ANNEX 5: USE OF ANTICOAGULANT RODENTICIDES: Risk management, consents & best practice protocols

Contents

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The Campaign for Responsible Rodenticide Use (CRRU) purpose is to promote the responsible use of rodenticides among all user groups. This document has been presented by the authors for consideration by the CRRU UK Best Practice Work Group. The CRRU UK Work Group notes that the document expresses the views and opinions of the authors with respect to the potential environmental effects of anticoagulants. The opinion of the Work Group is that the document comprehensively presents best practice advice in the use of rodenticides for the removal of alien invasive rodents in island restoration projects.

1 Rodenticide use in Island Restoration

1.1 Overview

1.1.1 There are three stages in Island Restoration programmes in which the deployment of rodenticides will/may be necessary:

- The eradication itself (Stage 5 of the six major stages of rodent eradication projects, as detailed in the Overview document, Section 2);
- Reactive biosecurity measures (i.e. in response to a probable or confirmed (re)incursion - Stage 6); and
- Preventative biosecurity measures (Stage 6).

1.1.2 Eradication and incursion response (Stages 1 & 2) require widespread bait use in open areas, but only for a limited period of time. Preventative biosecurity measures (Stage 3) may require small amounts of rodenticide to be deployed indefinitely (e.g. in bait stations on boats which regularly visit rat-free islands), subject to appropriate local approvals and risk assessments.

1.1.3 There are two categories of anticoagulant rodenticides (the type of rodenticides that should be used for island restoration) – **first generation and second generation**. All anticoagulant rodenticide use carries risks to non-target vertebrate species, i.e. all species other than invasive mice and rats, but the risks from Second Generation Anticoagulant Rodenticides (SGARs) (e.g. those containing the active ingredients difenacoum, bromadiolone, flocoumafen, difethialone or brodifacoum) are generally considered to be higher than the risks from First Generation Anticoagulant Rodenticides (FGARs) (e.g. those containing the active ingredients warfarin or coumatetralyl), due to SGARs greater ability to accumulate in biological tissues.

1.1.4 For the eradication phase of an island restoration programme *and* for incursion response, use of a SGAR will be required. In order to reduce risks to the environment and non-target species, a FGAR *may be considered* for use as the primary bait during the eradication phase, with the SGAR used in more limited amounts towards the end of the operation. However, expert advice must be sought on how such a decision will impact the project delivery.

1.1.5 Any action which may increase the risk of an eradication failing should be avoided. If eradication is unlikely to be achieved within acceptable levels of environmental risk then it is not the appropriate course of action.

2 How anticoagulant rodenticides work

2.1.1 Anticoagulant rodenticides interfere with the Vitamin K (blood clotting) cycles in vertebrates, leading to death by haemorrhaging (usually internal but often external as well if there are wounds - many wild animals are injured in the course of their lives and wounds inflicted may be more likely to lead to death when anticoagulant s have been ingested). The active ingredients can kill a wide range of vertebrates by direct (primary) poisoning, including, in the unlikely event they ingest enough to harm them, humans. It is not just rodents that will be put at risk by the use of anticoagulant rodenticides.

2.1.2 **Vitamin K_1 is the antidote to anticoagulant rodenticides**. However, depending on the rodenticide used and the amount consumed, it may need to be administered over a long period of time (weeks to months). Appropriate levels of antidote and a licensed person/people capable of administrating it (for the full range of species which may be affected) **must** be available in a timely manner for the duration of the baiting programme and for at least 12 months after the baiting ceases, in order to allow for the persistence of some rodenticides in the environment (e.g. non-target species encountering stores of bait cached by rats in the early stages of the eradication).

2.1.3 Poisoning can occur as a direct result of eating bait (primary poisoning) or as a consequence of eating another animal which has itself consumed bait (secondary poisoning). Both types of poisoning are potentially fatal. Sub-lethal doses can also be consumed, with unknown effects to the individual or environment. The toxicity of anticoagulants is cumulative; chronic toxicity is greater than acute toxicity. Many species are tolerant of a relatively high single dose, but may be susceptible to that same dose administered over several days. Depending on the species and the dose ingested, many non-target animals will therefore recover from a single incident of accidental exposure unless the most potent SGARs (e.g. brodifacoum or flocoumafen) have been ingested.

2.1.4 One of the reasons anticoagulant rodenticides are successful against rodents is that they have a delayed onset of symptoms, meaning rodents are likely to have consumed a lethal dose before they feel unwell. This prevents them becoming wary of the poison and eating only a sub-lethal dose ('bait shyness'). Death usually occurs in rodents within a week to ten days of eating a lethal dose, but it may take longer. Before death occurs, intoxicated rodents may become more diurnal, slower-moving, and more prone to use open areas (Cox & Smith 1992, in Buckle & Smith 2015) making them easier to catch, and as such they can present a significant risk to anything predating upon them (e.g. raptors, pets). Their carcasses also pose a risk to scavengers.

2.1.5 Invertebrates have a different blood clotting system and thus are not thought to be susceptible to anticoagulant rodenticides. However, invertebrates that have consumed bait may cause secondary poisoning in animals which eat them, such as shrews, and potentially tertiary poisoning in species which, in turn, consume insectivores. Sub-lethal rodenticide residues have been found in sparrowhawks, presumably from passerines, as well as species such as barn owls and red kites which prey on rodents. The presence of rodenticide residues in passerines may result from invertebrate consumption or possibly from direct consumption of bait – the phenomenon demonstrates how widespread the impacts of rodenticide use can be. The impact of sub-lethal rodenticide residues in wildlife is unclear, but all island restoration programmes should, while not jeopardising the success of the project, strive to limit the amount of rodenticide reaching the environment. However, it must be borne in mind that the best way to limit the total amount of rodenticide available to other species is to ensure that the initial eradication attempt is successful, thus avoiding the need for ongoing control or a repeat of the entire eradication process.

2.1.6 SGARs are more potent and persistent in biological tissues than FGARs and were developed in response to the development of rodent resistance to warfarin. Although the risks to non-target species are lower with FGARs, no ground-based eradication programme in the UK should proceed based on a planned application of FGARs **alone**, as the risk of eradication failure is too high. There are three key reasons behind this:

1) The risk of failure is higher with FGARs as multiple feeds are needed, meaning that rats need to continue feeding at bait stations for longer than with SGARs. If individual rats find the bait less palatable, there is a higher risk of them not consuming a lethal dose.
2) It is important to provide a bait choice during eradication projects, to allow for fussy individuals.
3) Currently there isn't a FGAR wax block formulation available.

2.1.7 However, the outdoor use of SGARs should be considered a last resort for preventative biosecurity measures. Indeed, if such use is required, the viability of a project should be reconsidered.

3 Risks from using anticoagulant rodenticides

3.1 Overview of risks

3.1.1 Anticoagulant rodenticides differ in their toxicity and risks to non-target species, including humans. The risks to people and non-target species must be carefully managed throughout the project and comprehensive risk reduction and mitigation strategies must be deployed.

3.1.2 The risks to non-target species can be summarised by the equation **Risk = Hazard x Exposure**, where risk is a function of both chemical hazard and environmental exposure. So while the hazards of anticoagulants to a range of non-target species are very real, and vary between compounds, the likelihood of exposure to them must also be considered in order to properly assess the risks they pose. Using formulations of bait likely not to appeal to a wide range of species (e.g. wax blocks) and setting the bait out only inside secure bait stations will greatly reduce the risks of using anticoagulant rodenticides. While this mainly relates to reducing the risks of primary poisoning (i.e. species which take the bait directly), reducing the range of species accessing the bait will also lead to a reduction in secondary poisoning of the species which predate upon them.

3.1.3 **On populated islands, or those with livestock, both the antidote and a licensed administrator must be available and prepared to act at all times of day and night for the duration of risk.**

3.1.4 Material Safety Data Sheets (MSDS) provide information on the proper handling and disposal of a product and related health concerns and these should be available and referred to for all rodenticide products that are used. This information will help you to carry out your Control of Substances Hazardous to Health assessment as required by the Control of Substances Hazardous to Health Regulations 1999. Such an assessment will help ensure that the product you select, and its method of application, will result in least risk to yourself and anyone else who may come into contact with the rodenticide. Your assessment should be recorded in writing.

3.2 Risks to humans

3.2.1 Humans are susceptible to poisoning from anticoagulant rodenticides although in the UK (and elsewhere in the EU) poison bait must contain a bittering agent (denatonium benzoate, often known as Bitrex$^{(R)}$) that makes it unpalatable to eat. The amount of bait which constitutes a lethal dose depends on the potency of the poison and the weight of the individual.

3.2.2 Provide thorough information/safety training sessions for all residents and island users who may come in to contact with bait, with extra attention on children. Plan this as part of your mitigation strategy/ health and safety plan and regularly repeat training/ communicate safety information.

3.2.3 People deploying bait in an eradication operation are unlikely to be affected by it. However, precautions should always be taken such as providing training in rodenticide use, wearing personal protective equipment such as gloves, keeping bait separate from food preparation or eating areas, and washing hands before eating/drinking/smoking. Appropriate face masks should also be worn if dust is anticipated, e.g. during the movement of large quantities of bait at the beginning or end of the operation or when working in enclosed environments, though this is a much lower risk when handling the wax block baits typically used in UK ground-based eradications than the cereal pellets used elsewhere in the world for aerial eradication projects.

3.3 Risks to pets

3.3.1 Pets are at significant risk from rodenticide poisoning, particularly uncaged animals such as cats and dogs. Cats are prone to secondary poisoning by eating dead or dying rodents. Dogs may consume poisoned animals too, but they have also been known to be attracted to bait itself. Significant liaison with pet-owning residents on the island will be required: the project should consider meeting the costs of homing pets off the island in kennels/ catteries, where appropriate. There would also be risks to dogs brought on (day) trips to the island. The use of muzzles may reduce the risks of both primary and secondary poisoning in dogs.

3.3.2 Although the majority of poisoned rodents will die underground or in areas of cover, regular (i.e. daily/near-daily) searches for carcasses or moribund rodents can help reduce the risk to pets and other non-target species (e.g. raptors). Such checks should be undertaken wherever practical and should not be limited to the transects on which bait stations are positioned.

3.4 Risks to livestock

3.4.1 The use of bait stations significantly decreases the amount of bait which enters the environment and which is available for consumption by livestock (compared to aerial or hand broadcast techniques commonly used outside of the UK). It is not usually necessary to remove livestock from the island during a bait station eradication operation, although it may be preferable and should be considered, especially if the animals are due to enter the human food chain in the near future.

3.4.2 Stock interference with bait stations should be anticipated and discussions with stock owners should be held prior to the operation so that, if necessary, animals can be moved to other areas (or removed from the island entirely) to ensure full deployment of bait whilst limiting exposure to livestock. Outside of the UK it is not uncommon for stock to be slaughtered prior to a baiting operation and then replaced, on project expenses, once baiting is completed. This may be an option if the risks are deemed high and no other effective mitigation measures are possible.

3.5 Risks to wildlife

3.5.1 Although some vertebrates, such as birds, are considered less susceptible to certain rodenticides (particularly FGARs), death can – and does – occur. Raptors are likely to be at particularly high risk of death following consumption of poisoned rodents (secondary poisoning).

3.5.2 If there are (non-target) native rodents or small mammals on the island, they are likely to be at high risk of primary poisoning since there are currently no bait station designs capable of excluding small mammals which could be used over a sufficiently large scale for an island-wide rat eradication project. It may be possible to adjust the size of the bait station grid in order to ensure non-target small mammal *populations* survive the eradication operation. If that is not possible, or if added insurance is required, captive populations of these small mammals can be established. Avoiding deaths of individuals of these species may not be possible, but must be considered during the feasibility study (e.g. is the project still socially-/ legally-/ environmentally-acceptable in the wake of individual mortality of non-target native small mammals?).

3.5.3 To assess primary poisoning risk, you should use non-toxic bait trials to learn more about whether non-target species are likely to eat the bait. In each of the habitats on the island, place out a non-toxic version of the specific product(s) you wish to use during eradication, incursion response and biosecurity prevention measures, in the type of bait stations which will be used during the proposed eradication. Leave camera traps positioned on the bait, record what eats it/ shows interest/ interferes with it. If any known, potentially at-risk, species do not encounter the bait, you should more proactively seek them out in order to observe their interaction with it.

3.5.4 To assess secondary poisoning risks you will need to determine which species prey upon any species (target and non-target) that eat the bait and the known or likely effects of the poison on these predators. Many anticoagulants persist for a long time in the bodies of animals which have consumed them.

3.5.5 The 'LD_{50}' (LD=lethal dose) describes the amount of toxin required to result in the death of 50% of individuals exposed to it, see Table A5.1. The lower the LD50, the more toxic the poison to the species tested. Although useful, LD_{50} does not describe possible effects of exposure to sub-lethal doses of the toxin and for many species no LD_{50} data are available.

Table A5.1 - LD_{50} (lethal dose) details of rodenticides coumatetralyl, difenacoum, bromadiolone, brodifacoum on different species; with references stated below. Note that for some species/ rodenticide combinations LD_{50} values are not available. Where figures are available they can be highly variable and are often based on small sample sizes. All figures given are acute values unless stated otherwise.

Rodenticide / Species	Coumatetralyl (FGAR) LD_{50} estimate (mg/kg)	Difenacoum (SGAR) LD_{50} estimate (mg/kg)	Bromadiolone (SGAR) LD_{50} estimate (mg/kg)	Brodifacoum (SGAR) LD_{50} estimate (mg/kg)
Brown rat	16.5[1] (Chronic: 0.3 mg/kg given daily for 5 days[1])	1.8 (males) 2.5 (females)[2]	0.57 (males) 0.75 (females)[2]	0.22 (males) 0.26 (females)[2]
Black rat	9-35[7]	7.0 (males) 2.5 (females)[8]	2.2 (males, 95% CI 1.1-4.4) 1.75 (females, 95% CI 0.76-4.02)[9]	0.65 (males) 0.73 (females)[2]
House mouse	2000 – 4000[1] (Chronic:3.5 mg/kg given daily for 5 days[1])	0.8[2]	0.86 (males) 1.10 (females)[2]	0.4[2]
Dog	35[4]	50[2]	10 (females)[3]	0.25 – 3.56[3]
Cat	50[10]	100[2]	> 25[3]	c.25[3]
Rabbit	> 500[11]	2 (males)[3]	1[3]	0.29 (males)[3]
Pig	1-2[6]	80 - 100[3]	3[3]	0.5 - 2.0[3]
Sheep/Goat	NA	100[3]	NA	11 - 33[3]
Chicken	50[6]	50[2]	5[5]	10-20[5]
Raptor sp.	NA	NA	NA	Australasian Harrier 10[6]

[1] Pospischil & Schnorback (1994) in Buckle & Smith (2015)

[2] Buckle & Smith (2015), no additional reference given

[3] Interational Programme on Chemical Safety, Environmental Health Criteria 175: Anticoagulant Rodenticides (1995) http://www.inchem.org/documents/ehc/ehc/ehc175.htm

[4] Directive 98/8/EC concerning the placing biocidal products on the market Inclusion of active substances in Annex I or IA to Directive 98/8/EC Assessment Report: Coumatetralyl (2009) https://circabc.europa.eu/sd/a/279235ef-d16a-4183-aa39-f4b4f6e2a434/Final%20assessment%20report%2011-03-09%20clean.pdf

[5] Gupta, R.C. (Ed.) (2012) Veterinary Toxicology: Basic and Clinical Principles, Academic Press, London, Waltham & San Diego

[6] Eason & Wickstrom (2001) Vertebrate Pesticide Toxicology Manual (poisons). *Department of Conservation Technical Series 23*. Wellington, New Zealand.

[7] Mukthabai K, Khrishnakumari MK 1976. Responses of Rattus species to anticoagulant poisoning. Comp Physiol Ecol 1: 129-135.

[8] Bull JO 1976. Laboratory and field investigations with difenacoum, a promising new rodenticide, Proceedings of the Seventh Vertebrate Pest Conference, California. University of California, Davis. Pp. 72.

[9] Sridhara, S. and Krishnamurthy, T. R. 1992. Potentiation of anticoagulant toxicity to Rattus rattus by two non-steroid anti-inflammatory drugs. Borrecco, J. E. and Marsh, R. E. Proceedings of the 15th Vertebrate Pest Conference, 212-217. University of California, Davis

[10] Berny P 2011. Challenges of anticoagulant rodenticides: resistance and ecotoxicology In: Stoytcheva M ed. Pesticides in the modern world - pests control and pesticides exposure and toxicity assessment, InTech. Pp. 441-468.

[11] Danish Environmental Protection Agency 2011. Proposal for Harmonised Classification and Labelling Based on Regulation (EC) No 1272/2008 (CLP Regulation), Annex VI, Part 2. Substance Name: Coumatetralyl. 63 p.

3.6 Rodenticides in the environment

3.6.1 Even when bait is deployed in stations it is likely that some will be cached by rats in their burrows and may, therefore, pose a risk of contamination even after all other, more accessible bait is removed from the environment at the end of the poisoning operation. As eradication requires all rodents to have access to bait (i.e. including lactating females which may not leave the burrow and sub-dominant animals who are unlikely to remain in the station feeding), it is important rodents are able to remove bait from stations. However, the potential risks to the environment must be properly considered.

3.6.2 You should obtain rodenticide-specific information about lethal doses for the non-target species present on your island where this information is available. Some details are contained in data safety sheets, specific to a rodenticide product. Some effects on non-target species have not been substantially tested. An unknown risk is not the same as no risk.

3.6.3 Soil type, moisture/ temperature and the presence of soil micro-organisms capable of degrading rodenticides all affect rodenticide mobility and degradation in soil. Some bait formulations are designed to break down following absorption of soil moisture or after rain, which causes swelling, cracking and crumbling. Such breakdown is less likely/ rapid in wax-based products.

Table A5.2 - Assessment of anticoagulant rodenticides available* in the UK. ***as of 01/09/2016**

Toxin	Pros	Cons
Coumatetralyl *First generation* *NOT RECOMMENDED WITHOUT BACKUP SGAR*	• Low potency • Less persistent than second generation anticoagulants • Reduced risk of non-target poisoning (both primary and secondary) • Cheaper than second generation anticoagulants • Antidote available • Binds to soil and breaks down slowly • Highly palatable therefore used at higher concentrations which can offset lower toxicity	• Low potency • Multiple feeds required • Repeated applications required • Longer access to bait required • Less persistent (metabolised relatively quickly) • Non-target species have longer to access bait • **Few successful island-wide eradications - none when used as sole bait** **NOT RECOMMENDED AS ONLY TOXIN: backup second generation toxin needed**
Difenacoum *Second generation*	• Moderately potent • Effective on rats • Antidote available (but long-term treatment required) • Insoluble in water • Binds strongly to soil and breaks down slowly • Previously successfully used in UK eradications	• Persistence issues (> 9 months in some species) • Multiple feeds required • High secondary poisoning risks • Limited data on non-target impacts • Slightly less potent than bromadiolone • Less potent than brodifacoum and flocoumafen • Less palatable than bromadiolone or coumatetralyl
Bromadiolone *Second generation*	• Moderately potent • Particularly effective on brown rats • Antidote available • Not readily soluble in water • Binds strongly to soil and breaks down slowly • Previously successfully used in UK eradications • Regarded as the most palatable (readily accepted) rodenticide, but consider history of rodenticide use at the site to determine potential for resistance.	• Persistence issues following sub-lethal exposure (> 9 months in some species) • Slightly less potent than brodifacoum and flocoumafen • Multiple feeds required • High secondary poisoning risks • Limited data on non-target impacts • Resistance may be more widespread than for other SGARs possibly due to more widespread use
Difethialone Second generation *NOT CURRENTLY REGISTERED FOR USE IN OPEN AREAS*	• Moderately potent • Similar high potency against brown rats as bromadiolone • Antidote available • Low solubility in water • Binds to soil (slowly degraded)	• **Not widely used in eradications** • Multiple feeds required • Currently only registered for use in the UK indoors, in and around buildings and in sewers, not in open areas • Less potent than brodifacoum and flocoumafen • Secondary poisoning risks • Limited data on non-target impacts

Brodifacoum *Second generation* *UNLIKELY TO GAIN CONSENT FOR ISLAND-WIDE USE IN UK*	• Very potent • Only a single feed required • Very effective on rodents • Insoluble in water • Binds to soil (slowly degraded) • Widely and successfully used in eradications worldwide • Efficacy data widely available • Non-target impact data widely available • Range of bait formulations available • Antidote available	• Persistence issues following sub-lethal exposure (> 9 months in some species) • High secondary poisoning risks • Non-target impacts recorded • Relatively expensive • Long-term treatment required for antidote • Not likely to be permitted for widespread use in open areas
Flocoumafen *Second generation* *UNLIKELY TO GAIN CONSENT FOR ISLAND-WIDE USE IN UK*	• Very potent • Only a single feed required • Effective on rodents • Antidote available • Not readily soluble in water • Binds strongly to soil and breaks down slowly	• **Not widely used in eradications: if considered for use ensure a back up active ingredient is available with a proven track record in eradication projects.** • Persistence issues following sub-lethal exposure (> 9 months in some species, and can be longer than with brodifacoum) • High secondary poisoning risks • Limited data on non-target impacts • Expensive • Long-term treatment required for antidote • Not likely to be permitted for widespread use in open areas

3.7 Resistance

3.7.1 The permanent use of rodenticides is undesirable, particularly from a conservation perspective. Biosecurity requirements must be considered thoroughly at the planning stages of a project including the feasibility study. If the only way to maintain an island as rodent-free is via the permanent placement of rodenticides in outdoor situations (i.e. in situations away from buildings or transport vessels), the viability of the restoration project should be seriously questioned.

3.7.2 Continual use of rodenticides contributes to the development of rodenticide resistance, which in turn leads to the requirement for more potent toxins to be used. Resistance to some of the more potent rodenticides is well documented in parts of the UK, though is likely to be far less common on small islands than the mainland. Rodents have a rapid generation time and can respond quickly to selection pressures such as resistance to rodenticides.

3.7.3 The history of rodenticide use on the project island(s) should be ascertained and taken in to consideration during feasibility and operational planning. For example, if rodents have been controlled for many years using one type of rodenticide, it may be advisable to use a different active ingredient in an eradication attempt. Genetic tests for some types of resistance are available (see Annex 2, Rodent trapping and DNA sampling) and these should be undertaken to help determine which rodenticides to use.

4 Rodenticides, stewardship and the law

4.1.1 The EU Biocides Regulation (528/2012) is the regulatory system governing authorisation and use of biocidal products across the EU. It requires the review of all 'existing' active substances used in biocidal products, including SGARs. The result of the EU reviews on SGARs is that all fail contemporary risk assessments, primarily due to concerns for primary and secondary poisoning of non-target animals. Therefore the use of SGARs is controlled. For further information see: http://echa.europa.eu/regulations/biocidal-products-regulation/legislation

4.1.2 Therefore, in the UK, the Health and Safety Executive (HSE), with the Industry sector, introduced stewardship for the professional **outdoor** use of products containing anticoagulant rodenticides. Currently the only rodenticide stewardship scheme is that run by the Campaign for Responsible Rodenticide Use (CRRU) (www.thinkwildlife.org). This scheme aims to ensure that rodenticides are used responsibly and effectively and acts as an accreditation process for pest controllers, and other professionals (e.g. gamekeepers, farmers and conservation users) in the UK.

4.1.3 Project managers should also be familiar with the requirements of CRRU's Stewardship Scheme which, although designed for mainland commercial pest control purposes, will apply equally to rodenticide use for island restoration purposes. Their Code of Best Practice (see http://www.thinkwildlife.org/downloads_resources/) should be consulted, particularly with regard to ongoing requirements for rodenticide use in biosecurity. However, as the guidance is designed to apply to rodent *control*, rather than eradication, not all of it is appropriate for the eradication and incursion response aspects of island restoration. The Recommended Procedures toolkit (both this annex and all other sections of this toolkit) should be referred to as the overriding best practice guidance documents for rodent eradications.

4.1.4 Professional users, including conservationists, seeking to purchase anticoagulant rodenticides for outdoors are now required to prove they are trained in their use and so understand the risks associated with use and how to minimise them. A list of approved training courses can be found on the CRRU website (http://www.thinkwildlife.org/list-of-training-and-certification/). A bespoke training course incorporating information on rodenticide use in conservation is currently in development. From October 2016 it will be necessary to show evidence of having received appropriate training in order to purchase anticoagulant rodenticide baits for outdoor use and everyone handling bait as part of eradication projects must undergo this training.

4.1.5 **Rodenticide use must always be undertaken in accordance with the specifications on the product label**. Professional products containing any of the anticoagulant rodenticides can possibly be authorised for professional use under stewardship, in and around buildings, in sewers and in open areas (this last being the category of use needed for products used in island restoration projects). However, the areas of use that are allowed for each specific product should be clearly stated on the product label, and must be adhered to.

4.1.6 A full list of products currently authorised for use in the UK is available on the HSE website at: http://webcommunities.hse.gov.uk/connect.ti/pesticides/viewdatastore?dsid=10116

4.1.7 At present, difenacoum and bromadiolone are the only SGARs available in wax block products (the formulation most likely to be used in restoration projects) currently registered for use in open areas.

4.1.8 For further information on legal and regulatory aspects of rodenticide use in the UK contact the HSE: biocidesenquiries@hse.gov.uk or the authors of this report (Sophie.Thomas@rspb.org.uk or Karen.Varnham@rspb.org.uk)

5 Best Practice Protocols for rodenticide use in Island Restoration

5.1 Overview

5.1.1 In order to reduce the risks posed by using anticoagulant rodenticides in island restoration operations, strict adherence to the Current Recommended Procedures for UK (Bait Station) Rodent Eradication Projects (including Annexes 1-6) is required.

5.1.2 Use of rodenticides is closely monitored by the Health and Safety Executive (HSE) and the Chemicals Regulation Directorate (CRD). Misuse or abuse of rodenticides, failure to adhere to these guidelines, or unauthorised deviation from peer-reviewed Operational Plans, will compromise future island restoration projects in the UK and may prevent ongoing work on UK islands already cleared of invasive rodents.

5.1.3 The Required Actions (section 5.5 below), and the rest of this annex, are pending approval by CRRU. Adherence to these actions will:

1) Minimise the risks associated with the use of anticoagulant rodenticides;

2) Obtain permission to use other SGARs if an extension of use or derogation is required; and

3) Ensure permissions for future projects are not compromised.

5.1.4 If projects are unable to meet these standards, advice should be sought from the authors of this toolkit (Sophie.Thomas@rspb.org.uk and Karen.Varnham@rspb.org.uk) and, if appropriate, CRRU as to whether or not the planned rodenticide use can go ahead.

5.1.5 The required actions are listed in Sections 5.2 to 5.4.

5.2 Planning the eradication and biosecurity operations

5.2.1 Key documentation that forms part of the eradication project, including the Feasibility Study, Project Plan, Operational Plan, Monitoring and Evaluation Plan, Biosecurity Plan and Operational Review will be independently peer-reviewed by an island restoration expert/expert group. They will be provided to the HSE, Stewardship Steering Group or the government Oversight Group if requested for monitoring, review and evaluation purposes.

5.2.2 The seriousness of the impacts of the target species on species of conservation value will be demonstrated, via methods such as stomach content analysis, use of camera traps and analysis of population trends of species thought to be affected by the target species or demonstrating impacts on similar species elsewhere.

5.2.3 Non-lethal measures will have been assessed and found not practicable for eradication before lethal measures are considered.

5.2.4 Lethal measures will be shown to be an effective way of addressing the problem.

5.2.5 An assessment of the rodent population will be made which covers the size and distribution of the population and confirms the target species, so that baiting requirements (quantity of bait required, duration of baiting, location of bait points) can be determined and risks of unintended primary and secondary poisoning can be reduced.

5.2.6 Rodenticide resistance testing will be undertaken to determine the least toxic active ingredients that can be used without compromising eradication success. However, bear in mind that resistance testing will only be carried out on a small number of individuals, meaning that it is possible that some genes conferring resistance may be missed. The possibility of resistance is one of the reasons why it is necessary to continue monitoring for rat activity using other, non-toxic monitoring tools towards the end of the main poisoning phase and why it is important to have a back-up bait.

5.2.7 An island- and toxin-specific assessment of risks to people will be undertaken.

5.2.8 An island- and toxin-specific risk assessment for non-target species will be undertaken.

5.3 Implementing the eradication operation

5.3.1 Appropriate levels of antidote and a licensed administrator will be available to the project in a timely fashion, to deal with potential poisoning events in humans, livestock, pets or other non-target species.

5.3.2 The Operational Plan will incorporate the findings of the risk assessments undertaken under Section 5.2.7 and 5.2.8 above.

5.3.3 A Health & Safety plan covering risks to humans associated with SGAR use will be produced and followed. Risks to people will be minimised, e.g. via discussion with every household and school about rodenticide risks, not tampering with equipment, and who to contact in an emergency.

5.3.4 Risks to non-target species will be mitigated before, during and after the eradication operation – e.g. by adapting bait station design to reduce risk of access to bait by non-target species, using diversionary feeding for raptors, and appropriately timing the operation.

5.3.5 Projects will be overseen by specialist eradication experts who will supervise the use of rodenticides during the eradication phase. Experts will hold relevant certification to demonstrate their competence in rodenticide use. A list of approved courses can be found here: http://www.thinkwildlife.org/list-of-training-and-certification/.

5.3.6 All staff/volunteers taken on to work on island restoration projects will undertake appropriate training (Section 5.3.5) and are expected to have passed the subsequent examination in order to demonstrate they understand how to use anticoagulant rodenticides appropriately and in a risk-averse manner.

5.3.7 Adequate signage detailing the poison use (type, when and where) will be in place both during and for 12 months after the administration of rodenticides, or for as long as required for the specific product that has been used.

5.3.8 Harbourage and accessible food sources will be reduced prior to the eradication attempt and there will need to be a commitment to keep harbourage and accessible food sources low following eradication in case of incursion. Although this may cause disturbance and wider movement of rats this is not a problem in an eradication scenario where bait will be placed across the entire island.

5.3.9 Sites of bait placement will be recorded by GPS and mapped, with stations numbered individually and labelled with a poison warning.

5.3.10 Amounts of bait placed in and taken from each site at each check will be recorded and allocated to a specific species as far as possible – allowing amounts of take by non-target species to be calculated and adaptive management to be deployed in order to try to reduce any interference by non-target species. We recommend counting the number of blocks added and estimating the amount taken (with practice this becomes a rapid and reasonably accurate process).

5.3.11 The aim should be to staff projects sufficiently such that checking stations at least every third day is the norm for all readily-accessible bait stations (i.e. those not on offshore stacks or requiring rope access) for at least the first 6-8 weeks of baiting. Individual Island circumstances make it difficult to prescribe the exact frequency of checks that will be achievable in all projects. However, an eradication operation generally requires more frequent checking of stations than that prescribed in best practice for rodent control. The highest possible frequency of station checks that is practical (i.e. does not compromise other aspects of the project such as staff safety) will be determined before project commencement, and risks assessed and mitigated accordingly.

5.3.12 Searches for poisoned carcasses will take place with at least the same regularity as checking bait stations.

5.3.13 Monitoring of key species/species groups before and after eradication will be undertaken to determine any population level effects which may be contributable to SGAR use.

5.3.14 Any potential contribution of rodenticides to any non-target species mortalities will be determined (e.g. via necropsy) and corpses will be submitted to the Chemicals Regulation Directorate (CRD) if required.

5.3.15 Independent site visits during baiting operations will be facilitated for compliance monitoring purposes.

5.4 Planning and implementing the biosecurity arrangements

5.4.1 A risk assessment for all biosecurity measures will be undertaken to consider and plan mitigation of risks to humans, non-target species and risk of toxins entering the wider environment

5.4.2 Use of rodenticides for on-going preventative biosecurity measures will be limited to places where it is unavoidable because the risk of reinvasion if these techniques are not deployed is deemed by eradication experts to be too high. Wherever possible, other measures will be undertaken to reduce the amount of rodenticide that is required.

5.4.3 Permanent laying of SGARs in open areas (away from buildings or transport vessels) should not happen unless approved by CRRU. You should determine if permanent baiting in open areas is likely to be required at the outset of the project and write a proper risk-benefit analysis to justify this, which should be approved by CRRU. Potential impacts on terrestrial small mammals (e.g. mice and voles) capable of entering stations and feeding on baits, and on their predators, may be severe and should be factored into any risk assessment.

5.4.4 Lockable bait stations/lockable rodent motels will be used and secured in place for any rodenticide use required for preventative biosecurity measures.

5.4.5 There will be regular checking and documentation of biosecurity measures to search for any non-target activity or tampering with stations. The standard is for checks to be made at least on a monthly basis, or as frequently as access/ logistics/ resources allow if this is not achievable. If rodenticides are used as part of these measures, they should be checked more frequently, preferably at least fortnightly.

5.4.6 A regular, preferably annual, review of biosecurity measures will be undertaken to ensure they remain necessary, appropriate, and adequate, with adaptation as required (e.g. ensure they are up to date with evolving best practice protocols).

5.4.7 If rodents are found to have returned to a cleared island and an incursion response is required, SGAR use will be carried out to the same standards as outlined above in the eradication operation but due to the need to respond immediately to confirmation of an incursion, the incursion response may not have the direct, on site supervision of an eradication expert. Experts will, however, be consulted during the operation and all persons handling bait will have appropriate training in rodenticide use. Section 5.3.9 – Locations will be marked on a high-resolution map if a GPS device is not available (GPS is strongly advised, however). Section 5.3.11– Checks in week one of the response will ideally be daily, but may be reduced to twice/week in subsequent weeks depending on accessibility. Section 5.3.13 – due to the need to respond immediately, bespoke baseline monitoring of species will not be possible. If baseline information is available, post-operation monitoring should also be conducted.

6 References and sources of additional information

Airey, A.T. & O'Connor, C.E. 2003. *Consumption and efficacy of rodent baits to Norway rats.* DOC Science Internal Series 148, Department of Conservation, Wellington, New Zealand.

Buckle, A.P & Smith, R.H. (Eds.) 2015. *Rodent Pests and their Control* (2nd Edition), CABI Wallingford & iBoston

Campaign for Responsible Rodenticide Use (CRRU) Code of Best Practice available from:

http://www.thinkwildlife.org/downloads_resources/

DEFRA, 2002. *The control of rats with rodenticides: A complete guide to best practice*. Available at http://webarchive.nationalarchives.gov.uk/20140605090108/http://www.naturalengland.org.uk/Images/ratcontrolguidelines_tcm6-11216.pdf (accessed December 2014). *[**N.B. This is a guide for the CONTROL of rodents.** It contains a lot of information about rodenticides and their use for control purposes, but do not use the methods described during an eradication attempt.]*

Health and Safety Executive [online] http://www.hse.gov.uk/biocides/eu-bpr/rodenticides.htm

Morriss, G.A., O'Connor, C.E., Airey, A.T. & Fisher, P. 2008. *Factors influencing palatability and efficacy of toxic baits in ship rats, Norway rats and house mice.* Science for Conservation 282, Department of Conservation, Wellington, New Zealand.

O'Connor C E. &. Booth, L.H 2001 *Palatability of rodent baits to wild house mice*. Science for Conservation 184, Department of Conservation Wellington, New Zealand.

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Parkes, J., Fisher, P., & Forrester, G. 2011. Diagnosing the cause of failure to eradicate introduced rodents on islands: brodifacoum versus diphacinone and method of bait delivery. *Conservation Evidence* 8, 100-106.

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