resident?	Insectivorous	2003
White-naped honeyeater	*Melithreptus lunatus*			Insectivorous	1959
White-winged triller	*Lalage sueurii*			Insectivorous	1978
Yellow-faced Honeyeater	*Lichenostomus chrysops*			Insectivorous	1959
Yellow-rumped thornbill	*Acanthiza chrysorrhoa*			Insectivorous	1959

Highlighted rows are the focal species selected for assessment
EPBC ACT: Environment Protection and Biodiversity Act, 1999
FFG Act: Victorian Flora and Fauna Guarantee Act, 1988
Cr EN – critically endangered, EN – Endangered, VU – vulnerable, * introduced

A3.1 Slug-eating reptiles

White's skink (*Liopholis whitii*)
https://bie.ala.org.au/species/https://biodiversity.org.au/afd/taxa/ae2be63c-f203-4545-9c9d-568e157bece4
https://besjournals.onlinelibrary.wiley.com/doi/pdf/10.1111/1365-2656.12894
Body weight 26 g; DEE 3.8 kJ/d (calculated using equation 32 for reptiles from Nagy et al. 1999)

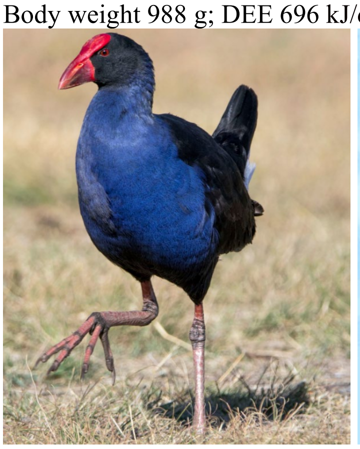
White's skink is found in rocky microhabitats in open woodland, coastal heathland and grasslands over a wide geographic range in South Australia, Tasmania, Victoria, New South Wales and Queensland. This diurnal lizard is usually seen basking or foraging on open rock surfaces and among leaf litter near crevices, rock slopes and exfoliating rock slabs. White's skink is a burrowing species, often digging or reusing complex tunnels underground that have two entrances to the tunnel if needing an escape route. They are polygynous and live in small, sometimes temporary familial groups, with up to five females per male. White's skink is omnivorous and feds mainly on invertebrates (ants, leaf hoppers, spiders and millipedes) and sometimes meat and plant material.

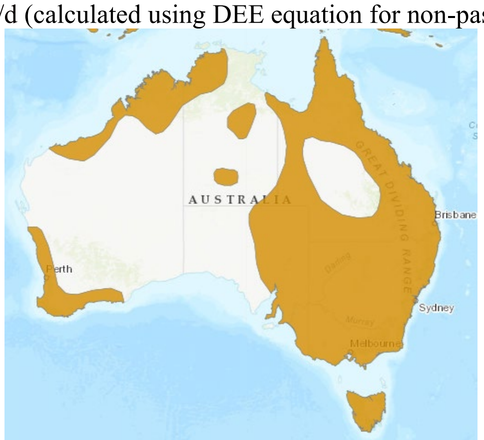
A3.2 Bait-eating birds

Australasian pipit (*Anthus novaeseelandiae*)
https://www.birdsinbackyards.net/species/Anthus-novaeseelandiae
Body weight 26 g; DEE 97 kJ/d (calculated using DEE equation for passerine birds, EFSA 2009 p269)

The Australasian pipit is found across Australia. It is also found in New Guinea, New Zealand, as well as being widespread across Africa and Asia. Australasian pipits are found in open country, in a range of habitat types from wet heaths to dry shrublands and open woodland clearings. Australasian pipits feed on the ground on insects and their larvae, as well as seeds. They forage in a jerky, darting motion, stopping to perch on low stones or shrubs, wagging their tails up and down.

Australasian swamphen (*Porphyrio melanotus*)
https://www.birdsinbackyards.net/species/Porphyrio-porphyrio
Body weight 988 g; DEE 696 kJ/d (calculated using DEE equation for non-passerine birds, EFSA 2009 p269)





The Australasian swamphen is a subspecies of the purple swamphen. Purple swamphens are common throughout eastern and northern Australia. Birds have transported themselves from Australia to New Guinea and New Zealand and throughout the islands of the south-west Pacific. The purple swamphen is found around freshwater swamps, streams and marshes. The diet of the purple swamphen includes the soft shoots of reeds and rushes and small animals, such as frogs and snails. However, it is a reputed egg stealer and will also eat ducklings when it can catch them. The purple swamphen uses its long toes to grasp food while eating.

Australian magpie (*Cracticus tibicen*)
https://www.birdsinbackyards.net/species/Cracticus-tibicen
Body weight 300 g; DEE 509 kJ/d (calculated using DEE equation for passerine birds, EFSA 2009 p269)

Australian magpies are common and conspicuous birds. Groups of up to 24 birds live year round in territories that are actively defended by all group members. The group depends on this territory for its feeding, roosting and nesting requirements. Australian magpies are found wherever there is a combination of trees and adjacent open areas, including parks and playing fields. They are absent only from the densest forests and arid deserts. The Australian magpie walks along the ground searching for insects and their larvae. Birds will also take handouts from humans and will often venture into open houses to beg for food.

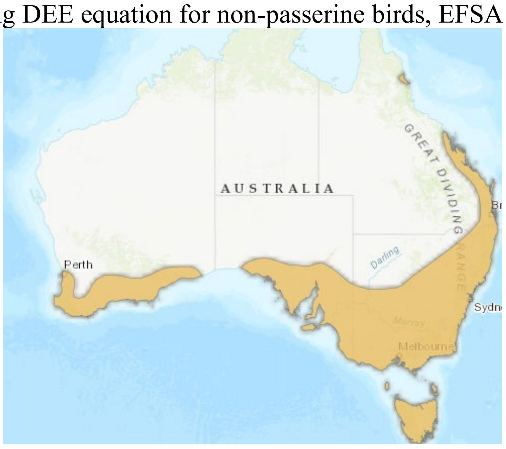
Blue-winged parrot (*Neophema chrysostoma*)
https://www.birdsinbackyards.net/species/Neophema-chrysostoma
Body weight 55 g; DEE 101 kJ/d (calculated using DEE equation non-passerine birds, EFSA 2009 p269)

The main populations of blue-winged parrots are in Tasmania and Victoria, particularly in southern Victoria and the midlands and eastern areas of Tasmania. Sparser populations are found in western New South Wales and eastern South Australia, extending to south-west Queensland and occasionally into the Northern Territory. The blue-winged parrot inhabits a range of habitats from coastal, sub-coastal and inland areas, right through to semi-arid zones. Throughout their range they favour grasslands and grassy woodlands. They are often found near wetlands both near the coast and in semi-arid zones. Blue-winged parrots can also be seen in altered environments such as airfields, golf-courses and paddocks. Pairs or small parties of blue-winged parrots forage mainly on the ground for seeds of grasses and herbaceous plants.

Crimson rosella (*Platycercus elegans*)
https://www.birdsinbackyards.net/species/Platycercus-elegans
Body weight 129 g; DEE 178 kJ/d (calculated using DEE equation for non-passerine birds, EFSA 2009 p269)

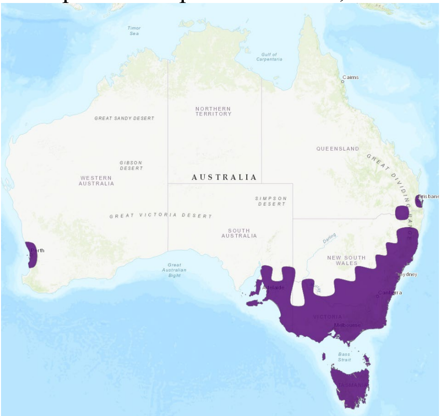

There are several populations of the crimson rosella. Red (crimson) birds occur in northern Queensland, in southern Queensland to south-eastern South Australia and on Kangaroo Island. Orange birds are restricted to the Flinders Ranges region of South Australia, while yellow ones are found along the Murray, Murrumbidgee and neighbouring rivers (where yellow birds meet red birds they hybridise, producing orange offspring). Red birds have been introduced to Norfolk Island and New Zealand. Throughout its range, the crimson rosella is commonly associated with tall eucalypt and wetter forests. Crimson rosellas are normally encountered in small flocks and are easily attracted to garden seed trays. Once familiar with humans, they will accept hand held food. Natural foods include seeds of eucalypts, grasses and shrubs, as well as insects and some tree blossoms.

Double-banded plover (*Charadrius bicinctus*)
https://www.birdsinbackyards.net/species/Charadrius-bicinctus
Body weight 70 g; DEE 118 kJ/d (calculated using DEE equation for non-passerine birds, EFSA 2009 p269)

In Australia, the double-banded plover is found mainly on the east coast and Tasmania and is a regular visitor to Norfolk and Lord Howe Islands. It has been recorded occasionaly in Western Australia. It is widespread throughout New Zealand. The double-banded plover is found on coastal beaches, mudflats, sewage farms, river banks, fields, dunes, upland tussock grasses and shingle. The double-banded plover migrates to New Zealand where it breeds and moves back to south-eastern Australia in the winter. Double-banded plovers eat molluscs, crustaceans, insects, and occasionally seeds and fruit.

European goldfinch (*Carduelis carduelis*)
https://www.birdsinbackyards.net/species/Carduelis-carduelis
Body weight 16 g; DEE 70 kJ/d (calculated using DEE equation for passerine birds, EFSA 2009 p269)



The European goldfinch is a widespread species in Europe, central Asia and northern Africa and was introduced to Australia in the 1860s. Originally restricted to urban areas, the European goldfinch has successfully moved out into country areas of south-eastern Australia, including Tasmania. The European goldfinch is found in settled areas, farmlands and weedy areas such as roadsides, railway lands and industrial wasteland. They are often seen in gardens and parks. Particularly associated with patches of Scotch thistle. The European goldfinch has a finer bill than its relative, the greenfinch, and eats smaller seeds, especially those of the introduced Scotch thistle. They also eat insects in summer.

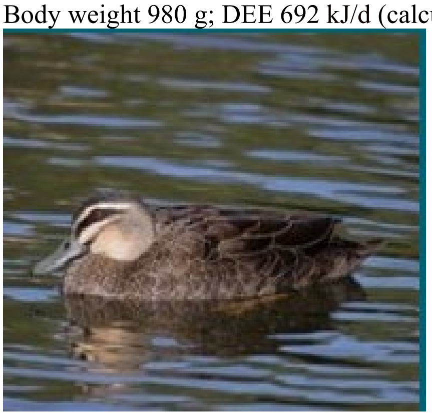
Grey teal (*Anas gracilis*)
https://www.birdsinbackyards.net/species/Anas-gracilis
Body weight 554 g; DEE 473 kJ/d (calculated using DEE equation for non-passerine birds, EFSA 2009 p269)

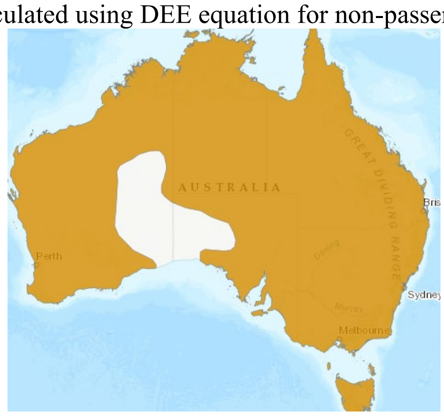
Grey teals are found throughout Australia. Grey teals are common in all sheltered watered areas. These include fresh, brackish and salt water, and the birds can be found on the smallest area of water in the driest of areas. The most favoured habitat type is timbered pools and river systems of the inland areas, where these birds can be found in quite large numbers. Grey teals feed in small to large flocks. Food consists of a variety of types and includes dry land plants, aquatic plants, seeds, crustaceans, and insects and their larvae. Feeding methods are also varied. Birds may dabble (filter surface water or mud through the bill), upend and feed from the bottom, or graze from the surface of the water on plant material.

Kelp gull (*Larus dominicanus*)
https://www.birdsinbackyards.net/species/Larus-dominicanus
Body weight 940 g; DEE 673 kJ/d (calculated using DEE equation for non-passerine birds, EFSA 2009 p269)

The kelp gull has become established in Australia since the 1940s, with the first breeding recorded on Moon Island near Lake Macquarie in New South Wales in 1958. Their numbers have increased rapidly since the 1960s and they are now common in many parts of the south-east and south-west coasts, and especially in Tasmania. The kelp gull prefers the sheltered parts of coasts such as bays, inlets and estuaries; also beaches and reefs on off-shore islands. It is likely that the kelp gull is in serious competition with the endemic Pacific gull because of their similar habitat, food and habits. The kelp gull forages on land or in water, rarely in the air. It feeds mainly on fish and crustaceans, but will scavenge when an opportunity arises. Like the Pacific gull, the kelp gull habitually drops molluscs from mid-air onto rocks to smash them.

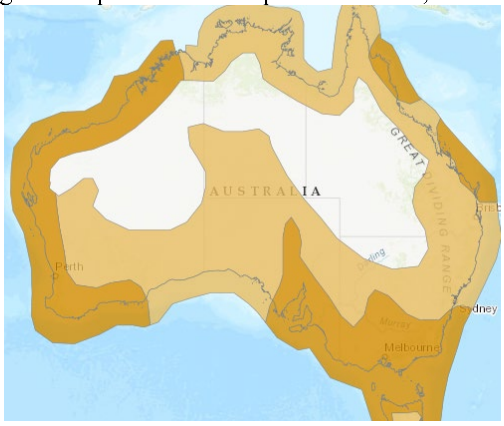
Pacific black duck (*Anas superciliosa*)
https://www.birdsinbackyards.net/species/Anas-superciliosa
Body weight 980 g; DEE 692 kJ/d (calculated using DEE equation for non-passerine birds, EFSA 2009 p269)





The Pacific Black Duck is found in all but the most arid regions of Australia. Outside Australia, its range extends throughout the Pacific region. The Pacific Black Duck is one of the most versatile of the Australian ducks. It frequents all types of water, from isolated forest pools to tidal mudflats. Pacific Black Ducks are usually seen in pairs or small flocks and readily mix with other ducks. In the wild, birds are often very wary of humans and seldom allow close approach. Birds in urban ponds become quite tame, however. The Pacific Black Duck is mainly vegetarian, feeding on seeds of aquatic plants. This diet is supplemented with small crustaceans, molluscs and aquatic insects. Food is obtained by 'dabbling', where the bird plunges its head and neck underwater and upends, raising its rear end vertically out of the water. Occasionally, food is sought on land in damp grassy areas.

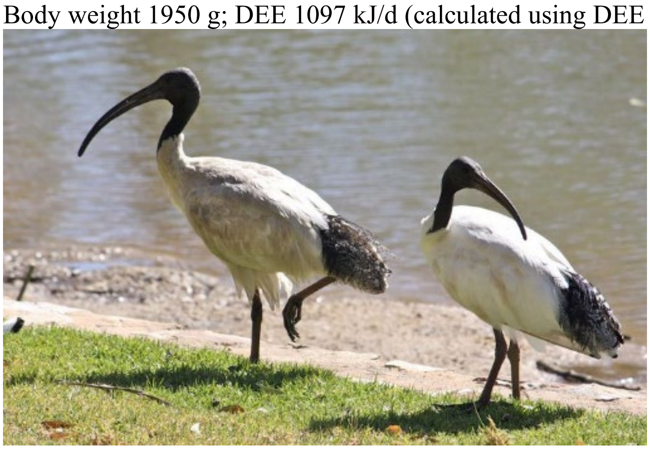
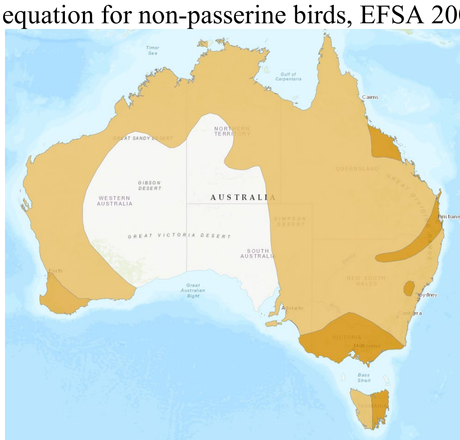
Silver gull (*Chroicocephalus novaehollandiae*)
https://www.birdsinbackyards.net/species/Chroicocephalus-novaehollandiae
Body weight 313 g; DEE 322 kJ/d (calculated using DEE equation for non-passerine birds, EFSA 2009 p269)

The silver gull is common throughout Australia and is also found in New Zealand and New Caledonia. The silver gull is found at virtually any watered habitat and is rarely seen far from land. Birds flock in high numbers around fishing boats as these leave or return to the coast, but seldom venture far out to sea. As with many other gull species, the silver gull has become a successful scavenger, readily pestering humans for handouts of scraps, pilfering from unattended food containers or searching for human refuse at tips. Other food includes worms, fish, insects and crustaceans.

A3.3 Carrion-eating birds

Australian white ibis (*Threskiornis molucca*)
https://www.birdsinbackyards.net/species/Threskiornis-molucca
Body weight 1950 g; DEE 1097 kJ/d (calculated using DEE equation for non-passerine birds, EFSA 2009 p269)

The Australian white ibis is common and widespread in northern and eastern Australia, and both its range and abundance in western Australia is expanding, despite its absence from Western Australia prior to the 1950s. The species is absent from Tasmania. The Australian white ibis can be observed in all but the driest habitats. Preferred habitats include swamps, lagoons, floodplains and grasslands, but it has also become a successful inhabitant of urban parks and gardens. The Australian white ibis' range of food includes both terrestrial and aquatic invertebrates and human scraps. The most favoured foods are crayfish and mussels, which the bird obtains by digging with its long bill. Mussels are opened by hammering them on a hard surface to reveal the soft body inside.

Barn owl (*Tyto alba*)
https://www.birdsinbackyards.net/species/Tyto-alba
Body weight 520 g; DEE 453 kJ/d (calculated using DEE equation for non-passerine birds, EFSA 2009 p269)


The barn owl is found throughout Australia. Its distribution is limited only by habitat and food availability. By day, the barn owl roosts in hollow logs, caves or dense trees, and is usually seen alone or in pairs. The preferred habitat is open, often arid country, such as farms, heath and lightly wooded forest. Barn owls feed mostly on small mammals, mainly rodents, and birds, but some insects, frogs and lizards are also eaten. One of the more favoured foods is the introduced House Mouse, *Mus musculus*. Barn Owls hunt in flight, searching for prey on the ground using their exceptional hearing. The heart-shaped structure of the facial disc is unique to these types of owls (*Tyto* species). The slightest sound waves are channelled toward the ears, allowing the owl to pinpoint prey even in complete darkness. Work in New Zealand has shown that moreporks (*Ninox novaeseelandiae*) have been killed during brodifacoum operations (Stephenson et al. 1999).

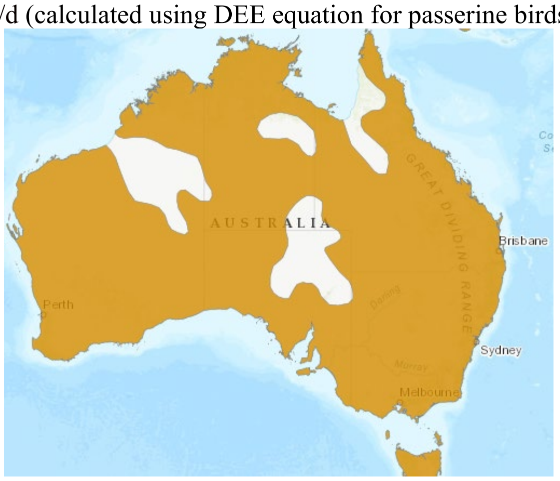
Brown falcon (*Falco berigora*)
https://www.birdsinbackyards.net/species/Falco-berigora
Body weight 530 g; DEE 459 kJ/d (calculated using DEE equation for non-passerine birds, EFSA 2009 p269)


The Brown Falcon ranges throughout Australia, and north to New Guinea. The Brown Falcon is found in all but the densest forests and is locally common throughout its range. The preferred habitat is open grassland and agricultural areas, with scattered trees or structures such as telegraph poles which it uses for perching. Around outback towns, the birds become quite tame and will allow quite close approach. Birds may stay within the same areas throughout the year or may move around locally in response to changes in conditions. Paler birds are usually associated with inland areas, but all the colour varieties are fairly scattered throughout the range. Brown Falcons are usually seen alone, searching for food from an exposed perch. When prey is sighted, the bird swoops down and grasps it in its claws (talons), killing the prey with a bite to the spine. The powerful bill has specialised 'tomial' teeth and matching notches for this purpose. Less often the species will hunt by hovering or gliding over the ground, often at great heights. Brown Falcons feed on small mammals, insects, reptiles and, less often, small birds.

Brown goshawk (*Accipiter fasciatus*)
https://www.birdsinbackyards.net/species/Accipiter-fasciatus
Body weight 454 g; DEE 467 kJ/d (calculated using DEE equation for non-passerine birds, EFSA 2009 p269)

Brown goshawks are found across Australia in suitable habitats. The brown goshawk is found in most timbered habitats. Brown goshawks feed on small mammals, with rabbits a particularly important prey item, as well as birds, reptiles and insects and sometimes, carrion (dead animals). They hunt stealthily from a low, concealed perch, using sudden, short bursts of speed to pounce onto prey and use their long legs and clawed toes to reach out and strike it. It will occasionally stalk or run along the ground after insects. Prey items are taken back to a perch to be partially plucked (mammals, birds) and then eaten.

Grey shrike-thrush (*Colluricincla harmonica*)
https://www.birdsinbackyards.net/species/Colluricincla-harmonica
Body weight 63 g; DEE 177 kJ/d (calculated using DEE equation for passerine birds, EFSA 2009 p269)



Grey shrike-thrushes are found in all but the most arid regions of Australia and Tasmania. The Grey Shrike-thrush is found in forests and woodlands. It is a common and familiar bird, although some decrease in numbers has been noted around human habitation, particularly in the west of its range. The grey shrike-thrush searches for food on the ground, generally around fallen logs, and on the limbs and trunks of trees. It has a varied diet consisting of insects, spiders, small mammals, frogs and lizards, and birds' eggs and young, and some birds have been observed feeding on carrion. Fruits and seeds may also be eaten on occasion.

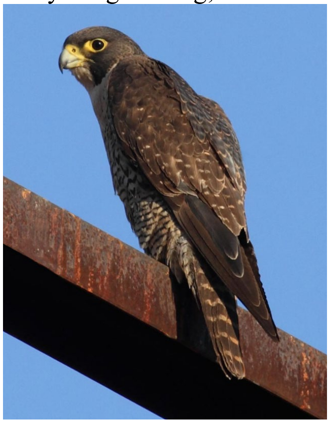
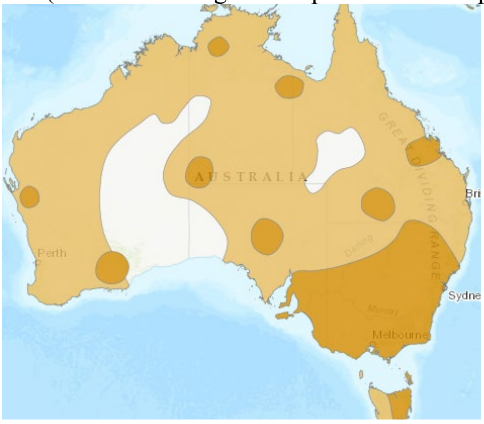
Grey-headed albatross (*Thalassarche chrysostoma*)
https://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=66491
Body weight 3350 g; DEE 1575 kJ/d (calculated using DEE equation for non-passerine birds, EFSA 2009 p269)

In Australian territory, grey-headed albatross breed on the southern and western flanks of Petrel Peak, Macquarie Island. The grey-headed albatross has bred in this same restricted area on Macquarie Island for at least the past 30 years. The grey-headed albatross is marine, pelagic and migratory. Its habitat includes subantarctic, subtropical, and occasionally Antarctic waters in the Pacific, Indian, Atlantic and Southern Oceans. Breeding and non-breeding birds disperse widely across the Southern Ocean, at more southerly latitudes in summer than in winter, when they frequent the waters off southern Australia and New Zealand. Most Australian records come from south and west of Tasmania, occasionally in Victorian waters, rarely in South Australia and Western Australia, and only as a vagrant in NSW. It has only been recorded once in southern Queensland. The diet of the grey-headed albatross varies geographically and includes fish, squid, crustaceans, penguin carrion and lampreys. Most prey is taken by surface-seizing.

Pacific gull (*Larus pacificus*)
https://www.birdsinbackyards.net/species/Larus-pacificus
Body weight 1000 g; DEE 701 kJ/d (calculated using DEE equation for non-passerine birds, EFSA 2009 p269)

The Pacific gull is endemic to southern Australia and occurs mostly on south and west coasts, Tasmania and infrequently on the east coast. The Pacific gull prefers sandy, or less often, rocky coasts and sandy beaches. In eastern Australia, the Pacific gull prefers areas that are protected from ocean swells such as estuaries, bays and harbours. In Western Australia, it occurs occasionally in harbours but mostly on exposed coasts and offshore islands. It usually avoids human habitation but is occasionally seen on farmland and rubbish tips near the coast but rarely inland. It can be found roosting or loafing in elevated situations such as rocky headlands or on structures such as wharves and jetties. The Pacific gull forages along the coasts between the high-water mark and shallow water on sandy beaches, feeding mainly on molluscs, fish, birds and other marine animals.

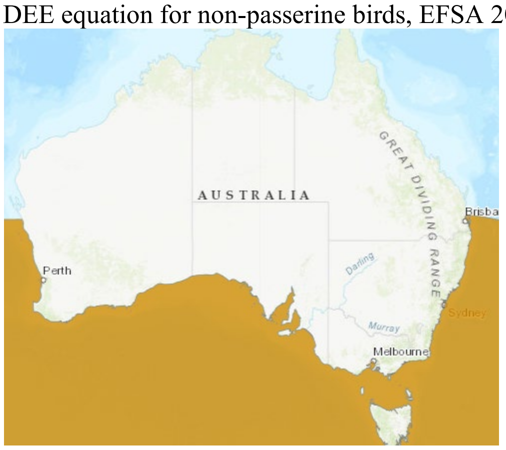
Peregrine falcon (*Falco peregrinus*)
https://www.birdsinbackyards.net/species/Falco-peregrinus
Body weight 765 g; DEE 586 kJ/d (calculated using DEE equation for non-passerine birds, EFSA 2009 p269)

The peregrine falcon is found across Australia, but is not common anywhere. It is also found in Europe, Asia, Africa and the Americas. The peregrine falcon is found in most habitats, from rainforests to the arid zone, and at most altitudes, from the coast to alpine areas. It requires abundant prey and secure nest sites, and prefers coastal and inland cliffs or open woodlands near water, and may even be found nesting on high city buildings. The peregrine falcon feeds on small and medium-sized birds, as well as rabbits and other day-active mammals. It swoops down on its prey from above, catching or stunning it with its powerfully hooked talons, before grasping and carrying it off to a perch to pluck and eat it. It will pursue flying birds, being able to fly at speeds of up to 300 km/h, and it soars to a great height in search of prey. Pairs may hunt co-operatively, with one member, usually the male, scattering a flock of birds while the other swoops down to attack a particular individual. This co-operative behaviour is most often observed during the breeding season.

Silver gull (*Chroicocephalus novaehollandiae*)
See description on bait-eating birds (A3.2)

Southern giant-petrel (*Macronectes giganteus*)
https://www.antarctica.gov.au/about-antarctica/animals/flying-birds/petrels-and-shearwaters/southern-giant-petrel/
Body weight 4400 g; DEE 1890 kJ/d (calculated using DEE equation for non-passerine birds, EFSA 2009 p269)

The Southern Giant Petrel is the largest petrel. It occurs in Antarctic to subtropical pelagic and inshore waters. It breeds on the Antarctic Continent, Peninsula and islands, and on subantarctic islands and South America. Breeding islands include Macquarie Island, Heard Island and McDonald Island in the Southern Ocean, and Giganteus Island, Hawker Island, and Frazier Island in the Australian Antarctic Territories. Large nests are often built in exposed areas of open vegetation or, in Antarctic colonies, of no vegetation. The Southern Giant-Petrel is abundant over the pack-ice near penguin colonies and is attracted to sewage outfalls. At sea, it feeds mainly on the surface, but might occasionally dive to shallow depths. On the pack-ice, it will roost on icebergs and snow slopes at the sea edge. The Southern Giant-Petrel is an opportunist scavenger and predator. In summer, it will scavenge primarily penguin carcasses, although it will also feed on seal and whale carrion. It catches and kills live birds including Albatrosses *Diomedea*, a wide variety of smaller seabirds, and penguin chicks. Cephalopods are taken by surface-seizing; krill are scooped from the surface of the water. It is also recorded consuming other crustaceans, kelp, fish, jellyfish, and rabbits.

Swamp harrier (*Circus approximans*)
https://www.birdsinbackyards.net/species/Circus-approximans
Body weight 740 g; DEE 573 kJ/d (calculated using DEE equation for non-passerine birds, EFSA 2009 p269)


The swamp harrier is widespread in Australasia and the South Pacific. The swamp harrier is found in terrestrial wetlands and open country of tropical and temperate Australia and New Zealand. It is mainly seen in fresh or salt wetlands, often in deep swamps with emergent reeds and over open water. Swamp harriers hunt for birds and eggs, large insects, frogs, reptiles and small mammals up to the size of hares or rabbits. When hunting they 'quarter', which means that they systematically search for prey by gliding low to the ground or water, then drop down on to their quarry. In New Zealand, swamp harriers often feed on carrion.

Wandering albatross (*Diomedea exulans*)
https://www.birdsinbackyards.net/species/Diomedea-exulans
Body weight 9315 g; DEE 3122 kJ/d (calculated using DEE equation for non-passerine birds, EFSA 2009 p269)


The wandering albatross visits Australian waters from Fremantle, Western Australia to northern New South Wales between June and September each year. At other times birds roam the southern oceans and commonly follow fishing boats for several days. Wandering albatrosses spend most of their life in flight, landing only to breed and feed. Distances travelled each year are hard to measure, but one banded bird was recorded travelling 6000 km in twelve days. Wandering albatrosses are often seen scavenging scraps from fishing boats, but squid and fish are the preferred foods. Galley refuse and floating waste also form part of the diet. Feeding is one of the few times that birds land, and this is mostly undertaken at night. Pairs of wandering albatrosses mate for life and breed every two years. Breeding takes place on subantarctic islands and commences in early November. The nest is a mound of mud and vegetation, and is placed on an exposed ridge near the sea.

Wedge-tailed eagle (*Aquila audax*)
https://www.birdsinbackyards.net/species/Aquila-audax
Body weight 4025 g; DEE 1781 kJ/d (calculated using DEE equation for non-passerine birds, EFSA 2009 p269)

The wedge-tailed eagle is found throughout mainland Australia, Tasmania and southern New Guinea. The wedge-tailed eagle is found from sea level to alpine regions in the mountains, but prefers wooded and forested land and open country, generally avoiding rainforest and coastal heaths. Wedge-tailed Eagles eat both live prey and carrion. Their diet reflects the available prey, but the most important live items are rabbits and hares. Rabbits usually comprise about 30-70% of the diet, but may comprise up to 92%. Other food items include lizards, birds (weighing over 100 g) and mammals (usually weighing over 500 g). Carrion is a major food source; roadkills and other carcasses are readily eaten. Many of the reports of predation on lambs result from birds scavenging already dead animals. Up to 20 birds may attend a carcass, although only two or three feed at any one time. Wedge-tailed eagles may hunt singly, in pairs or in larger groups. Working together, a group of eagles can attack and kill animals as large as adult kangaroos. Often, eagles may cache food items on a branch near the nest area.

White-bellied sea-eagle (*Haliaeetus leucogaster*)
https://www.birdsinbackyards.net/species/Haliaeetus-leucogaster
Body weight 2630 g; DEE 1340 kJ/d (calculated using DEE equation for non-passerine birds, EFSA 2009 p269)

White-bellied Sea-Eagles are a common sight in coastal and near coastal areas of Australia. In addition to Australia, the species is found in New Guinea, Indonesia, China, south-east Asia and India. White-bellied Sea-Eagles are normally seen perched high in a tree, or soaring over waterways and adjacent land. Birds form permanent pairs that inhabit territories throughout the year. The White-bellied Sea-Eagle feeds mainly off aquatic animals, such as fish, turtles and sea snakes, but it takes birds and mammals as well. It is a skilled hunter, and will attack prey up to the size of a swan. Sea-Eagles also feed on carrion, such as sheep and fish along the waterline. They harass smaller birds, forcing them to drop any food that they are carrying. Sea-Eagles feed alone, in pairs or in family groups.

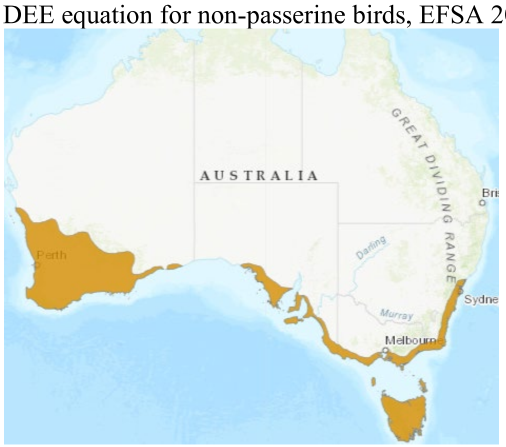
A3.4 Slug-eating birds

Australian magpie (*Cracticus tibicen*)
See description on bait-eating birds (A3.2)

Fan-tailed cuckoo (*Cacomantis flabelliformis*)
https://www.birdsinbackyards.net/species/Cacomantis-flabelliformis
Body weight 104 g; DEE 104 kJ/d (calculated using DEE equation for non-passerine birds, EFSA 2009 p269)

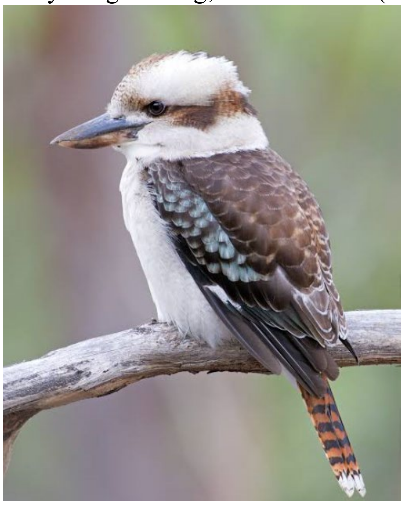
Fan-tailed cuckoos are found throughout eastern Australia, south-western Western Australia and Tasmania. Birds in Tasmania migrate to the mainland in the non-breeding season. Fan-tailed cuckoos also occur in New Caledonia, New Guinea, Fiji, New Zealand and several islands in between. The fan-tailed cuckoo enjoys hairy caterpillars in its diet, but will also take a variety of other insects and their larvae. Food is located from an exposed perch and is seized in flight or from the ground. The bird returns to its perch to eat the prey.

Hooded plover (*Thinornis cucullatus*)
https://www.birdsinbackyards.net/species/Thinornis-rubricollis
Body weight 95 g; DEE 145 kJ/d (calculated using DEE equation for non-passerine birds, EFSA 2009 p269)



The Hooded Plover occurs on sandy beaches between Jervis Bay, New South Wales and the Eyre Peninsula, South Australia, as well as in Tasmania and between Esperance and Perth in south-west Western Australia. They are not abundant. In eastern Australia, the Hooded Plover inhabits sandy ocean beaches that are exposed to the constant might of the swell. There they pick tiny invertebrates from the sand near the water’s edge, and they lay their eggs in shallow scrapes in the sand, either on the upper beach or in adjacent backing sand dunes. West of the Nullarbor Plain, Hooded Plovers are also often recorded on ocean beaches, but they are just as likely to be seen foraging at salt lakes, sometimes hundreds of kilometres from the coast. The Hooded Plover's diet includes insects, sandhoppers, small bivalves, and soldier crabs. It forages at all levels of the beach during all tide phases. It is most usually seen in pairs or small groups, darting about at the water's edge as waves recede, bobbing and pecking along the shore.

Laughing kookaburra (*Dacelo novaeguineae*)
https://www.birdsinbackyards.net/species/Dacelo-novaeguineae
Body weight 340 g; DEE 341 kJ/d (calculated using DEE equation for non-passerine birds, EFSA 2009 p269)



Laughing kookaburras are found throughout eastern Australia. They have been introduced to Tasmania, the extreme south-west of Western Australia, and New Zealand. Replaced by the blue-winged kookaburra in central northern and north-western Australia, with some overlap in Queensland, although this species is more coastal. The laughing kookaburra inhabits most areas where there are suitable trees. Laughing kookaburras feed mostly on insects, worms and crustaceans, although small snakes, mammals, frogs and birds may also be eaten. Prey is seized by pouncing from a suitable perch. Small prey is eaten whole, but larger prey is killed by bashing it against the ground or tree branch.

Little grassbird (*Megalurus gramineus*)
https://www.birdsinbackyards.net/species/Megalurus-gramineus
Body weight 12 g; DEE 58 kJ/d (calculated using DEE equation for passerine birds, EFSA 2009 p269)

The Little Grassbird is a small, unobtrusive dark brown-grey bird which is found across eastern Australia and Tasmania, inland to central Australia and in south-western Australia. It is also found in New Guinea. The Little Grassbird occurs in swamps and marshes, preferring thick reed beds, and will occur in temporary wetlands after rains and builds a deep cup nest of reeds and coarse grasses, lined with feathers, hidden in thick reedy vegetation. The Little Grassbird eats insects and other small arthropods, usually remaining in the dense cover of grasses and swamp vegetation.

Magpie-lark (*Grallina cyanoleuca*)
http://www.birdsinbackyards.net/species/Grallina-cyanoleuca
Body weight 92 g; DEE 229 kJ/d (calculated using DEE equation for passerine birds, EFSA 2009 p269)


Magpie-larks are confined to Australasia, being found throughout Australia (although only a rare vagrant to Tasmania), southern New Guinea and Timor. Magpie-larks are found in almost any habitat except rainforests and the driest deserts and are familiar urban birds. The magpie-lark is mostly ground-dwelling, and is usually seen slowly searching on the ground for a variety of insects and their larvae, as well as earthworms and freshwater invertebrates. In a non-toxic baiting trial on Lord Howe Island (Wilkinson 2007), the one magpie-lark captured between 2 and 11 days after baiting showed no signs of exposure to the fluorescent biomarker within the baits.

Masked lapwing (*Vanellus miles*)
https://www.birdsinbackyards.net/species/Vanellus-miles
Body weight 315 g; DEE 324 kJ/d (calculated using DEE equation non-passerine birds, EFSA 2009 p269)


The Masked Lapwing is common throughout northern, central and eastern Australia. Masked Lapwings are also found in Indonesia, New Guinea, New Caledonia and New Zealand. The New Zealand and New Caledonian populations have been formed from birds that have flown there from Australia. The Masked Lapwing inhabits marshes, mudflats, beaches and grasslands. It is often seen in urban areas. Where this bird is used to human presence, it may tolerate close proximity; otherwise, it is very wary of people, and seldom allows close approach. Masked Lapwings feed on insects and their larvae, and earthworms. Most food is obtained from just below the surface of the ground, but some may also be taken above the surface. Birds are normally seen feeding alone, in pairs or in small groups.

Red-capped plover (*Charadrius ruficapillus*)
https://www.birdsinbackyards.net/species/Charadrius-ruficapillus
Body weight 37 g; DEE 77 kJ/d (calculated using DEE equation for non-passerine birds, EFSA 2009 p269)

The red-capped plover is the most common and widespread of Australia's beach-nesting shorebirds. They occur along virtually the entire Australian coastline, but they also occur in great numbers inland, especially around salt lakes. The nest site of the red-capped plover is a shallow scrape on a beach or stony area, nearly always close to water. Sometimes the nest is protected by a small plant or some rubbish. The eggs are usually well camouflaged. They usually inhabit wide, bare sand-flats or mudflats at the margins of saline, brackish or freshwater wetlands where they forage by using their characteristic 'stop-run-peck' method, taking small invertebrates from the surface. The red-capped plover may be seen foraging for molluscs, small crustaceans and some vegetation, on mudflats, sandy beaches and salt-marsh.

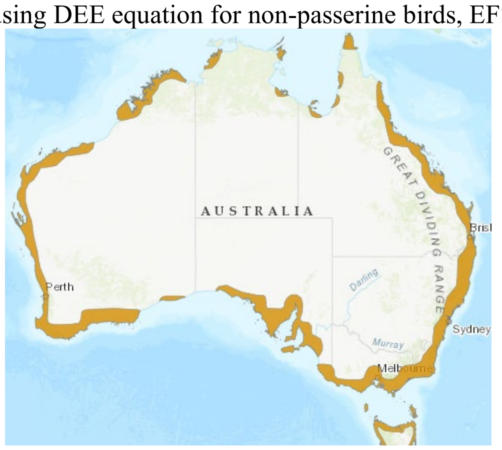
Red-necked stint (*Calidris ruficollis*)
https://www.birdsinbackyards.net/species/Calidris-ruficollis
Body weight 25 g; DEE 59 kJ/d (calculated using DEE equation for non-passerine birds, EFSA 2009 p269)

The red-necked Stint breeds in north-eastern Siberia and northern and western Alaska. It follows the the East Asian-Australasian Flyway to spend the southern summer months in Australia. It is found widely in Australia, except in the arid inland. In Australia, red-necked Stints are found on the coast, in sheltered inlets, bays, lagoons, estuaries, intertidal mudflats and protected sandy or coralline shores. They may also be seen in saltworks, sewage farms, saltmarsh, shallow wetlands including lakes, swamps, riverbanks, waterholes, bore drains, dams, soaks and pools in saltflats, flooded paddocks or damp grasslands. They are often in dense flocks, feeding or roosting. The red-necked Stint is a migratory wader, breeding in Siberia and west Alaska and then moving to non-breeding areas in South-East Asia and Australasia south of about 25° S. They arrive in Australia from late August to September and leave from early March to mid-April. Some first-year birds may remain in Australia. Red-necked Stints are omnivorous, taking seeds, insects, small vertebrates, plants in saltmarshes, molluscs, gastopods and crustaceans. They forage on intertidal and near-coastal wetlands. They usually feed for the entire period that mudflats are exposed, often feeding with other species. They forage with a rather hunched posture, picking constantly and rapidly at the muddy surface, then dashing to another spot.

Silvereye (*Zosterops lateralis*)
https://www.birdsinbackyards.net/species/Zosterops-lateralis
Body weight 11 g; DEE 54 kJ/d (calculated using DEE equation for passerine birds, EFSA 2009 p269)


Silvereyes are more common in the south-east of Australia, but their range extends from Cape York Peninsula, Queensland, through the south and south-west to about Shark Bay, Western Australia. They are also found in Tasmania. Silvereyes may occur in almost any wooded habitat, especially commercial orchards and urban parks and gardens. In the south of their range, Silvereyes move north each autumn, and move back south in late winter to breed. Silvereyes feed on insect prey and large amounts of fruit and nectar, making them occasional pests of commercial orchards. Birds are seen alone, in pairs or small flocks during the breeding season, but form large flocks in the winter months. In a non-toxic baiting trial on Lord Howe Island (Wilkinson 2007), all four silvereyes captured between 2 and 11 days after baiting showed no signs of exposure to the fluorescent biomarker within the baits.

Sooty oystercatcher (*Haematopus fuliginosus*)
https://www.birdsinbackyards.net/species/Haematopus-fuliginosus
Body weight 819 g; DEE 614 kJ/d (calculated using DEE equation for non-passerine birds, EFSA 2009 p269)

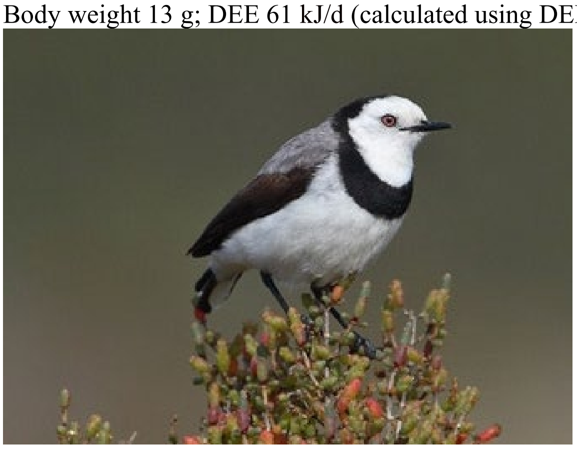
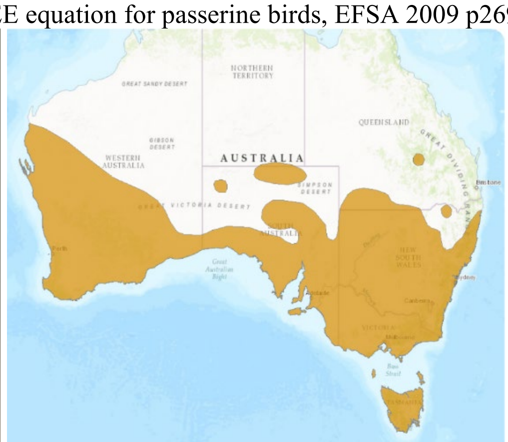



The sooty oystercatcher is endemic to Australia and is widespread in coastal eastern, southern and western Australia. The sooty oystercatcher is strictly coastal, usually within 50 m of the ocean. It prefers rocky shores, but will be seen on coral reefs or sandy beaches near mudflats. It breeds on offshore islands and isolated rocky headlands. The sooty oystercatcher feeds on molluscs, crabs and other crustaceans, marine worms, starfish and sea urchins, and small fish. It uses its long bill to stab at prey or to lever, prise or hammer open food items. It drinks seawater.

White-faced heron (*Egretta novaehollandiae*)
https://www.birdsinbackyards.net/species/Egretta-novaehollandiae
Body weight 525 g; DEE 456 kJ/d (calculated using DEE equation for non-passerine birds, EFSA 2009 p269)


White-faced Herons are the most commonly seen herons in Australia. They are found throughout the mainland and Tasmania, and most coastal islands. They also occur in Indonesia, New Guinea, New Caledonia and New Zealand. White-faced herons can be found anywhere where there is water, from tidal mudflats and coastal reefs to moist grasslands and gardens. The white-faced heron feeds on a wide variety of prey, including fish, insects and amphibians. Food is obtained in a variety of ways, such as walking and disturbing prey, searching among damp crevices or simply standing in the water and watching for movement.

White-fronted chat (*Epthianura albifrons*)
https://www.birdsinbackyards.net/species/Epthianura-albifrons
Body weight 13 g; DEE 61 kJ/d (calculated using DEE equation for passerine birds, EFSA 2009 p269)

The white-fronted chat occurs across southern Australia (including Tasmania) from Shark Bay in Western Australia around to the Queensland/New South Wales border. The white-fronted chat lives in salt marsh and other damp areas with low vegetation such as swampy farmland and roadside verges. It sometimes occurs on beaches and the edges of lakes. White-fronted Chats often forage in flocks of around 20 birds that congregate in areas where there are temporary outbreaks of insects. They run along the ground, picking up small insects, usually less than 5 mm long. Midges, kelp-flies, plant bugs and beetles are popular food items.

Willie wagtail (*Rhipidura leucophrys*)
https://www.birdsinbackyards.net/species/Rhipidura-leucophrys
Body weight 20 g; DEE 82 kJ/d (calculated using DEE equation for passerine birds, EFSA 2009 p269)

The willie wagtail is found throughout mainland Australia but is absent from Tasmania. It is also found in New Guinea, the Solomon Islands, the Bismarck Archipelago and the Moluccas. Willie wagtails are found in most open habitats, especially open forests and woodlands, tending to be absent from wet sclerophyll forests and rainforests. They are often associated with water-courses and wetlands and are common around human habitation. Willie wagtails are active feeders. Birds can be seen darting around lawns as they hunt for insects on the ground. As they do so, the tail is wagged from side to side. Insects are also captured in the air, in active chases.

Yellow-rumped thornbill (*Acanthiza chrysorrhoa*)
https://www.birdsinbackyards.net/species/Acanthiza-chrysorrhoa
Body weight 9.0 g; DEE 48 kJ/d (calculated using DEE equation for passerine birds, EFSA 2009 p269)

The yellow-rumped thornbill feeds mainly on insects, but may sometimes eat seeds. It is primarily a ground-feeding bird, more so than most other thornbills, but stays near tree cover and will sometimes feed in shrubs or trees. Often seen in mixed flocks with other thornbills and birds such as speckled warblers and weebills. The Yellow-rumped thornbill is found on the ground in open habitats, such as woodlands, forests, shrublands and grasslands with some trees. It is also common in agricultural lands, along watercourses, beside roads and in parks and gardens. It is found in most climatic zones, but only sparse in tropics, arid zone and east of the Great Dividing Range.

APPENDIX 4 Data relied on

Submitted

No unpublished environmental data relevant to brodifacoum have been submitted to support this application.

Data holdings

There are no unpublished environmental data relevant to brodifacoum in APVMA data holdings.

International assessments

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APPENDIX 5 Data not relied on

Submitted

ID no	Appl no	Ref. product	Author	Study date	Title	Rationale
A2784554	136442	92722	Brooke M de L, Bonnaud E, Dilley BJ, Flint EN, Holmes ND, Jones HP, Provost P, Rocamora G, Ryan PG, Surman C, Buxton RT	2018	Seabird population changes following mammal eradications on islands. Animal Conservation 21: 3-12	Rat eradication method(s) not reported. Not relevant to the environmental assessment.
A2784552	136442	92722	Buxton R, Taylor G, Jones C, O/B Lyver P, Moller H, Cree A, Towns D	2016	Spatio-temporal changes in density and distribution of burrow-nesting seabird colonies after rat eradication. New Zealand Journal of Ecology 40(1): 1-12	Rat eradication method(s) not reported. Not relevant to the environmental assessment.
A2784553	136442	92722	Croll DA, Newton KM, McKown M, Holmes N, Williams JC, Young HS, Buckelew S, Wolf CA, Howald G, Bock MF, Curl JA, Tershy BR	2015	Passive recovery of an island bird community after rodent eradication. Biol Invasions, DOI 10.1007/s10530-015-1042-9	The 5-year timeframe for recovery is not sufficient. Not relevant to the environmental assessment.
A2784565	136442	92722	Dennis TE, Fitzpatrick GJ, Brittain RA	2012	Phases and duration of the white-bellied sea-eagle *Haliaeetus leucogaster* breeding season in South Australia and the implications for habitat management. Corella 36(3): 63-68	Not relevant to the environmental assessment.
A2784564	136442	92722	Dennis TE	2007	Reproductive activity in the osprey (*Pandion haliatus*) on Kangaroo Island, South Australia. Emu 107: 300-307	Not relevant to the environmental assessment.
A2806105	136442	92722	Empson RA, Miskelly CM	1999	The risks, cost and benefits of using brodifacoum to eradicate rats from Kapiti Island, New Zealand. New Zealand Journal of Ecology 23(2): 241-251	Not relevant to the site-specific assessment
A2784549	136442	92722	Fisher P, Campbell K	2012	Non-target risk assessment for rodenticide application on Pinzon and Plaza Sur, Galapagos Islands. Landcare Research, New Zealand. www.landcareresearch.co.nz	Not relevant to the site-specific assessment
A2784556	136442	92722	Gollin JF, Gorman N, Armstrong DP	2021	Twenty years on: changes in lizard encounter rates following eradication of rats fro Kāpiti Island. New Zealand Journal of Ecology 45(1): 3423	Rat eradication method(s) not reported. Not relevant to the environmental assessment.

ID no	Appl no	Ref. product	Author	Study date	Title	Rationale
A2806111	136442	92722	Harper GA, Zabala J, Carrion V	2011	Monitoring of a subpopulation of Galapagos land iguanas (*Conolophus subcristatus*) during a rat eradication using brodifacoum. In: Veitch CR, Clout MN, Towns DR (eds.). Island invasives: eradication, pp.309-312. Gland, Switzerland	Not relevant to the site-specific assessment
A2784555	136442	92722	Herrera-Giraldo JL, Figuerola-Hernandez CE, Holmes ND, SwinnertonK, Bermudez-Carambot EN, Gonzales-Maya JF, Gomez-Hoyos DA	2019	Survival analysis of two endemic lizard species before, during and after a rat eradication attempt on Desecheo Island, Puerto Rico. In: Veitch CR, Clout MN, Martin AR, Russell JC, West CJ (eds.). Island invasives: scaling up to meet the challenge, pp.191-195. Occasional paper SSC no. 62. Gland, Switzerland	Not relevant to the site-specific assessment
A2784547	136442	92722	Howald G, Donlan CJ, Galvan JP, Russell JC, Parkes J, Samaniego A, Wang Y, Veitch D, Genovesi P, Pascal M, Saunders A, Tershy B	2007	Invasive rodent eradication on islands. Conservation Biology 21(5): 1258-1268	Not relevant to the site-specific assessment
A2806117	136442	92722	Laurence SE, Arnott TK, Lloyd BN, Morgan D	2008	Investigator Group Expedition 2006: History of the Investigator Group of Islands, South Australia. Transactions of the Royal Society of South Australia 132(2): 95-124, https://doi.org/10.1080/03721426.2008.10887097	Described settlement history not relevant to Deen Maar Island
A2784561	136442	92722	Robinson AC, Armstrong DM, Canty PD, Hopton D, Medlin GC, Shaughnessy PD	2008	Investigator Group Expedition 2006: Vertebrate Fauna. Transactions of the Royal Society of South Australia 132(2): 221-242	Vertebrate fauna survey not relevant to Deen Maar Island
A2806106	136442	92722	Rueda D, Campbell KJ, Fisher P, Cunninghame F, Ponder JB	2016	Biologically significant residual persistence of brodifacoum in reptiles following invasive rodent eradication, Galapagos Islands, Ecuador. Conservation Evidence 13: 38	Not relevant to the site-specific assessment
A2806112	136442	92722	Russell JC, Holmes ND	2015	Tropical island conservation: rat eradication for species recovery. Biological conservation 185: 1-7	Not relevant to the environmental assessment

ID no	Appl no	Ref. product	Author	Study date	Title	Rationale
A2806118	136442	92722	Samaniego-Herrera A, Aguirre-Muñoz A, Howald GR, Félix-Lizárraga M, Valdez-Villavicencio J, González-Gómez, Méndez-Sánchez F, Torres-García F, Rodríguez-Malagón, Tershy BR	2009	Eradication of black rats from Farallón de San Ignacio and San Pedro Martir Islands, Gulf of California, Mexico. Proceedings of the 7th California Islands Symposium. Institute for Wildlife Studies, Arcata, CA, pp 337-347	Not relevant to the site-specific assessment
A2784550	136442	92722	Sanchez-Barbudo IS, Camarero PR, Mateo R	2012	Primary and secondary poisoning by anticoagulant rodenticides of non-target animals in Spain. Science of the Total Environment 420: 280-288	Not relevant to the site-specific assessment
A2806108	136442	92722	Thorsen M, Shorten R, Lucking R, Lucking V	2000	Norway rats (Rattus norvegicus) on Fregate Island, Seychelles: the invasion; subsequent eradication attempts and implicates for the island's fauna. Biological Conservation 96: 133-138	Not relevant to the site-specific assessment
A2784558	136442	92722	Towns DR, Broome KG	2003	From small Maria to massive Campbell: forty years of rat eradication from New Zealand islands. New Zealand Journal of Zoology 30: 377-398	Not relevant to the environmental assessment
A2784551	136442	92722	Vyaz NB	2017	Rodenticide incidents of exposure and adverse effects on non-raptor birds. Science of the Total Environment 609: 68-76	Not relevant to the site-specific assessment
A2806119	136442	92722	Weston MA, Ehmke GC, Maguire GS	2009	Manage one beach or two? Movements and space-use of the threatened hooded plover (*Thinornis rubricollis*) in south-eastern Australia. Wildlife Research 36: 289-298	Not relevant to the environmental assessment.

Data holdings

There are no unpublished environmental data relevant to brodifacoum in APVMA data holdings.

APPENDIX 6 Confidential commercial information

No CCI was considered or relied on.