ISLAND BIOSECURITY MANUAL

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Contents

Note

This document forms part of the deliverables for action C3 of the Shiants LIFE13 NAT/UK/000209 project and is made up of annexes 2-4 of Thomas, S. & Varnham, K. (2016). *Current Recommended Procedures for UK (bait station) rodent eradication projects. (Version 3.0)* Royal Society for the Protection of Birds, Sandy, Bedfordshire. The full toolkit, consisting of an overview, six annexes and a selection of worked examples, is intended as a guide to planning and carrying out ground-based rat eradication projects on UK islands. Much of this material is also relevant to biosecurity, however, and these annexes have been collected together to create a useful guide to help those working on or managing islands to detect the early warning signs of the presence of rats and other invasive species and prevent them becoming established. Rapid detection and action against newly arriving invasive species is one of the most effective conservation measures we have for seabird islands. These guidelines are equally applicable to islands where rats have been removed and those where they are naturally not present.

CHAPTER 1: BIOSECURITY PLANNING AND INCURSION RESPONSE

Contents

1.1 Introduction

1.1.1 Biosecurity procedures are implemented so as to reduce the risks of invasive species spreading to new areas or reinvading areas from which they have been cleared. This means preventing the export of species *from* islands as well as preventing their arrival on islands.

1.1.2 *(Re)incursion* is when an invasive animal arrives on an island that was previously free of that species. If an incursion/reincursion is not handled effectively, it can soon become a *(re)invasion*, whereby a breeding population of the invasive animal is established. Response to a reinvasion will require a(nother) full-blown eradication operation to be developed and implemented. It is far preferable, therefore, for conservation, financial and social reasons, to prevent reincursions from becoming reinvasions, and ultimately, to prevent reincursion in the first place. This is the purpose of biosecurity.

1.1.3 Biosecurity is relevant to all stages of an island restoration programme, even before eradication has taken place - you do not wish to transport *any* species between sites.

1.1.4 Biosecurity is also important for sites where no invasive species have been recorded. It should not be assumed that failure of an invasive species to arrive and establish in the past in any way indicates that an island is safe from future invasion. The rate of rodent invasion on islands has hardly slowed in the past century. It may be luck, as much as anything else, which has kept some islands 'invasive-free' so far.

1.1.5 Biosecurity planning involves the identification of risk species and 'pathways' (routes to the island) and multiple barriers that can be placed along those pathways to obstruct the movement of invasive species.

1.1.6 There are then three areas of biosecurity implementation – quarantine (prevention), surveillance, and incursion response:

- **Quarantine or prevention measures** are devised, installed and continuously applied to in order to reduce the chance of invasive species moving from one area to another;
- **Surveillance procedures** are put in place to search for any sign that an invasive species has slipped through the preventative measures, and to raise the alarm quickly if quarantine has been breached;
- **Incursion response plans** are required so that people are ready and able to respond quickly and efficiently to any incursion (breach of quarantine) by an invasive non-native species.

1.1.7 Quarantine measures aim to prevent (re)incursion events, surveillance and incursion response aim to identify and respond quickly enough to incursion events to prevent (re)invasion.

1.1.8 In order to prevent incursions becoming invasions, the biosecurity implementation team must be ready to respond immediately – preferably, a team will be on the island implementing the incursion response plan within 48 hours of detecting an incursion. Such response requires a high level of planning and preparedness, just like for initial eradication programmes: who will go, which boat/helicopter will be used, where does it leave from, where will all the necessary gear (including rodenticide) be stored? etc.

1.1.9 Detailed planning and preparation are integral to biosecurity. Someone with no knowledge of the island should be able to pick up a biosecurity plan and implement it, if necessary.

1.1.10 Detailed biosecurity planning benefits from an in-depth knowledge of the island and the ways in which is it used. The quality of a plan is likely to develop during the course of a restoration programme. As such, it is recommended that an initial, brief biosecurity plan and biosecurity

checklist (for use before embarking on trips to/from the island) are in place from the outset of the project and that a more comprehensive plan is developed towards the end of the eradication operation. This comprehensive plan should be in place before the eradication team leave the islands.

1.1.11 A Biosecurity Plan should be considered a living document and should be reviewed regularly. If there are any significant changes in island use/incursion risk or external factors such as regulations surrounding permitted rodenticide use then it should be reviewed immediately. Similarly, if there is an incursion event, plans should be reviewed as soon as the incursion has been dealt with.

1.1.12 These guidelines specifically cover biosecurity planning and incursion response for invasive non-native *rodents*, but you should consider including in your plan measures to mitigate risks from all unwanted species, e.g. pathogens, invertebrates, plants and vertebrates. These guidelines are written as part of the *Current Recommended Procedures for UK (bait station) rodent eradication projects*, but can be applied to all islands requiring a biosecurity plan, even when no eradication has taken place. Other documents are available on more general biosecurity planning e.g. from the GB Non-Native Species Secretariat (http://www.nonnativespecies.org/index.cfm?sectionid=58).

1.1.13 In order to complete a Biosecurity Plan, you must:

- Identify and describe characteristics of the island that will affect biosecurity measures;
- Identify and prioritize risk species and pathways;
- Identify multiple barriers you can place in the pathways to mitigate the risks posed (Quarantine/ prevention measures);
- Design an appropriate Surveillance Strategy;
- Develop an Incursion Response Plan; and
- Have the plans reviewed by an independent expert, and amend them as necessary.

1.1.14 There are few hard and fast rules with biosecurity as so much depends on the island's unique characteristics, however, as general guidance:

- Place multiple barriers along pathways;
- Deploy multiple types of detection devices;
- Check the devices as often as possible;
- Be prepared to act immediately;
- Maintain constant vigilance.

1.1.15 Once the Biosecurity Plan is approved, you should immediately:

- Put the quarantine measures in place;
- Initiate the Surveillance Strategy; and
- Source equipment for the Incursion Response Kit (part of the Incursion Response Plan).

1.1.16 It is imperative that responsibilities for each element of the Biosecurity Plan are clearly assigned to individual staff members/stakeholders. These responsibilities should be built in to formal job descriptions and, where necessary, other responsibilities should be delegated so that sufficient time is available to deliver the Biosecurity Plan. Do not underestimate how much time biosecurity tasks/responsibilities can take. In the event of a confirmed quarantine breach, responsible staff should expect to be required to devote a significant amount of their time in the following weeks (most likely all of it) to implementing the incursion response plan. At least six weeks are likely to be needed. Managers must be prepared for, and supportive of, this.

1.1.17 It is important that the Biosecurity Plan is able to minimise the risk of invasive species being transported, whilst still allowing the site to function as a home, place of work, conservation area or site of tourist interest. Compliance from all island users is required for biosecurity to be successful. Expectations need to be sensitively managed and it's important not give the impression that it's going to be all gain and no pain. The key message should be that "it's worth it".

1.1.18 In order to complete the Biosecurity Plan, consult with other island users, for example, fishermen, graziers, and boat/ferry operators, as well as with island residents and landowners. You will get a better understanding of the risks, real and perceived, and produce a better plan as a result as these stakeholders may think of risks and pathways that do not occur to outsiders.

1.1.19 You will also need to talk with harbour operators on the mainland. If tourists visit the island, you will need to find a way to disseminate information about simple steps they should take to adhere to the biosecurity requirements.

1.1.20 Some elements of international best practice for biosecurity cannot be deployed in the UK at present. Other elements, such as the building of quarantine rooms for storing and checking all island-bound goods/equipment, may be considered impractical, but should still be installed wherever possible. Proposed biosecurity plans should be appropriate to the island and the level of risk, but plan managers should be aware of the increased risks where best practice is not implemented. In general, it is likely to be cheaper to plan and implement thorough biosecurity measures than it is to respond to incursions. The cost of good biosecurity is the insurance premium paid to protect the conservation value of the island.

1.1.21 N.B. Whilst these guidelines have been tailored for UK use, they remain generic guidelines and the lists of risk species, pathways and surveillance options are not exhaustive. In each case you should consider the unique circumstances and characteristics of your island.

1.2 Identifying the risks

Site description

1.2.1 Here you need to identify and describe characteristics of the island that will affect biosecurity measures. This can be achieved by describing the island, its wildlife interest and its uses, and by creating annotated maps of the island.

1.2.2 Do not underestimate the importance of annotated maps and detailed site descriptions: keeping an island rodent-free may depend on the advice and actions of people who have never visited it.

1.2.3 Some key considerations are:

- Where is the island?
  - Distances and orientation to neighbouring islands/mainland
  - Directions and strengths of currents/prevailing wind
  - Proximity to a river mouth/estuary
  - Jurisdiction
- How large is the island?
- How easy is it to get to the island/how often can it be visited?
  Are parts of the island inaccessible / have restricted access? (e.g. sheer or unstable cliffs, private property, important archaeological features, protected species or sites, impossible to land in winter/ during seal pup nursing/ sea eagle breeding locations)
- What is on the island? (infrastructure (particularly boat landings or quays), buildings, land use, habitats)

- Who owns, manages and accesses the island?
- Who lives on the island? e.g.:
    - People (how many, are they residents or employees)
    - Livestock and pets (which species)
    - Protected species and habitats
    - Species at risk from rodenticide poison or small mammal traps (e.g. raptors, voles)
    - Species at risk from the arrival of invasive species
- What happens on the island? e.g.:
    - Permanent/seasonal residence
    - Farming (provide details e.g. livestock / arable / organic)
    - Tourism (is it seasonal?)
    - Research (is it seasonal?)
- What is brought to the island, from where and how?
    - People (how many, how often, residents or visitors)
    - Goods & equipment (food, agricultural feed/seeds, fleece bags)
    - Boat (describe types) / air / road causeway
- What and where are the natural and manmade access points?

1.2.4 Consult widely with local communities – they will be a valuable source of information on species present on the island/surrounding islands, and on the vessels that visit the island.

1.2.5 They can also advise on potential effects on biosecurity risks that may not be apparent to experts who are only on the islands over winter during rodent eradication (e.g. seasonal ferries, increased visitors, migrating species).

1.2.6 It is also an effective way to find out what the local community perceives as the high risk species and pathways and gain commitment to comply with the plan. *Remember, you need all residents and other island users to comply with biosecurity in order for it to be effective.*

Risk species

1.2.7 Identify what is at risk on the island from the arrival/spread of invasive species, and which invasive species would be most damaging, were they to arrive.

1.2.8 You will need to know about the ecology of risk species. Their behaviour, feeding habits, and reproductive traits will all define the impacts they are likely to have on the island, as well as how quickly the impacts will be felt and how likely they are to arrive in the first place. See Chapter 2 for a summary of relevant rodent ecology.

1.2.9 Particularly problematic invasive mammals in the UK include:

- Brown (Norway) rats *Rattus norvegicus*
- Black (ship/roof) rats *R. rattus* (these are rare in the UK but, as their name suggests, are often found on ships and in ports and so the level of risk may be higher than assumed)
- Feral cat *Felis catus*
- American mink *Neovison vison*
- Hedgehog *Erinaceus europaeus* (where not native)
- Feral ferret *Mustela furo*
- Stoat *M. ermina* / weasel *M. nivalis* / polecat *M. putorius* (where not native)
- House mice *Mus musculus/domesticus*
- Grey squirrel *Sciurus carolinensis*
- Deer (all species where not native)
- Goat *Capra* spp.
- Rabbit *Oryctolagus cuniculus*

1.2.10 You should establish which invasive species are resident on nearby islands/mainland/and the ports from which the island's service vessels embark.

1.2.11 Rodents are more likely to arrive on an island and remain undetected than many of the larger invasive mammals and so are likely to be high risk species for all islands. If you identify species other than rodents as your island's highest risk, seek further advice – but bear in mind the principles of these guidelines will be equally applicable for many invasive animals.

1.2.12 Consider damage beyond the island's conservation interest, e.g. to island culture, economic activities or archaeological interests. These may be more important to stakeholders (whose compliance you require for biosecurity measures to be successful) than conservation concerns.

1.2.13 You can either use the species and features identified through your site description in order to assess which might be susceptible to harm by invasive species, or you can list invasive species that might arrive on your island and identify the damage they could do. E.g.:

Table 1.1 Risks identified by important species/island features (illustrative only)

Important species/feature	Risks posed by invasive species	Impact speed	Impact severity
Manx shearwater	Egg & chick predation by brown rat, black rat, stoat, cat Possible competition with rabbits for burrows	Rapid Slow	Critical Moderate
Storm petrel	Egg & chick predation by brown or black rat Possible predation by house mouse	Rapid Rapid	Critical High-critical
Breeding waders	Predation by rats, fox, mink, cat, hedgehog	Rapid	Critical
Endemic subspecies of vole	Competition/possible predation by brown or black rat Possible competition with house mouse	Moderate Moderate	Moderate Moderate
Scheduled ancient monuments	Rabbit warrens / burrowing under structures causing destabilization	Moderate	High

Table 1.2 Risks identified by invasive species (illustrative only)

Invasive species	Description of impacts	Impact speed	Impact severity
Brown rat	Decline and loss of native plants, invertebrates and vertebrates through predation and competition, including species for which UK has international importance.	Rapid (rapid rate of reproduction)	Critical
Feral cat	Decline and loss of vertebrates, including species for which UK has international importance.	Moderate-rapid (slower rate of reproduction)	Critical
Rhododendron	Decline in populations of native plants and invertebrates and vertebrates through habitat alteration.	Slow (woody shrub)	Moderate

Table 1.3 Example classification of impact severity of risk species on the various biodiversity, economic and cultural interests of an island. (Taken from Bell *et al*. 2014, adapted from Pacific Invasives Initiative 2010.)

Impact area / Impact Severity	Biodiversity	Economy	Culture
Critical	Loss of a threatened native species / species occurring in internationally important numbers	Significant reduction in income from tourism Significant costs of controlling rodents or of replacing rodent-damaged goods	Permanent damage to archaeological features
High	Loss or significant decline of at least one native species	Reduction in income from tourism High costs of controlling rodents or replacing rodent-damaged goods	Major damage to archaeological features
Moderate	Decline in population of several native species Decline in a species of significance	Decrease in tourism Continued costs in managing rodents	Degradation in an area or historic site
Low	Decline in population of at least one species	Small decrease in tourism	Small changes in protected archaeological sites Small changes to quality of an area of importance

Pathways

1.2.14 Once you know which species would cause damage were they to arrive, next you need to identify which 'pathways' an invasive species could use to reach the island and how likely is it that the pathway would be used. Once you have done this, create an annotated map of the island which identifies all possible incursion points.

Pathways are categorised into two types: natural and human-assisted.

Natural pathways

1.2.15 For rodents, mustelids and other mammals, natural pathways essentially comprise swimming or floating on driftwood/storm debris. Birds and some invertebrates may be able to fly or may be carried by the wind. Plants, fungi and pathogens may also be dispersed by wind. Other extreme and less predictable weather events may also assist arrival: climate change may exacerbate these risks. For tidal islands regular invasion should be anticipated as rodents and other mammals can simply walk across to them.

1.2.16 At the outset of a restoration project (i.e. at the feasibility stage) (or, if no eradication is required then as part of the biosecurity plan,) you should confirm the invasive non-native species present on surrounding islands and other islands/mainland from which island-bound services embark. DNA sampling may provide a useful guide to previous invasion sources and hence possible

reinvasion risks, and can confirm the source(s) of any future invasion(s). See Chapter 3 for information on DNA sampling.

1.2.17 Different species have different swimming strengths and this is important information in determining the risk from potential sources based on their proximity to the island. Water temperature, currents, and wave conditions have an un-quantified impact – do not assume that apparently adverse conditions will prevent arrival over distances shorter than those described below. Strong currents, for example, may slacken when the tide turns.

As a guide:

- Brown rats can swim better than black rats which can swim better than house mice. Mice, however, are high-risk stowaway invaders.
- At 50m all rodents can easily swim to an island, and will do so frequently.
- At 500m black rat will invade but the frequency of incursions may be low.
- At 500m brown rat could, in many circumstances, be expected to reach the island every year.
- If the distance is near the currently known record for the species, they can be expected to invade but may not.
- If the distance is twice the currently known record, reinvasion by swimming may not occur but we do not consider it impossible.
- It is only islands several kilometres off-shore where we can categorically say that rodents will not be capable of swimming there. However, the risk of quarantine failure on human-assisted pathways is ever present no matter how far it is.

Table 1.4 Guidance on rodent swimming distances

Species	Known swimming capability
House mouse	500m
Black rat	750m
Brown rat	1000m (‘easy’) 2000m (less frequently) 4000m (possible)

1.2.18 Longest distances achieved in cooler (UK) waters may be less than stated, but for the purposes of biosecurity planning these distances should all be considered swimmable in a UK context.

1.2.19 **N.B. As research continues in this area, swimming capabilities are often revised upwards.**

Human-assisted pathways

1.2.20 The main pathways are:

- vessels used for transport to the island (for people, goods or services);
- leisure activities in waters surrounding the island (even if vessels do not make land), and
- shipwrecks (includes vessels that pass near but do not make scheduled stops at the island).

1.2.21 These usually result in unintentional introduction of species, but intentional release may also be an important pathway, particularly if the initial eradication is contentious. Bear in mind that other illegal or unregulated activity may also represent a significant pathway.

1.2.22 Human-assisted climate change is also likely to increase the movement of invasive species, but is not considered further here, beyond highlighting that increased storm events may increase the risk of arrival by floating on storm debris. Managers of islands close to estuaries should take particular note.

Table 1.5 Examples of human-assisted pathways

Pathway	Activity
Small boats	Fishing/harvesting of local resources Transport between islands Boat trips for tourists Research trips – government/conservation bodies Private/residents transport/leisure
Larger/Commercial boats	Yachts Waste removal Transport of cargo/supplies Ferries Fishing fleets Tourism, incl. cruise ships Fisheries inspection, military, customs, police
Any boat	Shipwreck
Aircraft	Cargo Passenger/tourism Private
People	Intentional release

1.2.23 Boats are likely to vary considerably in the risk level they pose and should not be lumped together when assessing risk levels. e.g.:

- Small boats with no concealed areas which do not moor close to the island or stay overnight are likely to be lower risk than larger boats with a closed bilge/places for a rodent to hide which moor up to the island and stay overnight (rodents being more active at night).
- Boats carrying items such as waste/animal fodder/human food supplies, especially if cargo has been left in storage for any length of time, are likely to be higher risk than day-tripper tour boats.

1.2.24 Once you have established the pathways a species may take to get to your island, assess their likelihood of arrival. If resources are insufficient to cover all invasive species, you should prioritize those which are considered most likely to arrive and cause damage. e.g.:

Table 1.6 Risk matrix combining impacts and likelihood of arrival (illustrative only)

Invasive species	Impact speed	Impact severity	Likelihood of arrival
Brown rat	Rapid	Critical	High – likely stowaways and good, willing swimmers
Feral cat	Moderate	Critical	Low-Moderate - unlikely stowaways and don't like to swim. But are sometimes present as pets on boats and may reach islands this way
Rhododendron	Slow	Moderate	Medium - not present in nearby habitats/landscape, but seeds can be dispersed long distances.

1.3 Creating a quarantine (prevention) plan

1.3.1 The main aim of the quarantine plan is to prevent (re)incursion events by identifying barriers you can place along pathways to obstruct the movement of invasive species. If resources are insufficient to cover all invasive species or pathways, you should identify and prioritize those which pose the greatest risks to your particular island (e.g. species which are most likely to go undetected, boats that visit most often, that carry higher risk goods/people, that stay near the island overnight, or that come from highest risk places).

1.3.2 The principle of prevention is to place as many barriers and checks along pathways of introduction as possible. Barriers should be placed and checks made so as to:

- prevent species getting on to vessels, either directly (e.g. climbing up mooring ropes) or indirectly (e.g. as a stowaway in cargo);
- prevent species dispersing from land within swimming distance of the island;
- identify the presence of species on vessels in transit;
- prevent species getting off vessels; and
- prevent species getting out of quarantine areas on the island.

1.3.3 The exact measures deployed will depend on the species and pathways identified for your island. Carefully consider each pathway that you have identified and ensure there are multiple barriers in every one that is recognised as a biosecurity risk.

1.3.4 As many stakeholders as possible need to be aware of these preventative measures and content to implement them. This should include:

- island residents;
- dock/wharf/marina operators;
- vessel operators and owners;
- aircraft operators (those responsible for loading aircraft and running airports);
- tour operators and tourists;
- researchers; and
- any other visitors (e.g. fishermen, graziers, civil servants/inspectors).

1.3.5 Try to make the quarantine/preventative measures as simple as possible – the harder they are the less likely people are to undertake them.

1.3.6 Stakeholder engagement may be made easier if you are able to identify and communicate the benefits *to them*, as well as to wildlife, of the island being free of the invasive species in question.

1.3.7 If there are access approvers (e.g. landowners, government departments) you should ask them to make implementation of biosecurity (quarantine/prevention) measures a condition of access to the island. As far as possible, government agencies should assist with ensuring compliance on biosecurity measures.

1.3.8 Those responsible for implementing the biosecurity plan should **inform**, **motivate** and **equip** relevant stakeholders to implement biosecurity measures. 'Equip' means to provide, free of charge, both the physical equipment needed to implement biosecurity as well as technical training. Training should be offered following any changes in staff (e.g. amongst vessel operators) and periodically as a refresher. Annual training is recommended. Adequate funding should be secured for this.

1.3.9 Biosecurity is required in perpetuity and project funding will most likely be time-bound. As such, adequate plans should be made to fund the biosecurity requirements in the longer-term.

Potential barriers

The following lists are not exhaustive but give some ideas for barriers you can put in place.

Actions at points of origin

1.3.10 Have in place baited stations and/or traps on quays of servicing harbours. Such use needs to be in accordance with best practice outlined in Chapter 3 and in Annex 5 of the RSPB Rodent Eradication Best Practice Toolkit (Thomas & Varnham 2015).

1.3.11 Install good waste management and reduce harbourage at quays/along adjacent 'swimmable' mainland. You may wish to undertake lethal control measures in high risk habitats along adjacent coastlines to reduce the likelihood of dispersal events (see Chapter 3 and Annex 5 of Thomas & Varnham 2015).

1.3.12 As far as possible, place island-bound goods and supplies in rodent-proof containers. At the very least, all items (including visitor day packs) should be placed in a sealed container so that they can be inspected for signs of tampering/entry by rodents.

1.3.13 Before loading onto vessels, check goods and supplies that are island-bound for signs of rodent interference, especially items which cannot be placed inside rodent-proof containers or which have been stored overnight or longer. Look for chew marks and signs of entry/holes.

1.3.14 As far as possible, ensure goods are packed on the day of delivery. For items which will be stored long-term or overnight before being transported, store off the ground (e.g. on a pallet) and place traps/rodenticide underneath/around the goods. This is particularly important for high risk goods such as fodder.

1.3.15 As a preference, store all island-bound cargo in a **quarantine store** after it has been checked. Check cargo again before loading onto the vessel. More detailed information is available if installing a quarantine store is an option for your biosecurity plan (contact sophie.thomas@rspb.org.uk).

1.3.16 For boats moored on buoys or anchor:

- position the mooring so that the boat remains in the water at low tide;
- fix mooring hoods to mooring lines (where possible use a fixed mooring not an anchor);
- ensure nothing is suspended over the side of the boat;
- moor boats in areas free from shore-based rubbish and other food sources or concentrated rodent habitat.

1.3.17 Do not run mooring lines ashore unless you absolutely need to.

1.3.18 Larger ships should use line guards on ship-to-shore lines to stop rodents using mooring lines to get on and off the ship.

1.3.19 Do not land at night unless you absolutely need to.

1.3.20 Consider if any risks can be avoided altogether by a change in practice – e.g. using island sources rather than importing items (invasive-rodent-free Ramsey Island now produces hay itself rather than importing it, for example).

1.3.21 Raise awareness of the invasive-rodent-free nature of the island and inform visitors of biosecurity actions they need to undertake (such as sealing and checking all their bags). Consider:

- placing signs at key departure and arrival points about the risks of reincursion and the measures you would like people to take to reduce risks;
- providing information leaflets at these points;
- placing information on vessels (visual or audio – e.g. over ferry tannoy announcements);
- designing visitor/ferry tickets so that they provide biosecurity information (e.g. using the reverse side for this purpose);
- placing awareness-raising notices in local papers or radio.

1.3.22 Publicise a contact number so people can report if they think they see an invasive rodent/rodent sign.

1.3.23 For people planning to visit a number of islands (e.g. researchers, tour guides, rubbish collection vessels), visit those that are invasive-free (or have less chance of invasive species escaping onto your vessel) before visiting those with invasive species. Visiting islands in order of least risk decreases the chances of you transporting invasives from invaded to invasive-free islands.

1.3.24 Encourage all relevant stakeholders to maintain vigilance at all points of origin.

Actions *en route* to the island

1.3.25 Rodenticide poison and/or kill traps should be in place on all vessels which pose a significant risk of transporting rodents to the island. Second generation anticoagulant rodenticides are best for biosecurity purposes on vessels, but check the legality of using them in this way.

1.3.26 All rodenticides and kill traps should be placed in covered and lockable containers and significant effort should be undertaken to reduce risk of harm to all non-target species.

1.3.27 Traps should be checked at least once a day. If they cannot be checked with this frequency, they should not be used. Refer to Chapter 3.

1.3.28 Rodenticides should be checked at least weekly for any sign of consumption or tampering, and bait refreshed regularly (at least once per month or sooner if weekly checks show it to be damaged by weather/less attractive to rodents for any other reason). Refer to Annex 5 (Rodenticides) of the Best Practice Toolkit (Thomas & Varnham 2015)

1.3.29 Train boat operators and encourage visitors to maintain vigilance whilst in transit.

1.3.30 If a rodent (or any other invasive species) is found on a boat which is island-bound, the **boat should not land**. The boat should return to its point of origin until it is clear all rodents present have been removed. **Never allow a live rodent to be thrown overboard**.

Actions on arrival at the island

1.3.31 Do not run mooring lines ashore unless you absolutely need to.

1.3.32 Do not land at night unless you absolutely need to.

1.3.33 Before unloading anything at the island, all packed gear should be thoroughly inspected for sign of rodent exposure (chews marks, gnawed holes, etc.).

1.3.34 Only unload what must be unloaded.

1.3.35 Unpack containers, luggage and cargo in enclosed, rodent-proof, well lit, and tidy areas. Preferably this would be in a quarantine room. This will allow easier detection and capture of any invasive species that do escape. The more secure the area, the easier it will be to stop the invasive species escaping onto the island.

1.3.36 If there are no appropriate buildings on the island and a quarantine room cannot be built, goods should be unloaded and checked close to shore in an area which can be surrounded by people who are poised to take action should a rodent/other invasive species escape. N.B. there are significant additional risks to this approach.

1.3.37 Consider installing lethal control measures at the main incursion points identified earlier in your biosecurity plan (an EIA and measures to limit risks to non-target species will be required).

Actions on departure from the island

1.3.38 Apply the 'Actions at points of origin' measures to ensure you do not export invasive species from the island.

1.3.39 Do not remove anything from the island that could contain invasive species.

1.3.40 Remove all your rubbish, including fruit and vegetables, from the island. Rubbish provides a great food source to many invasive species and can hinder both surveillance efforts and incursion responses. Discarded species may also prove invasive themselves (e.g. fruit from vines/climbers).

Basic biosecurity checklist to be completed by team leaders for all island visits

Task	Completed?
1. Have I given clear biosecurity instructions to <u>all</u> trip members?	Yes/No
2. Have I checked they have understood these instructions?	Yes/No
3. Have all stores and supplies (which are small enough) been packed in approved rodent-proof containers?	Yes/No
4. Itemise gear too bulky/awkward to fit into rodent-proof containers: • • Items checked immediately prior to departure -	 Yes/No
5. Has <u>everything</u> been stored in a rodent-proof room in sealed containers or re-checked immediately prior to departure?	Yes/No
6. Have I checked with every member of trip: - packs kept in rodent-free areas or checked and re-packed since? - no food held in any unsealed bags? - boots and other footwear clean and free of soil/seeds? - packs, pockets, Velcro fasteners, socks, etc clean of weed or grass seed? - no-one in party has worked in area of known invasive plant/invertebrate infestation recently without changing/ washing gear (including shoes/bags)?	 Yes/No Yes/No Yes/No Yes/No Yes/No
ANSWERS 1-6 MUST BE 'YES' BEFORE TRIP CAN PROCEED	
7. <u>Identify any added risks of the trip:</u> - are we leaving/ travelling at night? - are there planned stops *en route* where pests could enter or exit? - are we travelling on a boat with no poison rat baits or effective rodent control measures? - are any items being stored on deck or in non-rodent proof holds?	 Yes/No Yes/No Yes/No Yes/No
8. Have I addressed these concerns by identifying and implementing bespoke solutions to minimise potential risk to the islands?	Yes/No
YOUR ANSWER TO TASK 8. MUST BE 'YES' BEFORE TRIP CAN PROCEED	
<u>In Transit to Islands:</u> If any sign of rodent or other invasive species is detected on the boat whilst *en route* to your destination, DO NOT land at the destination island or any other island until the problem has been identified and remedial actions implemented in consultation with experts.	
<u>On Arrival:</u> - Have I re-inspected all containers for rodent entry or damage which could allow entry? - Has everything been unpacked or opened up and carefully inspected in an	Yes/No Yes/No

open area or quarantine room? - Have I instructed everyone on rules for disposal of organic rubbish? - If planning to go to other islands from here, have I considered and established how to apply quarantine procedures before we leave? - If on a daytrip, have I ensured only day-bags are taken, and that they have been checked as clean and been packed only on the day of departure?	Yes/No Yes/No Yes/No

1.4 Designing an appropriate surveillance strategy

1.4.1 If your quarantine/prevention measures fail, your surveillance strategy is all that stands between species of conservation interest or concern and a full blown reinvasion of the island that would take you back to square one. Getting surveillance right requires significant on-going time commitments and carries with it an annual running cost. By preventing invasions, however, it will save a lot of time and money in the long run.

1.4.2 Chapter 2 details surveillance methods for rodents applicable to various stages in island restoration projects, including for biosecurity purposes.

1.4.3 However, there are **additional, important considerations when planning a surveillance strategy as part of biosecurity**:

a) Behaviour of rats in very low densities is less predictable than when an established population is in place, for example:

They are likely to **wander widely** to explore the island and search for other rodents to mate with. The rat may be nowhere near the point at which it left sign by the time of your next surveillance check**. If incursion is detected, you should immediately search across the island to check for further sign.**

A newly-arriving rat is unlikely to be food-stressed and might be most **attracted by good habitat**. Rodent motels are deployed with this in mind - as a particularly sheltered and safe environment they can make ideal habitat and be very attractive to rats.

b) You need to **plan for the quirks of an individual rat's behaviour** – the rat that has made it to the island might be wary of traps or be uninterested in chocolate flavoured wax. **Deploy as many different types of detection devices as possible.**

1.4.4 Detection techniques include:

- Flavoured wax blocks – e.g. chocolate, coconut, peanut butter, meat gravy, fish. Plain wax is considered less reliable for use in surveillance
- Tracking tunnels/plates or natural mud/sand traps
- Cameras
- Traps
- Visual searches for runs/droppings/chew marks on naturally occurring foods
- Hair traps
- UV light

1.4.5 In the UK surveillance cannot usually involve 'passive' killing of invasive species as permanent laying of poison or traps is not likely to be permitted. It is even more important, therefore, that surveillance devices are checked as frequently as possible so as to catch any incursion before it becomes an invasion.

1.4.6 It is worth noting that even international best practice still states that it is better to detect an incursion and launch a calculated response than to rely on permanent baiting.

1.4.7 The location of all permanent monitoring devices should be recorded using GPS and mapped for ease of reference when doing routine surveillance or if incursion response is required.

Table 1.7 Appropriate surveillance strategies for generic island types.

Scenario	Recommended surveillance for rodents
1. The island can be easily or regularly visited and is **small** enough to cover with a grid of detection devices – e.g. up to ca. 250ha. (Includes inhabited islands)	Deploy a **broad array of detection devices over the whole island** at about 1 or 2 per hectare and check each of them on every visit. Use, primarily, **tracking tunnels** and **flavoured wax blocks**. Put fresh tracking cards and wax out each time you visit, or freshen wax blocks by shaving off outer layers – the smell of the flavour (chocolate etc.) should be easily detectable. Wax blocks should be checked within around 7 days of being set. Ideally, tracking tunnels would be run for 7-10 days each time and checked at the end of this period. Bait them, e.g. with peanut butter. Supplement this with looking for feeding sign and footprints on sand or mud. Place wax/tracking cards inside permanent wooden boxes in preference to plastic stations. These can double up for use housing traps or poison if an incursion is detected. **Monthly checking is advised**. As an absolute minimum do 4 checks per year (about every 3 months). If you only do 4 checks a year and a pregnant female arrives, you can expect a breeding population to be establishing by your next check.
2. The island can be easily or regularly visited but is too **large** to cover with a grid of detection devices – e.g. larger than ca. 250ha. (Includes inhabited islands)	Deploy a **broad array of detection devices in a range of likely habitats** which are easy to access, **and at possible incursion points** (e.g. around the coastline). Supplement this with looking for feeding sign/footprints on sand or mud. Use, primarily, **tracking tunnels** and **flavoured wax blocks**. Put fresh tracking cards and wax out each time you visit, or freshen wax blocks by shaving off outer layers – the smell of the flavour (chocolate etc.) should be easily detectable. Wax blocks should be checked within around 7 days of being set. Ideally, tracking tunnels would be run for 7-10 days each time and checked at the end of this period. Bait them, e.g. with peanut butter. Place wax/tracking cards inside permanent wooden boxes in preference to plastic stations. These can double up for use housing traps or poison if an incursion is detected. **Monthly checking is advised**. As an absolute minimum do 4 checks per year (about every 3 months). If you only do 4 checks a year and a pregnant female arrives, you can expect a breeding population to be establishing by your next check.

3. The island has a known history of regular rodent incursions, or you **expect the likelihood of** future **incursions to be high** (Includes inhabited islands)	Given permanent trap use in the UK will be impractical, and permanent poison baiting considered poor practice, there must be exceptionally high conservation interest on the island for eradication to have been undertaken. **Consider installing rodent-proof fences** to create exclusion zones around sites of high conservation value. See Xcluder® (http://xcluder.co.nz/xcluder-fences/fences-designs.html) for more information. N.B. if exclusion zones extend to the coast, they cannot be considered complete barriers. Surveillance must continue inside the fenced area, regardless of the fencing. Lay **poison bait in all buildings on the island** – concentrate on baiting during the winter months if permanent baiting is not possible. First generation anticoagulant rodenticides can be used for this if necessary. **A network of (empty) wooden trap tunnels should be in place across the entire island** which can be used for trapping, baiting or placing tracking cards. Place them on most likely sites if a 1-2 per hectare grid (or greater if mice are highest risk invader) is not possible. Run tracking tunnels for 5- 10 days and check at the end of this period. Wax blocks should also be checked within around 7 days of being set. Supplement this with searches for sign/footprints on sand/mud and at likely incursion points. Weigh up the costs of fewer, longer visits over shorter more frequent ones. How early do you need to detect and deal with an incursion in order to prevent catastrophic damage to the conservation interest? Where possible, fewer, longer visits are advised.
4. **Remote** and uninhabited islands which are seldom visited.	Ensure visits, when they do happen, **give the team as long as possible on the island.** Also ensure that the highest biosecurity standards are adhered to in order to prevent accidental introductions to the island. **A network of (empty) wooden trap tunnels should be in place across the entire island** which can be used for trapping, baiting or placing tracking cards. Place them in most likely sites if a 1-2 per hectare grid is not possible. When visiting run tracking tunnels for 5 nights or longer, focusing on likely areas if necessary. Check the tunnels at the end of this period. Supplement searches by using flavoured wax (these should be checked within c. 7 days of being set) and look for feeding sign/footprints on sand/mud and at incursion points.
5. At least 1 **native rodent** exists on the island and you want to detect new species arriving.	Carefully select detection devices to **maximise the chances of distinguishing between native species and invading species** – e.g. tracking tunnels, Bovril wax. **Do not use rodenticides pre-emptively.** Operate appropriate traps when visiting (e.g. set for rats if resident mice/voles are present) and look for feeding sign.

1.4.8 Carefully archive all devices that display some form of interaction with a species (e.g. tracking cards, chewed wax block) noting exact locations, dates and who interpreted them. This information may be useful to refer to when dealing with future invasion/incursion responses

1.4.9 Create a biosecurity log (see Table 1.11) **to** detail all suspicious sign or sightings, **including false alarms,** near-misses or other events occurring as part of the quarantine actions.

1.5 Confirming and responding to incursion

1.5.1 Correct identification of any sign of rodent incursion is crucial to making the right decision on how to respond. In some situations the evidence of an incursion will be indisputable, e.g. a dead body in a trap on the island/footage captured on a trail camera. However in many cases the evidence will be open to interpretation – e.g. sightings by third parties. It is important, therefore, that evidence collection techniques maximise the information available and minimise the chance of wrong conclusions being drawn from it. Table 1.8 provides advice on collecting and caring for different types of evidence indicating a rodent incursion.

Table 1.8 Collecting and archiving surveillance evidence

Sightings	Interview the person who made the sighting as soon as possible – preferably on the same day. Take account of their experience but do not judge a sighting on experience alone. The most important factors are how well they saw it, i.e. how close, how long, what visibility. *What made them think it was a rat/mouse?* Ask open questions e.g. "tell me what you saw? how long did you observe it? What did it look like?" DO NOT ask leading questions e.g. "was it brown and about this big?" Record or write everything down, including when the sighting took place, when the interview took place and who conducted the interview. Ensure the exact location of the sighting is recorded, if necessary take the person back to the location where they saw the animal. Always record the incident in the biosecurity log and check it against previous incident records. One vague sighting on its own may be dismissed but if you get a number of similar sightings in a similar area over time you may form a different conclusion. New techniques for identification may present themselves in the future which could allow the archived evidence to be reviewed. Try to establish other evidence that supports or challenges the sighting (could it have been a vole or a shrew, or even a wren?). Use a standard recording form to gather similar information from each sighting.
Droppings or feeding sign	Photograph the evidence *in situ* where possible before disturbing it. If taking digital photographs, use high definition settings for at least some photos and provide a size comparator (e.g. coin, pen lid). When retrieving evidence to take back, physically mark the spot and collect everything i.e. if there are 24 suspected rat droppings there pick up all 24 and take them back, not just one or two. Take time to look around carefully for other sign such as tracks, hair, scratch marks etc. Remember you are not only looking for evidence of the suspected species, you're also looking for evidence which may support an alternative explanation. Label the evidence, including photos with detail on when /where /who. If sending evidence to an expert for identification, think about the security of transporting it e.g. this evidence may be the crucial factor in a decision to spend thousands of pounds in a contingency response, so don't save £5 by sending it in the post instead of by courier or other traceable/more secure transport system. If the evidence is going to be difficult to identify, have more than one expert look at it independently to give their opinion. Ask each of them why they came to the conclusion they did and what other opportunities there may be to further verify this. Always archive the evidence and record the incident in the biosecurity log. Reference it against previous incident records (see above).
Carcasses	Photograph *in situ*. Preserve in alcohol or triple bag and freeze. Label the evidence with details on location, state, and who found it and when. If species cannot be determined (e.g. due to decomposition), follow instructions on gathering DNA evidence in Chapter 3.

1.5.2 If there is any uncertainty over the sign, **ask at least two experts to help interpret the evidence**. Experts prepared to offer advice should be identified in advance and their names and contact details should form part of the Incursion Response Kit (see below). As experts may be uncontactable in the field when you need their advice, ensure you gather details of several experts who are prepared to help.

1.5.3 In New Zealand, the first line of action if incursion is suspected is to use rodent detection dogs to help locate any individuals that are present. In the UK there is no trained dog resource at present for island restoration, although training dogs for conservation purposes does take place and the potential for bespoke training and application to island restoration purposes is being explored. **At present, dogs MAY NOT be used in UK projects**. The risk of falling foul of the Hunting Act (2004) or Protection of Wild Mammals (Scotland) Act 2002 is too high in the absence of dogs that have gone through a vigorous, bespoke, certified training scheme for island restoration. **Do not deploy dogs in the UK, no matter how obedient/well-trained they appear or their owner insists they are.**

1.5.4 As a possible alternative, caged rats may prove an effective lure for wild brown rats. This has **not been extensively field tested**, but is a promising field of research. **Seek further advice**: the risks of the rat escaping must be managed effectively and there will be animal welfare considerations regarding the use of caged animals. There is evidence to suggest this method doesn't work for black rats, so only consider using if you know only brown rats are present.

1.5.5 The following decision tree procedures are designed to help you manage potential incursions promptly and effectively, however they can be guides only as so much depends on island circumstances. This is why independent review is so important. The general course of action is:

1. A sighting is reported
2. The person who sighted the rodent is interviewed as soon as possible
3. The location of the sighting is visited (preferably with the observer) and assessed
4. Any further evidence is collected and, if necessary, sent to experts
5. The sighting is considered either **uncertain** or **probable/confirmed**
6. Uncertain sightings trigger a monitoring response
7. Probable & confirmed sightings trigger incursion response involving traps and rodenticide
8. All sightings and follow up actions are recorded in the biosecurity log

1.5.6 If rodent evidence is found:

1. If there is any doubt about the evidence, the location where the evidence was found is assessed
2. Any further evidence is collected and, if necessary, sent to experts
3. The evidence is considered either **uncertain** or **probable/confirmed** rodent sign
4. Uncertain evidence triggers a monitoring response
5. Probable & confirmed evidence triggers incursion response involving traps and rodenticide
6. All evidence and follow up actions are recorded in the biosecurity log

1.5.7 If there is a **shipwreck**, the area is immediately **considered as a probable/confirmed incursion and triggers an incursion response.** Consider working with maritime authorities who get involved in the shipwreck response to get more information about the level of risk e.g. if salvage experts are going on board the vessel they could be trained to look for rodent sign in the galley. Knowing the cargo and the prospects for the ship breaking up could also forewarn your response.

1.5.8 The speed of a response is crucial. For a probable or confirmed incursion, you want a team on the island ready to deploy bait/set traps/bolster the grid **within 48 hours**. For this to be possible, the mechanisms for responding to a reported sighting/sign find must be slick and lines of responsibility need to be clear. Transport arrangements should be in place and all equipment ready

for loading, if not stored on the island. As UK surveillance strategies are limited to detecting incursion events (by themselves they cannot deal with an incursion), it is even more imperative that plans for incursion response are in place and people are ready to respond immediately.

1.5.9 Where there is already a network of stations in place on the island, use it as the basis for the response. It may need to be bolstered – e.g. if rodent sign is discovered on a large island in an area where there is no grid or only a sparse grid. Speed is of the essence. A sparse but extensive network covering as much of the island as possible is probably better if a grid has to be established than a dense grid in a small area. 1 to 2 devices per ha targeting preferred habitat is sufficient – it doesn't need to be an exact grid because invading rodents are likely to travel. Cover all major habitat types, but focus on preferred sites and known invasion sites. If a grid is already established, you may have time to reduce the grid size around the area of the sighting/evidence.

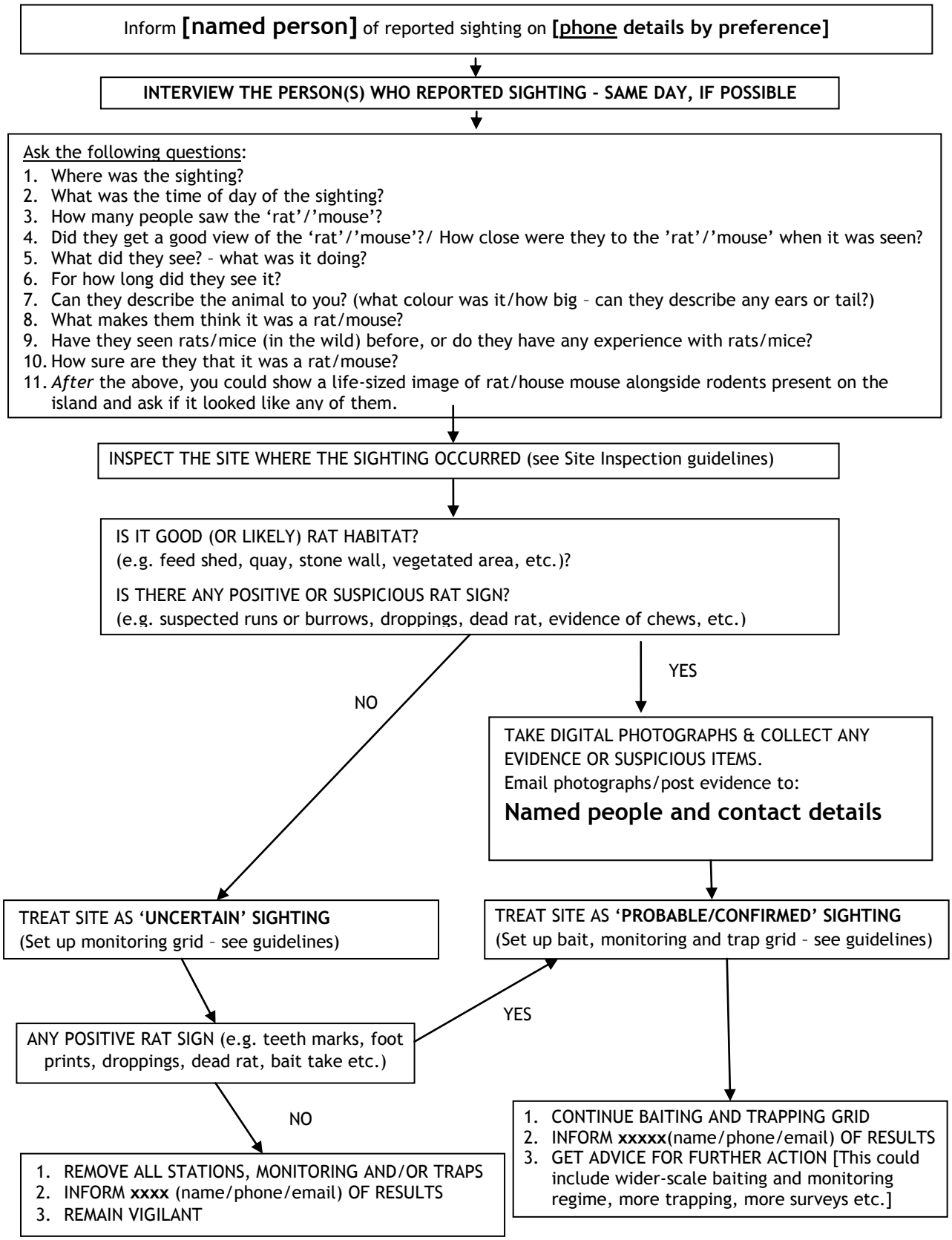
1.5.10 Place traps around the area of the sighting/evidence where there is plenty of natural cover and where rodents are likely to be active (e.g. alongside large rocks or walls, around the base of trees, under logs, overhanging vegetation, and under buildings). Traps can be baited with a mixture of peanut butter and rolled oats for an easy, durable bait which can be stored as part of the Incursion Response Kit. Tracks are used by invading brown rats and mice. Brown rats tend to be coastal foragers while black rats might prefer interior forest and may avoid tracks.

1.5.11 Having a Rodent Incursion Kit stocked is crucial to preparedness. Some items in the Incursion Response Kit will need to be replaced periodically even if not used (*****). An annual inspection of the kit is highly recommended. The contents of the kit will depend on the characteristics of your island, but a starter list is provided in Table 1.9.

Table 1.9 Rodent Incursion Kit contents

Item
Reference information - consider having laminated copies
Biosecurity plan *
Map of island
Map and description of GPS locations of permanent monitoring devices / grid
Species identification material
Operating instructions (e.g. CPS, trail camera, traps, installing bait stations)
Contact details for experts *
Record keeping
Waterproof notebooks
Copies of maps for note-making (incl. some laminated)
Pens/pencils
Vivid marker pens
GPS (loaded with locations of stations) and spare batteries*
Compass
Data sheets for recording activity at traps/tracking tunnels/monitoring stations
Flagging tape (at least two colours)
Specimen containers (jars, zip lock bags) & labels
1 litre of 70% ethanol
Sharp knife or dissecting tools (e.g. scalpel, tweezers)
Digital camera and spare batteries*
50m tape measure
Detection
Tracking cards*, ink* & tunnels
Bait for tracking tunnels - peanut butter/oats, pieces of coconut, etc *
Indicator baits - chocolate/peanut butter/coconut wax, soap, coconut, eggs, chocolate *
Trail camera(s) and spare batteries*
Headlamps/torches & spare batteries*
Eradication
Snap traps and covers with length of wire for each trap to attach to anchor-point. Mouse and rat-sized if both species a risk.
Bait for traps – eg peanut butter* and rolled oats*
Wire and bait stations – sufficient to create correct grid size across island, if required
Second generation rodenticide*- replace every couple of years: has limited shelf-life
Self-sealing bags
Disposable gloves* for handling baits, traps or dead animals
Tools e.g. hammers, spades, pliers, nails, thin wire, thicker wire
1st Aid kit including blankets*
Boat & safety gear*
Rope access gear*
Two means of long-distance communications – two-way radio and/or satellite phone and/or emergency locator beacons, and spare batteries* or means to charge these.
Personal protective equipment
Tent and sleeping equipment (if no accommodation available on island)
Water* and cooking implements (take fresh supplies of food and water as well)
Generator and fuel (if no electricity on island)
Rodent-proof and waterproof containers for all equipment to be packed in

Interview guidelines for sightings

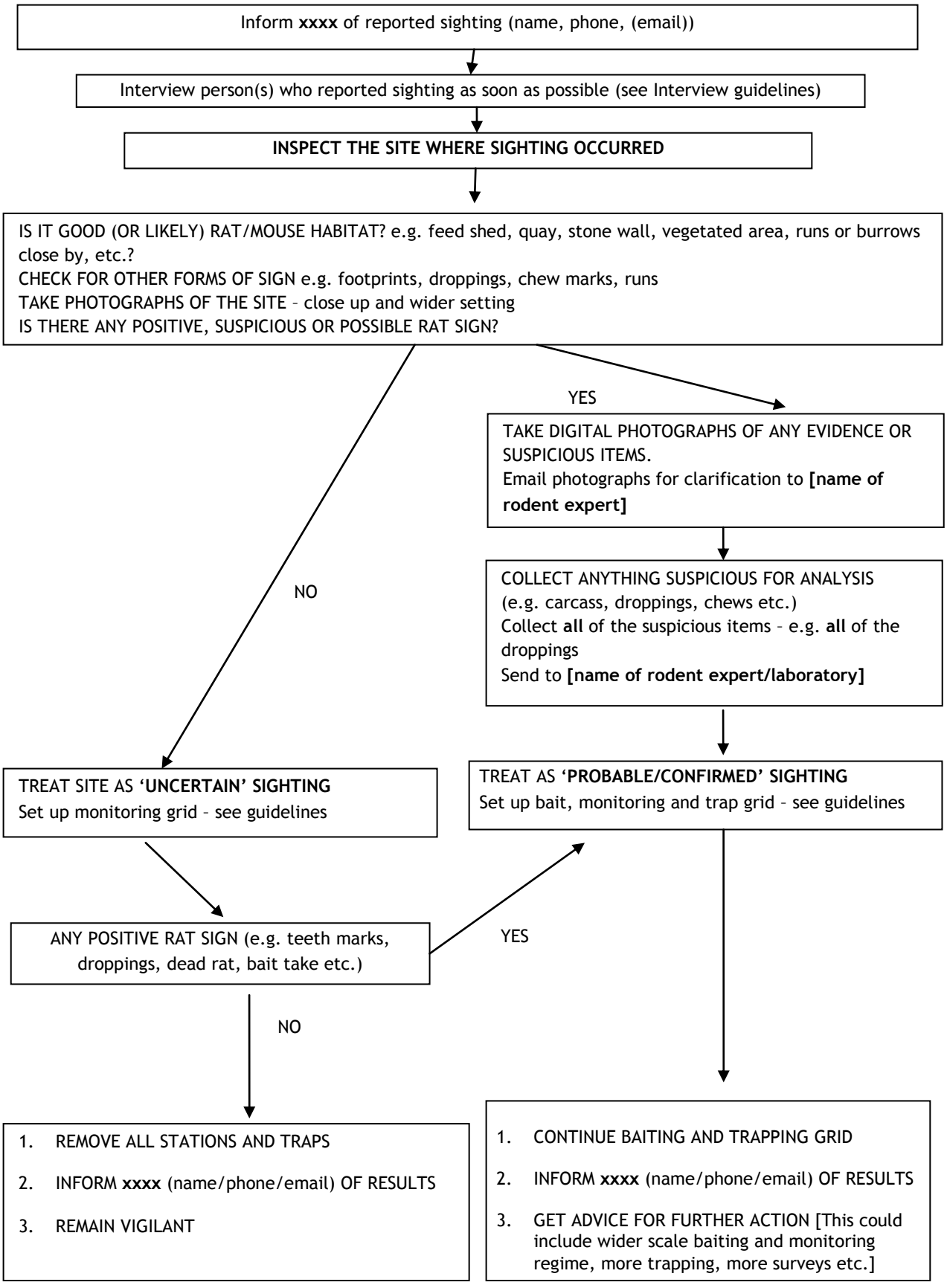


Interview Recording Sheet for reported sightings

Name of person reporting sighting:		Name of person who made sighting (if different)
Contact details of person reporting sighting Email: Telephone:		Contact for person who made sighting (if different)
Date of sighting:	Date of interview:	Interviewer:
Overview of action taken:		
Circumstances (circle as appropriate): Live animal Dead animal Footprints Droppings Damage Other		
Time / conditions of sighting:		
Location of sighting - as much detail as possible:		
Any other observers? Names and contact details if known:		
<u>Description of the sighting</u> What did you see? Can you describe the animal? What was it doing? How long did you observe it for? How close were you to it? Have you seen mice/rats in the wild before / Do you have any experience with mice/rats? What makes you think it was a rat/mouse? How sure are you that it was a rat/mouse?		
Does the observer wish to be notified of outcome of the monitoring? [Inform them that will take at least six weeks]		

Image of brown rat compared to house mouse and Scilly shrew (Scaled, but not life size, from Bell *et al*. 2014)

Site inspection guidelines for reported sightings

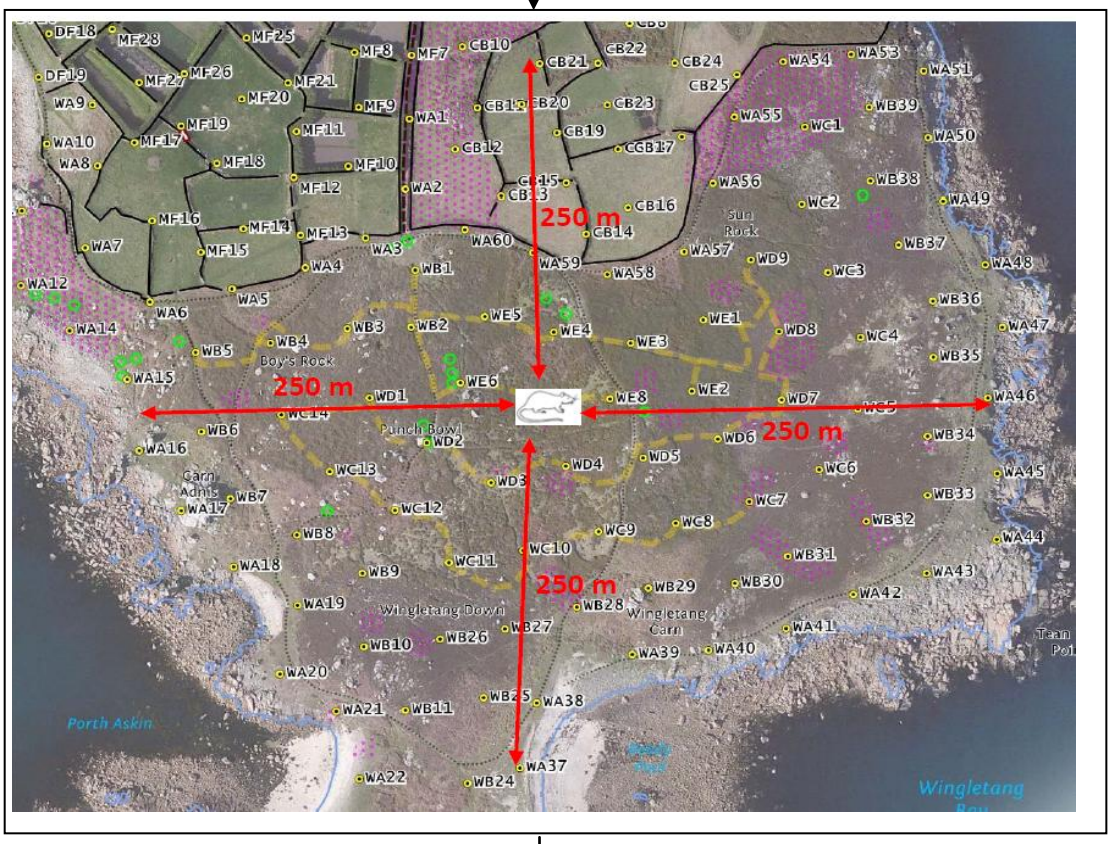


Guidelines for "uncertain" sightings/ evidence

Inform **xxxxx** of outcome of interview/site inspection (name/phone/email)

SET UP MONITORING GRID:

- Establish/bolster monitoring grid with stations 50 metres apart (closer if it is a mouse sighting) around the area of the reported sighting (use old bait station locations as mapped during the eradication operation for speed and ease of response)
- Spread monitoring stations to out up to 250 metres in all directions from sighting (terrain dependant).
- Put flavoured wax and/or tracking tunnels at each monitoring point. If you have more detection devices available, use them as well.
- **Check all points daily for three days, then once a week for four weeks**
- Check permanent detection devices across the whole island for any sign of rodent
- Enter daily monitoring data in to project database
- If there is any positive rodent sign, move immediately to a baiting, monitoring and trapping grid



ANY POSITIVE RAT SIGN? e.g. teeth marks, droppings, dead rat, monitoring take, etc.

NO

1. REVIEW THE SITUATION AFTER ONE MONTH, WITH EXPERT INPUT
2. REMOVE NON-PERMANENT MONITORING STATIONS
3. INFORM **xxxx** (name/phone/email) OF RESULTS
4. REMAIN VIGILANT

YES

1. IMPLEMENT BAITING, MONITORING AND TRAPPING GRID (see guidelines for **"probable/confirmed" sighting**)
2. INFORM **xxxx** (name/phone/email) OF RESULTS
3. GET EXPERT ADVICE FOR FURTHER ACTION [This could include wider-scale poisoning and monitoring regime, more trapping, more surveys etc.]

Guidelines for "probable/confirmed" sightings/evidence and shipwrecks

Inform **xxxxx** of outcome of interview/site inspection (name/phone/email)

↓

UPDATE COMMUNITY/STAKEHOLDERS AND PUT RODENTCIDE WARNING SIGNS IN PLACE

↓

INCURSION RESPONSE TEAM (4 people minimum) ARRIVE ON ISLAND (preferably within 48 hours)

↓

SET UP BAIT, MONITORING AND TRAPPING GRID:

- Check permanent detection devices across the whole island for any further sign of rodent.
- Set bait stations 50 metres apart (or closer if establishing a mouse grid, e.g. 25m) using the locations from the original eradication operation (if applicable) spread out for 500 m in all directions from the sighting/evidence and any other sign picked up from island-wide check, dependant on terrain.
- Wire 3 20g blocks of rodenticide into each bait station in the permanent and incursion response/bolstered grid.
- Add a line of baited stations around the coast if one is not already in place.
- Place and set baited traps (or pairs of traps) (T) every 50 metres in all directions from the sighting/sign (i.e. N, NE, E, SE, S, SW, W, NW, total 8 or 16 traps).
- **Check all stations daily for five days, then once a week for six weeks, replenishing bait as required to keep it fresh.**
- **Check all traps twice daily**: set at night and disarm in the morning.
- After the first week of poison baiting, place monitoring stations halfway between each bait station and place flavoured wax and/or tracking tunnels at each – check with same regularity as bait stations.
- Use trail cameras in any areas with active sign to confirm the presence of rodents; if confirmed, place traps in the site and run for five nights
- Maintain communication with the community, and other stakeholders using weekly Progress Reports

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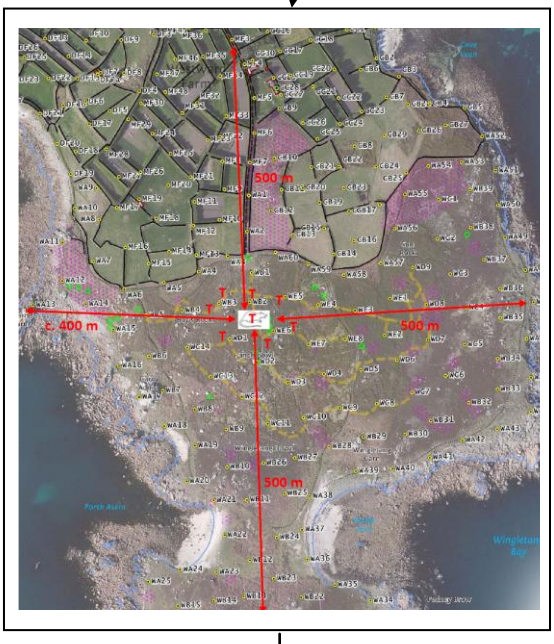

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AFTER SIX WEEKS: ANY POSITIVE RAT SIGN (e.g. teeth marks, droppings, dead rat, bait take

NO ↙ ↘ YES

NO:

1. REVIEW THE SITUATION, WITH EXPERT INPUT
2. REMOVE NON-PERMANENT STATIONS & ALL TRAPS
3. INFORM (**name/phone/email**) OF RESULTS
4. REMAIN VIGILANT

YES:

1. CONTINUE BAIT, MONITORING AND TRAP GRID for **at least** two weeks after the last rodent sign
2. INFORM **xxxx** (name/phone/email) OF RESULTS
3. GET EXPERT ADVICE FOR FURTHER ACTION [This could include wider-scale baiting and monitoring regime, more trapping, more surveys etc.]

Table 1.10 Incursion response bait take form

	Date	1/1/14			**Date**	2/1/14
	Surveyor	Sophie Thomas			**Surveyor**	Sophie Thomas
Station	**Bait taken**	**Notes**		**Station**	**Bait taken**	**Notes**
A1	2 blocks	Rat droppings found (all removed)		A1	0 blocks	Bait in good condition
A2	0.5 block	Suspected crow interference. Block replaced		A2	0.25 block	Block collected for tooth mark identification
A3	0 blocks	-		A3	0 blocks	bait replaced as damp around edges
A4				A4		
A5				A5		
A6				A6		
A7				A7		
A8				A8		
A9				A9		
A10				A10		
A11				A11		
A12				A12		
A13				A13		
B1				B1		
B2				B2		
B3				B3		
B4				B4		
B5				B5		
B6				B6		
B7				B7		
B8				B8		
C1				C1		

Table 1.11 Biosecurity Incident Log

Date	Recorder: name/contact details	Incident description	Response/Action taken	Outcome	Additional information
12/3/14	Sophie Thomas Sophie.thomas @rspb.org.uk 07703 888651	Rat droppings found on 'Brenda' boat by visitor *en route* to island	Boat did not land on island – returned to port. Full search conducted of vessel and cargo. Baited and covered traps placed on board. ST discussed tighter quarantine measures for the boat with owner and provided refresher info on rat sign. Boat had recently come out of winter storage.	**NEAR MISS** No rat found. Assumed it left boat after being disturbed. Boat to obtain rodent-free certification next spring before being launched. Owner committed to checking for sign.	Contact details for 'Brenda' owner, Chris Clune: 0799 1234567
1/5/14	Sophie Thomas Sophie.thomas @rspb.org.uk 07703 888651	Member of public (Joe Bright) reported rat sighting at grid reference SU12341234	ST interviewed Joe on same day and together visited location of sighting. Considered reliability of report to be poor (middle of day, middle of field), but instigated daily monitoring of surveillance grid 250m in each direction from sighting for four weeks, without further sign. Instigated one island wide check of all permanent surveillance stations	No confirmed rat sign. Regular surveillance checking resumed. **Assumed False alarm**	(Add hyperlink to completed interview form for this incident)
3/6/14	Ben Jones 0781 2345678	Member of public (Sam Hill) reported rat sighting at grid reference SU14371398	BJ interviewed Sam following day and visited location of sighting alone following detailed description. Considered reliability of report to be poor, but instigated daily monitoring of surveillance grid 250m in each direction from sighting for four weeks, without further sign. Instigated one island wide check of all permanent surveillance stations	No confirmed rat sign. Regular surveillance checking resumed. **Assumed False alarm**	(Add hyperlink to completed interview form for this incident)
9/8/14	Ben Jones 0781 2345678	Member of public (Mary Day) reported rat sighting at grid reference SU12381235	BJ interviewed Mary same day and together visited location of sighting. Considered reliability of report to be poor, but noted almost identical location to that of 1.5.14 so instigated daily monitoring of surveillance grid 250m in each direction from sighting for four weeks and brought in additional detection methods (cameras and tracking tunnels baited with peanut butter). Instigated island wide check of all permanent surveillance stations. No sign of rats found.	No confirmed rat sign. Regular surveillance checking resumed. **Assumed False alarm**, but extra surveillance (camera) left in place around sighting	(Add hyperlink to completed interview form for this incident)

1.6 References and sources of further information

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CHAPTER 2: RODENT SURVEILLANCE & INDENTIFICATION

Contents

2.1 Why and when is rodent surveillance useful?

2.1.1 Surveillance for rodents is used:

a) during the project planning phases to confirm the species and its distribution across the project site (in conjunction with Index trapping – see Chapter 3);

b) during the latter stages of the **eradication operation** to detect any individuals not killed by the initial baiting regime. To ensure the eradication to be successful, it is vital to know if any rodents remain so that they can be dealt with before the eradication team leave the island;

c) during the **intensive monitoring check**, usually conducted two years after the last sign of rat/mouse on the island, in order to be able to declare the eradication a success; and

d) as a major component of permanent, on-going **biosecurity measures** in order to be able to deal swiftly with any biosecurity breaches and so prevent a full invasion of the island (which would then require another expensive and risky eradication operation).

2.1.2 Rodents can be detected through the signs they leave: nests, runs, droppings, footprints or feeding marks. They may also be sighted or captured in traps (live, kill or camera).

2.1.3 **If a rodent is detected** at any point after the eradication, you must be prepared to **respond immediately**. Guidance is given in Chapter 1.

2.1.4 As eradication is all about targeting *every* individual, individual behaviour must be taken into account. Deploy as many different surveillance devices and techniques as possible in order to be able to detect and identify all rodents.

2.1.5 Rodents are very difficult to detect when present in small numbers – i.e. individuals invading an island after eradication or those surviving an initial baiting attempt. However, it is crucial to detect them as soon as possible, and to determine which species of rodent is present so that your response is appropriate. Lone rats may roam widely – do not assume that where you detect the sign is where you will catch the rat. Lone rats are likely to be more interested in roaming around looking for other rats.

2.1.6 Rats and mice are prolific breeders: if you fail to spot their presence early, within a few months you may have to eradicate a large, widespread, breeding population. **Early detection and intervention is of the utmost importance. Using multiple detection devices is integral to this.**

2.2 Surveillance methods

2.2.1 Brown rats are neophobic – i.e. they are wary of new things in their environment. During the eradication, this means that detection devices (and bait stations) need to be left *in situ* for up to two weeks before rats may interact with them. For a rat which has recently arrived on an island (i.e. after a biosecurity breach), all aspects of the environment will be new, and this 'bedding in' time may be less important. If you do not detect them early, however, neophobia could still be an issue.

2.2.2 Use as many types of device as the logistics of your island and resources allow. Bear in mind the reproductive capacity of rats and mice: checking devices monthly decreases the risk that a breeding population will already be established on the island before you detect there is a problem.

2.2.3 Most devices will only show that a rodent is present. Only traps and poison will kill the rodent (or capture it so that you can kill it), but these methods cannot usually be used in the UK as part of surveillance measures due to welfare concerns and risks to non-target species.

Table 2.1 Pros and cons of surveillance methods (Adapted from Bell *et al.* 2014.)

Surveillance method	Requirements for use	Pros	Cons
Permanent plastic station	• 1 visit per month • **OR** daily if using traps/ rodenticide	• Can be used to house monitoring tools such as flavoured wax • Can target rodent incursion directly by adding bait or trap	• Non-target consumption of monitoring tools possible between checks
Wooden rodent motel	• 1 visit per month • **OR** daily if using traps/ rodenticide	• Can be used to house other monitoring tools • Can target rodent incursion directly by adding bait or trap • Can be highly attractive as new home for invading rodents (i.e. may help locate as well as detect rodent)	• Non-target consumption of bait/ monitoring tools possible between checks
Tracking tunnel	• 1 to 3 consecutive nights per month • A lure such as peanut butter can be added to the tracking cards	• Can identify species (or at least distinguish rats and mice) • Tunnels can be placed out permanently, with plates/cards added when necessary • No risk to non-target species	• Does not kill the rodent • Cards left for long periods may be unreadable due to weather/ volume of activity
Flavoured wax	• 1 visit per month • Range of wax flavours can be used (chocolate, peanut etc.)	• Can identify to rat or mouse level • Can be left *in situ* for long periods • No risk to non-target species	• Does not kill the rodent • Non-target consumption possible between checks
Visual searches	• 1 visit per month - or as often as you visit the island • Search for tracks, droppings, runs, burrows and chew signs	• May be able to identify species if you get a good look • Does not require species to interact with any detection device • No risk to non-target species	• Does not kill the rodent
Trail camera	• Strategically positioned or *ad hoc* in response to suspected sign	• Can be used to confirm whether or not suspected sign is from target or non-target species	• Does not kill the rodent
Trap station (kill)	• 3 to 5 nights per month • **Guidance in Chapter 3 must be adhered to**	• Can target rodent incursion directly (depending on species and trap size) • Allows for DNA comparison with original rodent population	• **Ideally check daily when set** • Traps must be maintained regularly to ensure functioning correctly • Potentially high non-target risks

Trap station (live)	• 3 to 5 nights per month • **Guidance in Chapter 3 must be adhered to**	• Can target rodent incursion directly (depending on species and trap size) • Non-target species can be released unharmed • Allows for DNA comparison with original rodent population	• **Should ideally be checked at least twice per day when set**
Hair traps	• 2 visits per month	• Can identify rodent species via DNA or via microscope and comparison to reference samples	• Does not kill the rodent
UV light	• 1 visit per month	• Does not require species to interact with any detection device	• Difficult to use if other mammal species are present
Sniffer dog	• *ad hoc* in response to suspected sign	• Can be trained onto the scent of specific species	• Not currently used in UK • May be legal issues

2.2.4 The scale on which detection devices are deployed depends on the stage of the project and the specifics of the island. During the eradication phase, devices are likely to be on a dense, island-wide grid e.g. up to every 25m for brown rats and smaller still for mice or black rats (i.e. one device at every bait station and one in between each station). For ongoing biosecurity purposes, only one or two devices may be needed per hectare. On larger islands, logistics may dictate that devices are limited to high risk incursion areas and large parts of the island may be left with even more sparse surveillance.

Permanent plastic stations

2.2.5 These plastic boxes can be left in place permanently with detection devices secured inside. Lethal devices can be added quickly and easily in response to the confirmed or suspected detection of rodents. If poison is placed in them, warning/poison labels should be attached to the outside.

2.2.6 The boxes contain a locking device, which requires an Allen key (or similar) to open. This makes it harder for humans to tamper with the surveillance equipment or access rodenticide (especially important on islands where children live or visit). For ease of access when no rodenticide is laid you can place rocks on top to secure the lid instead.

2.2.7 Boxes should be secured to the ground e.g. via sturdy tent pegs/weighted down with rocks. However, if there are resident mice on the island and you only wish to detect rats, you may need to place them off the ground: rats can jump higher than mice.

2.2.8 Rodents (especially brown rats) may chew on the edges of the box: in this way the box itself may also act as a detection device. They may also drag nesting material in to the box, so be vigilant for this also. Soap is a useful detection device, but does not last well in the field – however, in weather-proof boxes it may present an additional option along with wax blocks. Small 'hotel bars' are ideal.

2.2.9 Most rodenticide manufactures will also produce a plastic station in which bait can be housed. In the UK, Protecta™ boxes are often used. They can be sourced from Barrettine Environmental Health and currently (2014) cost around £9 each. This does not include the costs of postage.

Figure 2.1 Permanent plastic station raised from the ground to prevent access to non-target species. Right: Permanent plastic station, opened to show a chocolate wax detection block. © WMIL

Rodent motels

2.2.10 Rodent motels are similar to permanent plastic stations, but are made of wood (treated plywood is fine, but treat with something not likely to be off-putting to rodents). Research has shown that wooden devices can be more attractive to rats than plastic ones (Spurr et al. 2006, Spurr et al. 2007) – but cost means plastic devices are used for the bulk of permanent surveillance stations.

2.2.11 If only a few rodent motels are used, they should be placed in the highest risk reinvasion areas and optimum habitats (e.g. coastal points, amongst seabird colonies, by farms or buildings) so as to increase chances of early detection. Place a lure inside, such as a wax detection block.

2.2.12 Rodent motels should measure around 530 mm square with an internal height of 140 mm. Two 55mm diameter holes should be made on opposite walls so rodents can see an exit route. Internal dividers/baffles help to shelter an area away from the entrances, encourage a rodent to set up home.

2.2.13 If you might place rodenticide in them at any point (e.g. to respond to post eradication rodent sign) a locking device – e.g. four padlock staples, or two if you make a hinged lid) - should be built in. Alternatively, use stainless steel screws in the corners and ensure that field staff carry screwdrivers. For ease of access when no rodenticide is inside, heavy rocks can be used to secure the lid instead.

2.2.14 You can add bedding material – but if you do, be sure to document that you have done so, otherwise someone else may mistake its presence as the result of a rodent making home there.

Figure 2.2 A wooden box suitable for use a rat motel, showing entrance holes, arrangement of internal baffles and an example of a good location. All photos © Alastair Wilson.

Tracking tunnels

2.2.15 Tracking tunnels are a simple and effective tool to monitor the prints of small animals.

2.2.16 Tracking tunnels consist of a rectangular box (c. 50cm x 10cm x 10cm) with a piece of card/ paper (a tracking plate) with an inked section in the middle. A lure (peanut butter is recommended) is placed on the ink to attract rodents. Anything going through the tunnel will leave footprints.

2.2.17 Gotcha Traps www.gotchatraps.co.nz sell ready-inked cards, tunnels and pegs which are easy to transport and assemble in large numbers in the field. Tunnels cost around £5 each and ink cards around 70p each (2014 prices and exchange rate), not including postage.

Their website provides useful information on how to identify prints as well as set the tunnels.

2.2.18 The Mammal Society have tracking tunnels available through Wildcare www.wildcareshop.com These are around £15 each (tunnel and kit to make cards). They are bulkier than the Gotcha tunnels.

2.2.19 Tracking plates can also be placed in natural tunnels built from stones/wood.

2.2.20 Homemade devices can be a made using a mixture of powder paint and oil and paper fastened to a rigid, flat base. Other, more weatherproof, systems can be created using carbon coated plates or mixing: ~80g ferric nitrate (technical grade); ~120g polyethylene glycol (PEG 300/400); ~40g non-foaming, unscented concentrated detergent; and water to a total of 270g (or any multiple) for the ink, and a solution of 5% tannic acid in 75% ethanol sprayed over the paper evenly and finely.

Figure 2.3 Gotcha tracking tunnels, above, A, B (Morton & Cole, 2013). Mammal Society tunnel (below left, © www.mammal.org.uk) and DIY plate baited with peanut butter (below right).

2.2.21 Carbon-coated tracking plates can be made by painting a suspension of one part carbon powder to 10-15 parts industrial denatured alcohol (methylated spirit) onto the surface of the plate. The IDA evaporates to leave a thin layer of carbon powder on the tile, which is weather proof once dry. The method has been calibrated against rat populations of known size on UK farms, and has been used to generate indices of brown rat activity on UK islands.

Figure 2.4 Brown rat footprints recorded on a carbon-coated tracking plate. Photo © National Wildlife Management Centre (Animal and Plant Health Agency).

Wax blocks

2.2.22 Flavoured wax blocks are simple to make and deploy and can last for several months in the field. Rodents are particularly attracted to them and leave teeth marks when they nibble on them. Rodent teeth marks can be distinguished from other species that might be attracted to them (such as invertebrates, shrews, rabbits, birds).

2.2.23 Blocks can be placed in Protecta™ boxes or rodent motels, or can be simply pegged in the ground using a tent peg/piece of wire, or tied to vegetation using wire. However, they are at increased risk of interference from non-target species such as birds if they are placed in the open. They are non-toxic, but also useless if other species have removed or eaten them.

Figure 2.5 Left: large and small chocolate wax blocks.

Right: blocks in production using silicon ice cube/ cupcake moulds © WMIL.

2.2.24 Recipe for making flavoured wax blocks (from WMIL):

Makes approximately 30 large or 60 small blocks.
Equipment:
Standard 25 cm saucepan
Gas ring and gas bottle (Can use a hob, but it is a messy business: may ruin your cooker)
Silicon cupcake tray (12 large or 24 mini)
Wooden spoon for mixing
Heatproof glass jug for pouring

Chocolate wax:
Ingredients:
12 standard white wax candles
5 heaped tablespoons of **pure cocoa powder** – **N.B. Do not use drinking chocolate as it burns**

Instructions:
6. Melt candles in pot, remove wicks, add cocoa powder and stir thoroughly to mix.
7. Then carefully pour into the silicon tray using the heatproof jug. Just before wax sets, put a hole through centre of the block. Another option is to let the wax blocks set overnight and then drill a hole using a battery-drill. Alternatively put a bent paperclip (for tying to vegetation) in the centre of the wax block while it sets.

Coconut wax:
Ingredients:
12 standard white wax candles
5 teaspoons of coconut essence (or ½ block of creamed coconut)
1 heaped tablespoon of pure cocoa powder (cocoa is added to make teeth-marks easier to see on the wax block)

Instructions:
Melt candles in pot, remove wicks, add cocoa powder and stir thoroughly to mix. Take off the heat and add coconut essence one spoonful at a time taking care as the mixture will bubble and fizz.
Then as from instruction 2, chocolate wax recipe, above.

Peanut wax: N.B. Does not last or store as long as chocolate or coconut wax.
Ingredients:
12 standard white wax candles
½ jar of smooth peanut butter

Instructions:
Melt candles in pot, remove wicks, add peanut butter and stir thoroughly to mix. Do not leave on a high heat too long as the peanut butter can burn.
Then as from instruction 2, chocolate wax recipe, above.

2.2.25 Plain candles can be used during the intensive monitoring phase, but are considered less reliable for detecting very low numbers of rodents. Consider them an extra device rather than a primary technique, especially for biosecurity purposes.

2.2.26 WaxTags^{R} (a wax lure mounted on a plastic tag which can be stuck in the ground) can also be purchased and used in a similar manner to wax blocks.

2.2.27 **Flavoured resin** is an innovative device developed by Jenny Daltry/Flora & Fauna International, which mixes plastic with cocoa, meat gravy or other flavours: it *might* be less attractive to non-target species but has not been widely tested in the UK to date. More information and recipes are available.

Visual searches

2.2.28 Searches for rodents or rodent sign can be conducted at any time or place on the island and require no equipment. See 2.3 below for information on identification of rodents and rodent sign. If you need help confirming sign, photograph it *in situ* alongside an object that will help determine size (e.g. a coin, pen lid, match), collect all that you can (e.g. *all* droppings/carcass/chewed item) and seek expert advice (see Chapter 1 for further information).

2.2.29 Sightings of target rodents are *most likely* at night around the coast or buildings. Mud and sand are good places to look for footprints, although the prints are quite different and can be harder to identify than those left in tracking tunnels. Droppings may be left in latrines along runs or near burrows. Target species may nest in cavities and buildings as well as burrows. Brown rats leave oily marks along their regular routes – e.g. walls or trees. Chew signs may be found on egg shells, seeds, bones, wood and woody vegetation, and plastic (e.g. rubbish along beaches).

Trail cameras

2.2.30 Rodents can be detected by identifying them in either still images or video from (night vision) trail cameras. There are a number of trail cameras available in the UK, costing £100-300. Bushnell® Trophy Cams were used during the St Agnes & Gugh (Isles of Scilly) brown rat eradication. Cameras can be set to record still images or short videos at specific times or when the motion sensor detects movement. They are particularly useful when suspicious but unconfirmed sightings or sign have been reported. They can be left to record over multiple days.

Figure 2.6 Night vision cameras were used to confirm last remaining black rats were feeding on poison bait (Dog Island, Anguilla, 2012 © WMIL)

Traps – Live and kill

2.2.31 Traps should be used in response to detecting rodent sign post-eradication: some traps are designed to fit into permanent stations such as T-Rex™ traps in Protecta™ boxes.

2.2.32 However, great care and consideration must be given before using traps – either live or kill - as part of on-going surveillance, due to the potential risks to animal welfare and non-target species. Tracking tunnels are more likely to detect rodents in small numbers than traps.

2.2.33 If you do use traps, you must adhere to the guidance provided in Chapter 3.

Hair traps

2.2.34 Sticky traps (glue boards or tape traps) can be used to help identify some animals by collecting hair, fur or skin. DNA can then be used to confirm the species.

2.2.35 Glue traps should **only** be used if they are registered and appropriate to use at the site. They **should not be used to trap animals – it is not humane**, but rather to collect fur/hair. **Set them so that the tape / glue is on the roof of a tunnel.** A full assessment of risk is required before use.

2.2.36 Alternatively, a hair trap using **Velcro**™ can be made using a small diameter drainage pipe (or a bait station from the initial eradication) with a piece of adhesive Velcro™ attached to the top or side of the pipe – this is **far preferable to the risks associated with using 'upside-down' glue traps**. Velcro™ can also be placed on entrances to wooden motels, permanent plastic stations, tracking tunnels etc.

2.2.37 Hair should be preserved by wrapping it carefully in paper and placing it with silica desiccants in a paper envelope. DNA can be extracted from the hair follicles.

UV light

2.2.38 A UV light passed over sites of suspected rodent activity at night, will cause urine to fluoresce. Urine of other mammal species will also fluoresce, however, so this is likely to be of limited use.

2.3 Rodent identification

2.3.1 There are several publications and guides to assist with the identification of mammals (e.g. Macdonald & Barrett 1993, Cunningham & Moors 1996, Bullion 2001, Sargent & Morris 2003, Howie et al. 2007, Agnew 2009, Gillies & Williams 2009a, Gillies & Williams 2009b.) Many of these are available for download as PDF files. They should be used to supplement this guide.

2.3.2 Knowledge about the ecology and behaviour of target rodents can help you design suitable surveillance strategies, determine which species are present, and help you plan your response.

Table 2.2: Key features of UK target rodents

	Brown rat	Black rat	House mouse
Senses	Acute smell, touch and hearing	Acute smell, taste, touch and hearing	Acute sight, smell and hearing: Large eyes
Habitat preference	Associated with water (but live in range of habitats). Move along edges of structures, rather than out in the open	Associated with forests and vegetated areas (but live in range of habitats): tracks and runs on the ground are common despite arboreal preferences	Full range of habitats (commonly associated with humans)
Swimming ability	Excellent swimmers up to 4 km	Known to swim up to 750m	Excellent swimmers up to 500 m
Climbing ability	Agile (but less so than black rats) Can jump up to 1m	Incredibly and often unbelievably agile (and skilful) – can jump up to 1m	Agile and can jump up to 0.5m
Activity	Predominately nocturnal – may be seen in day	Predominately nocturnal –but can be seen in day	Predominately nocturnal – but often seen in day, esp. in summer
Behaviour	Neophobic (wary of new things)	Neophobic (but less so than brown rats)	Not neophobic (investigate new things)
Breeding habitat	Extensive burrow nesters	Nest in trees or under vegetation	Burrow and cavity nesters (wood piles, banks, buildings)
Nesting materials	Grass, newspaper, cardboard, leaves, feathers	Usually vegetation (twigs, leaves) or feathers, but can use paper/card	Vegetation, feathers, human materials (e.g. newspaper)
Life span	12 to 24 months	12 to 18 months	12 to 18 months
Home range	0.1 to 3 ha depending on food availability/ habitat quality	0.1 to 1 ha depending on food availability/ habitat quality	0.5 to 2.5 ha
Feeding	Often cache food in burrows. Omnivorous, opportunistic. Eat 30g/day	Often cache food. Eat 15g/day	Omnivorous, opportunistic. Do not need a water source.
Breeding cycle	Can breed all year round	Can breed all year round	Can breed all year round
Gestation Weaning & Sexual maturity	24 days 28 days 2-3 months	20-22 days 21-28 days 3 months	19-21 days 20-23 days 6-8 weeks
Number of young	3-10 (usually 6-8)	3-10 (usually 5-6)	2-12 (usually 6-8)
Other	Small groups live in colonies: young males evicted as they mature or when the colony becomes overcrowded	Do not live in colonies (unless in urban areas): prefer to disperse throughout the available area	Can be found in environments with no water (obtain water requirements from food)

Sightings & corpses

2.3.3 'Black' rats can look very similar to 'brown' rats: most black rats are not black. Although black rats are not common in the UK, they are associated with ships (another common name for them is the

ship rat) and are likely to be present in a number of UK port towns. As such, there is an ongoing biosecurity risk from black rats as well as brown rats and you should be familiar with identifying them.

2.3.4 The feet (colour and size) of house mice can be used in combination with ear size to distinguish them from juvenile rats: juvenile rats will have larger feet and ears than an adult house mouse.

2.3.5 If identification is in doubt, preserve *at least* the head for later detailed examination (either triple-bagged and frozen or in 75% ethanol). If you keep the whole specimen, open the gut cavity.

Table 2.3: Identifying features of the key target species

	Brown rat ***Rattus norvegicus***	**Black rat** ***Rattus rattus***	**House mouse** ***Mus musculus***
Tail	Heavy short tail: no longer than head-body Pale underside	Long scaly tail ≤ 250mm: no shorter than head-body Uniform colour	Long tail, 50-100mm: similar to head-body length Uniform colour
Ears	Small ears: do not cover eyes 14-22mm Obvious hairs extend beyond edge of ear	Large ears: cover eyes when pulled down 19-26mm Fine hairs do not extend beyond edge of ear	Large, round ears 12-15mm
Hind feet	Pale 30-42mm long	Dark, hairy 28-38mm long	Small, thin, grey 15-19mm long
Body & head-body length	Long, stout body Up to 275mm	Long, slender body Up to 230mm	Slender body 70-100mm
Average weight	450g (can be up to 600g)	Up to 350g	10-25g
Colouration	Brown back with long, dark guard hairs Pale grey belly	**Three colour morphs** ***rattus:*** black back, dark grey belly ***alexandrinus:*** brown back, pale grey belly ***frugivorous:*** brown back, white or cream belly	Dull brownish grey back Grey, brown or white belly
Nipples	12	10-12, usually 10	10-12

Figure 2.7 Colour phases of rats found in the UK (Photo © WMIL)

From left: The three common colour morphs of black rats – *Rattus rattus alexandrinus*, *R.r. frugivorous* and *R.r. rattus*. Brown rat (*R. norvegicus*) is on the right.

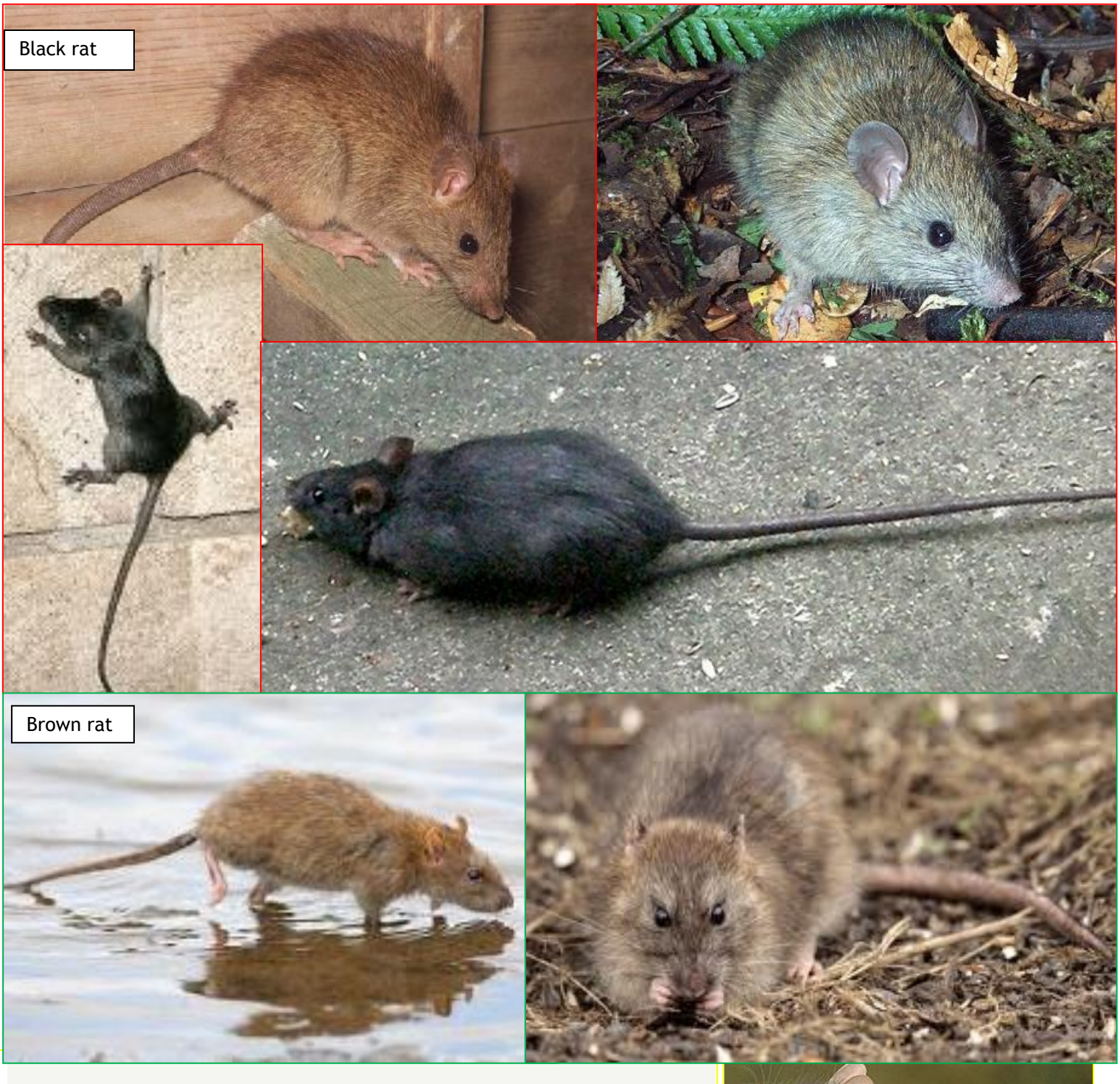


Figure 2.8
UK invasive rodent species

Droppings

2.3.6 Rodent droppings can be very variable (depending on diet), including in colour, but as a guide:

Brown rat	Black rat	House mouse
-13-19mm long, -3-4mm thick -Rounded ends, one end may go to a point (as pictured) -Likely to contain fur -Often located in latrines along tracks, at feeding sites and on prominent rocks	-7-14mm long -3-4mm thick -Tapered ends -Often slightly curved -Likely to contain fur	-4-8mm long -2mm thick -Small and thin -A bit like grains of rice -Strong smell of ammonia.
		

Figure 2.9 Droppings of UK invasive rodents. Images: taken from Morton & Cole 2013

2.3.7 **Rabbit** or **goat** droppings be mistaken for rat droppings, though they are usually more spherical (particularly rabbit) and uniform. Goat droppings may be more cylindrical but with flatter or round, rather than tapered ends. Breaking up droppings should help (wear gloves): rabbit and goat droppings just contain vegetation, whereas rat droppings are likely to contain fur and a range of food stuffs.

2.3.8 **Shrew** droppings – typically 2-4mm long and 1-2mm thick, these should be smaller than rat or mouse droppings. However, evidence from St Agnes and Gugh (Isles of Scilly) shows shrew droppings can be much larger than this. They are of a sandy consistency and are largely comprised of insect remains, whereas rodent droppings generally contain a wider array of food sources. Rat droppings usually contain fur as they are extensive groomers.

2.3.9 **Vole** droppings are fairly uniform, cylindrical and tend to be rounded at both ends. Water vole droppings are 7-10mm long and 3-4mm wide and are those which are most likely to be confused with brown rat droppings. Rat droppings are usually tapered at one end (and are likely to contain fur/wider range of food sources). Droppings from smaller species of voles cannot be distinguished, but their uniform nature may help distinguish them from mouse droppings.

Figure 2.10 Invertebrate droppings

2.3.10 **Wood mouse and yellow-necked mouse** droppings look short and thick compared to house mouse droppings.

2.3.11 **Invertebrates,** e.g. **rose chafer beetles** may produce piles of frass that could be mistaken for a rat latrine (right). However, their droppings are likely to be more prolific and uniform.

2.3.12 DNA testing can be done to confirm species. Droppings should be photographed *in situ* and then *all* of them should be collected, not just a sample. See Chapter 3 for more details.

Teeth marks

Black rat / Brown rat	Mouse
• Marks consist of two parallel grooves • 1mm wide per groove (2mm per mark) • 'Messy' eaters – chew in all directions	• Marks consist of two parallel grooves • 0.5mm wide per groove (1mm per mark) • 'Neat' eaters – often chew around edge
	

Figure 2.11 Rodent teeth marks All photos © WMIL

2.3.13 **N.B.** Distinguishing between mouse species or voles and mice is not possible (the bottom mouse image is a wood mouse, the top a house mouse). Incorporating lures into wax/resin which are unlikely to be attractive to non-target species such as voles (e.g. meaty gravy) could be helpful if interference with detection devices is a problem, but this has not been widely tested to date.

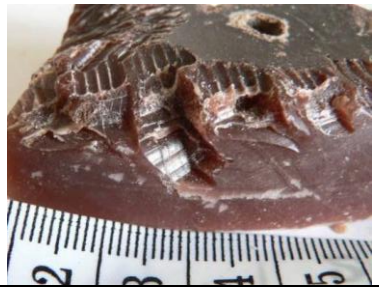
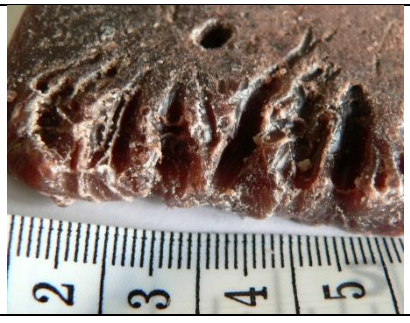
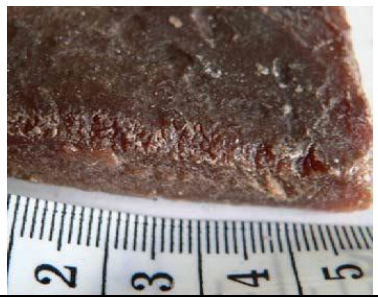
Rabbits can have split incisors, making four parallel grooves that are similar to rat sign. There would be two large bite marks from the bottom teeth (larger than the 1mm groove for a rat) per four grooves.	**Birds** tend to leave deep gouges which start at a point and are triangular. They are often curved rather than straight. They may also leave peck marks.	**Shrew** marks are very distinctive, with tiny, pin-like scratches less than 0.5mm wide. They may have a triangular shape as individual grooves build up over time.
		

Figure 2.12 Teeth marks of common non-target species. All photos © WMIL

Footprints

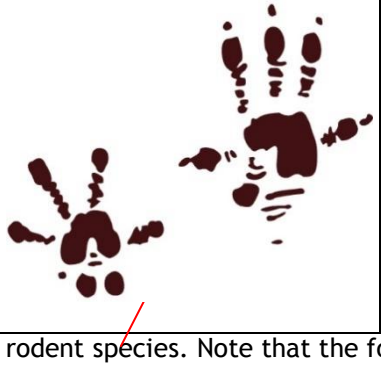
Black rat	Brown rat	House mouse
4 toes on front feet, 5 on rear 28-34mm long Clear split in hind foot central pad	4 toes on front feet, 5 on rear 30-42mm long Solid hind foot central pad	4 toes on front feet, 5 on rear 15-23mm long.
 (not to scale)		

Figure 2.13 Footprints of UK invasive rodent species. Note that the footprints of black rats shown here are similar to those which would be left on tracking tunnel plate, while those of the brown rat and house mouse are similar to those that would be left in a soft substrate such as mud, which allows more detail to be seen (see Figure 2.14). http://www.pestdetective.org.nz/ is a good resource for identifying sign.

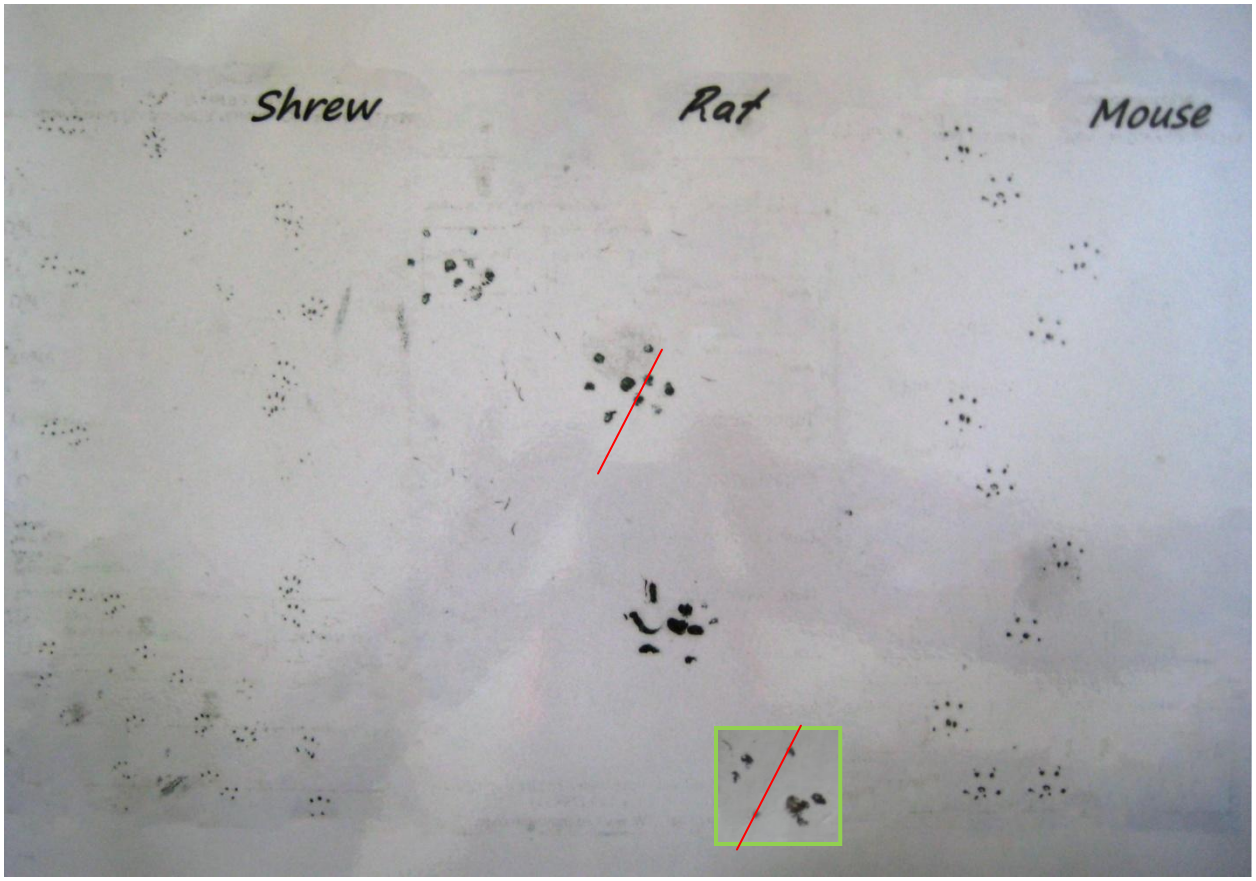


Figure 2.14 Size comparison of rat, house mouse and shrew prints:

2.3.14 Rat prints are similar in size to squirrel prints, but can be distinguished by drawing a line between the first and last toes. In rat foot prints the line will pass through the central pad, but this is not the case for squirrels (inset image in green box).

Figure 2.15 Rat prints in sand (above left), mud (above right) compared to tracking plate (below)

Nests and other signs

2.3.15 If you encounter baby rodents in a nest, install a trail camera to confirm the species, and take further action accordingly.

Black rat

Brown rat burrow and nest

House mouse

Figure 2.16 UK invasive rodent nests and burrows

Figure 2.17 Burrow system of brown rat on coastal cliffs. Search for other signs around the entrances to a burrow system, such as droppings.

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CHAPTER 3: RODENT TRAPPING & DNA SAMPLING

Contents

3.1 Why and when do you need to trap rodents?

3.1.1 There are a number of reasons why trapping rodents is required, most usually when you need the rodent itself, rather than just evidence that a rodent is present. There are occasional other uses for trapping, also. **However, animal welfare must be a primary consideration when using traps. Animal welfare may render traps - both live and kill - unfit for use.**

3.1.2 Trapping can/should be used:

a) To obtain genetic material (DNA) to **help assess a project's feasibility - is eradication sustainable** or are rats likely to reinvade quickly?
- A genetic comparison should be made between the animals on the target island with those of likely/possible source populations on the mainland or neighbouring islands, particularly those within twice the known swimming distance of the target species. This involves taking representative DNA samples from each population (See 3.5 below).
- Results are used to estimate the frequency of animals invading the island - or the 'connectivity' of the island's rodent populations with potential source populations - which will support a decision on whether or not eradication is the best course of action.
- However, recent research shows that newly arriving rats are less likely to become established on islands where rats are already present (Fraser et al. 2015). This means that rat populations on two islands may be genetically distinct despite rats being able to move between them. The results of DNA genetic comparison studies should therefore be interpreted very cautiously, especially where the islands are within or close to the known swimming distances for rats.

b) To obtain DNA to **assess rodenticide resistance** in the island rodent population, and so be able to identify a toxin that is likely to achieve a 100% kill rate – i.e. **is eradication technically feasible**?
- Resistance to a number of rodenticides is known in the UK, including from islands. Tests for some types of resistance are available and require DNA samples in order to be conducted.
- **N.B.** There is a trade off between applying early for rodenticide permissions and conducting early resistance testing & conducting resistance testing closer to the time of eradication and applying later for the rodenticide permits. **Seek advice**.

c) To obtain DNA for **biosecurity planning** purposes.
- DNA samples can be used as the basis for a genetic comparison if rodents are discovered and collected on the island after the eradication in order to gauge whether there was a reinvasion or the eradication attempt failed. This can only be done if DNA samples are taken prior to the eradication. It may be possible to get a university or resistance testing facility to store the DNA strand information for the project in one of their long-term DNA/resistance mapping projects.
- This knowledge is crucial: if there has been a reinvasion you will need to revisit biosecurity arrangements. If the initial eradication failed, you need to re-evaluate the Operational Plan and Operation Log and determine the cause of failure and whether or not it can be addressed if a fresh eradication attempt is made.

d) To determine the exact rodent/target species present on the island, gain insight into abundance and spread across the island to assist with the **Feasibility study** and also

Operational planning, and gain insight into their diet (e.g. to help demonstrate the **project need**).

- Ensuring correct rodent identification is important, for example, to determine the required grid size across the different project areas
- An idea of abundance and spread can be gained by Index trapping (see 3.3 below). If there are hotspot areas, a smaller grid may be required in these areas. In areas of low rodent density (e.g. in poor habitats such as bogs) it may be possible to reduce the number of grid points.

e) If the presence of house mouse/other invasive rodents is unknown – i.e. as **part of the assessment of the project's environmental-acceptability (Feasibility Study).** It is important to determine whether or not there a rat-suppressed house mouse population with potential for mesopredator release, for example.
   - If mice are present, your project objectives may need to change (you may need to target mice as well). If you do not target mice, you will need to assess the likely environmental impact of replacing a rat population with a potentially invasive mouse population.
   - To determine if mice are present, 'trap out' rats from an area of good house mouse habitat (e.g. around buildings), protect the area from rat reinvasion (e.g. by rat-proof fencing), allow time for mice to respond/population to recover and implement a mouse surveillance programme. An area approximately 1-5ha should be trapped to ensure that there are enough mice present to produce a measurable response to the lack of rats within a reasonably short time. Historical information and/ or consultation with residents may also provide information on the presence of mice. Setting traps specific for small mammals (e.g. Longworth live-capture traps), tracking tunnels and camera traps can also be useful ways of determining the presence of mice

f) In the lead up to an eradication attempt using toxins, routine rodent control using such products must stop (**implementation of Operational Plan**).
   - This is most likely to be necessary on inhabited islands, but control using rodenticide may also be in place on uninhabited islands.
   - Rodenticide use for routine control purposes should cease at least six months before the start of the eradication operation. In between times, residents may wish to have an alternative control method to the use of poisoned bait. Traps should be provided to the residents by the project (free of charge), and a suitably skilled person should provide training in proper trap use. You must ensure guidelines (1.2 below) are followed.

g) As a **complimentary eradication technique** used, for example, around homes and food stores.

N.B. Traps are not effective tools for eradication unless used in combination with anticoagulant rodenticides (although future developments in trap design or efficiency may increase their role in eradication projects).

- You must ensure guidelines (3.2 below) are followed.

h) To respond to a confirmed rodent sighting towards the end of the eradication operation or at any point after it (**eradication** and **biosecurity implementation**)
   - If a rat/mouse is discovered on a recently cleared island, an emergency response should be initiated to locate and kill it. As many different detection and capture devices as possible should be deployed in the area, including traps. **N.B.** Traps are not usually used as part of on-going surveillance for rodents, but are deployed in response to a rodent being detected by other devices.

- Any captured rodent should be necropsied to determine whether or not they are already breeding on the island – and so to help assess at what stage the invasion may be at/whether there are more rodents that require capture (see 3.4 below).

3.1.3 In addition to the DNA samples, other information important to the project can also be obtained from trapped rodents (e.g. breeding status of population, population structure). Follow the guidance in 3.4 (below) to obtain this information from the animals you capture.

3.2 Guidance on the use of live and kill traps for rodents

3.2.1 You must ensure that all trap use as part of the project, or resulting from the project, is in accordance with these guidelines.

3.2.2 Animal welfare should be a primary consideration when using traps: animal welfare may render traps - both live and kill - unfit for use.

3.2.3 **DO NOT USE LIVE TRAPS IF THERE MAY BE ACCESS ISSUES WHICH MEANS DAILY CHECKING CANNOT BE GUARANTEED.**

3.2.4 Traps should be set at dusk and checked and disarmed at dawn. The target species are most active at night, so this increases the chances of trapping successfully whilst also reducing the chances of catching non-target species.

3.2.5 Live traps may be useful if there is a high risk of non-target casualties resulting from the use of kill traps. However, live traps will need to be checked ***at least twice a day*** as any animal caught in them is protected by the Animal Welfare Act (2006) (making it an offence to cause unnecessary suffering). Live traps must be placed so that any captured animal is protected from weather and temperature extremes or flooding.

3.2.6 Spring traps (e.g. Fenn and DOC traps) should be checked ***at least once per day*** as a kill cannot be guaranteed. Only spring traps designed to catch and kill rats or mice humanely, listed by the relevant Spring Traps Approval Order and used in accordance with the stipulations of the Order may be used. Approved kill traps have to cause irreversible unconsciousness within 5 minutes (300 seconds) in 80% of captures. Fenn traps are currently legal for use in the UK but are likely to be withdrawn for stoats in the near future due to their failing to meet the AIHTS standards (Agreement on International Humane Trapping Standard). New Zealand DOC traps are relatively expensive, bulky and must be used inside bespoke wooden tunnels, but they achieve very high kill rates, with a high catch efficiency. They are not, however, suitable for catching mice.

3.2.7 Spring traps approval is a devolved issue. Relevant documents can be found on http://www.legislation.gov.uk Check you are referencing the correct Order (and for updates):

- **England (2012)** Update (2015) Update (2016)
- **Northern Ireland (2012)**
- **Scotland (2011)**
- **Wales (2012)**

3.2.8 Break-back (snap) traps may be used against rats and mice. They are not subject to the Spring Traps Approval Order so any models can be used. However, Baker et al. (2012) assessed the performance of break-back traps available in the UK, with a view to their humaneness and found that strength and performance varied widely between models. Seek advice from professionals in the field before selecting trap types. Trapper T-Rex™ traps and Victor Professional™ break-back traps are easy to carry in the field and set, but may not kill particularly large brown rats. Ideally, break-back traps should also be checked once a day.

3.2.9 It is illegal to use leg-hold traps (gin traps) in the EU. There are serious welfare concerns surrounding the use of glue boards and these should not be used (unless set upside down to capture hairs as part of surveillance (see Chapter 2), though using Velcro is preferable.

3.2.10 Goodnature A24 traps (self re-setting multi-kill devices) have been approved for use in England against rats (as well as stoats in areas where they are not native). Approvals for use in the other UK nations are also likely but updates to the individual countries Spring Traps Approval Orders need to be made before they can be used there. Check http://www.legislation.gov.uk for updates.

3.2.11 Even approved kill traps may not kill all animals that enter them: all personnel involved in checking traps should be trained in killing injured or maimed animals in a humane, legal and efficient manner. It is illegal to release some non-target species in the UK (such as grey squirrels – see Section 14 of the Wildlife and Countryside Act for full lists). You must have a plan for dealing with the accidental capture of such species – e.g. personnel must be trained and prepared to kill these species also, even if they are not harmed in the trapping process, or to transport them to a rescue centre where they will live in captivity.

3.2.12 **All set traps must be covered** so as to reduce the likelihood of non-target species being maimed or killed. Covers should be designed so as to guide the rodent into the front of the trap to increase the likelihood of a clean kill: e.g. by building a natural or artificial tunnel, or placing in a bespoke rodent surveillance box (see images below).

3.2.13 A full assessment of risks to non-target species should be conducted prior to setting traps and appropriate mitigation measures installed. For example wire, or similar, should be placed across the entrances of covers to **reduce the entrance size**. This should be covered in the Environmental Impact Assessment (as part of the **Feasibility study**). Be aware that such measures may make it less likely that your target species will enter them.

3.2.14 Place traps where there is plenty of natural cover and where rodents are likely to be active e.g. alongside walls, buildings or large rocks, around the base of trees, or near any rodent sign.

3.2.15 **Break-back (snap) traps must be tied firmly** with strong string or wire to vegetation or held by a firmly set peg, so that injured animals cannot drag them away or be dragged away by scavenging predators.

3.2.16 Break-back traps should be set in pairs, back to back. Leave a slight gap between them so one trap can be set off without triggering the second. If both rats and mice are present, or if you are unsure which rodents are present, set a mouse and a rat trap at each site. If only rats or only mice are present, set two traps of the appropriate type. Always use the right trap: large rats may escape from mouse traps (or not be killed cleanly), whilst mice may not trigger rat traps.

3.2.17 A lure (commonly known as 'bait' but not be confused with poison bait containing rodenticide) should be placed between traps if one cannot be placed in each trap. A mixture of rolled oats and peanut butter is recommended, but chicken eggs, chocolate, fish oil, and bacon can also be used. Use a protein bait for brown rats.

3.2.18 Ensure traps are on a level surface and are stable so that they don't move/rock if pressure is put on any corner or side of the trap.

3.2.19 Traps need to be maintained. Un-galvanised traps may rust quickly if used outside, reducing their efficacy. Metal parts can be treated with fish oil or wax but anti-rust sprays may deter rodents. Disarming traps each morning helps prevent jamming. Take traps in when not in use.

3.2.20 Some traps are capable of breaking a person's fingers. Ensure you only ever handle a set trap from the back. Refer to guidelines for individual trap types and seek assistance if unsure. Cover safe trap handling within the Health and Safety Plan.

3.2.21 Rodents are carriers of diseases which can be fatal to humans. Appropriate measures should be taken to ensure people handling rodents and rodent carcasses are protected, e.g. cover scratches and cuts, wear gloves and wash hands thoroughly before eating, drinking or smoking. Cover safe rodent handling within the Health and Safety Plan.

Figure 3.1 Above: Two (set) Trapper T-Rex™ traps back to back in a homemade wooden tunnel. The entrance to the tunnel restricts entry by larger species and prevents the trap being dragged away. The gap between traps prevents them setting each other off. Below: The same in a natural tunnel made of branches (shown both open and covered). Images © WMIL.

Figure 3.2 (left): trap set and placed within a lockable plastic box (Protecta™) and (right) station closed and secured to post with wire. Single trap use like this is most likely in response to an incursion or reinvasion (biosecurity breach), rather than initial scoping and planning phases. Images © WMIL.

3.3 Index trapping

3.3.1 Index trapping helps assess the density and distribution of rodents over the island, which in turn can inform operational planning (e.g. grid density in different parts of the island). It can also be used to compare populations between years, although it is important to recognise that lower abundance does not equate to 'easier to eradicate'. For best results, use a mixture of methods to determine abundance (e.g. index trapping and tracking tunnels or wax chew blocks – see Chapter 2 for information on using surveillance devices).

3.3.2 Abundance (or rat density) is recognised as low (less than 10%), moderate (between 11-25%), high (between 26-50%) and very high (over 50%) (King 1990, Moors 1985). Islands usually vary between 5-25%. The % figure is also known as 'rats per 100 trap nights' (see below).

3.3.3 Always use the same brand of trap and the same lures for index trapping to enable comparison (differences in their effectiveness will otherwise bias your results). Break-back (snap) traps are the most commonly used type for index trapping.

3.3.4 An index line should consist of at least 25 trapping sites evenly spaced within the same habitat type (e.g. grassland, woodland), with two traps per site. Try to place traps in sites likely to appeal to rats – see 3.2.14 for guidance while keeping to the correct distance spacing. The distance between pairs of traps should be as large as possible, within the range of 25-50m. Keeping the distance between pairs of traps equal within and between trap lines in different habitats means their results can be more meaningfully compared. Index lines are usually run for three consecutive nights. A minimum of 100 corrected trap-nights should be achieved in each habitat: fifty traps (one index line) for three nights gives a *maximum* of 150 trap-nights; this number will be reduced if any traps are found to have been set off without capture ('empty & sprung').

3.3.5 Place trap lines in different habitats across the island to determine relative abundance.

3.3.6 Number each trap and record its position using GPS. Keep accurate records for each trap (e.g. 'no take & unsprung', 'bait taken but unsprung', 'empty & sprung', 'rodent captured') and make note of the weather conditions overnight.

3.3.7 The Abundance Index is a measure of the number of individuals captured adjusted by the number of traps deployed (Cunningham & Moors 1996):

Factor	Calculation
50 traps run 3 nights 16 rats caught 9 sprung, empty traps	Total trap nights (TTN) = number of traps x number of nights • TTN = 50 x 3 = 150 Lost trap nights (LTN) = ½ (captures + sprung, empty traps) • LTN = ½ (16+9) = ½ (25) = 12.5 Corrected trap nights (CTN) = TTN – LTN • CTN = 150 – 12.5 = 137.5 Index of Abundance (IoA) = captures x 100 / CTN • IoA = 16 x 100 / 137.5 = 1600 / 137.5 = 11.6 **rats per 100 trap nights** = **11.6%**

3.4 Necropsy, measuring and sexing rodents

Try to collect the following information from the animals you capture:

1. **Date of capture** and **trap location**
2. **Head-body length (mm)** – taken from tip of nose to end of anus
3. **Tail length (mm)** – taken from middle of anus to tip of tail
4. **Hind foot length (mm) -** taken from heel to tip of longest toe, record measurements both including and excluding claw (to allow comparison with results from other researchers)
5. **Ear length (mm) -** taken from bottom of the notch of the ear to furthest point along the rim
6. **Weight (g)**
7. **Age** – juvenile or adult (see below)
8. **General body condition** – condition of coat (shiny/ dull), presence of scabs, damage to the tail and ears, injuries, parasites and other general comments
9. **Sex -** see below
10. **Breeding condition** - see below. If nipples are large with little hair around them, check to see if the female is lactating.
11. **Stomach contents**

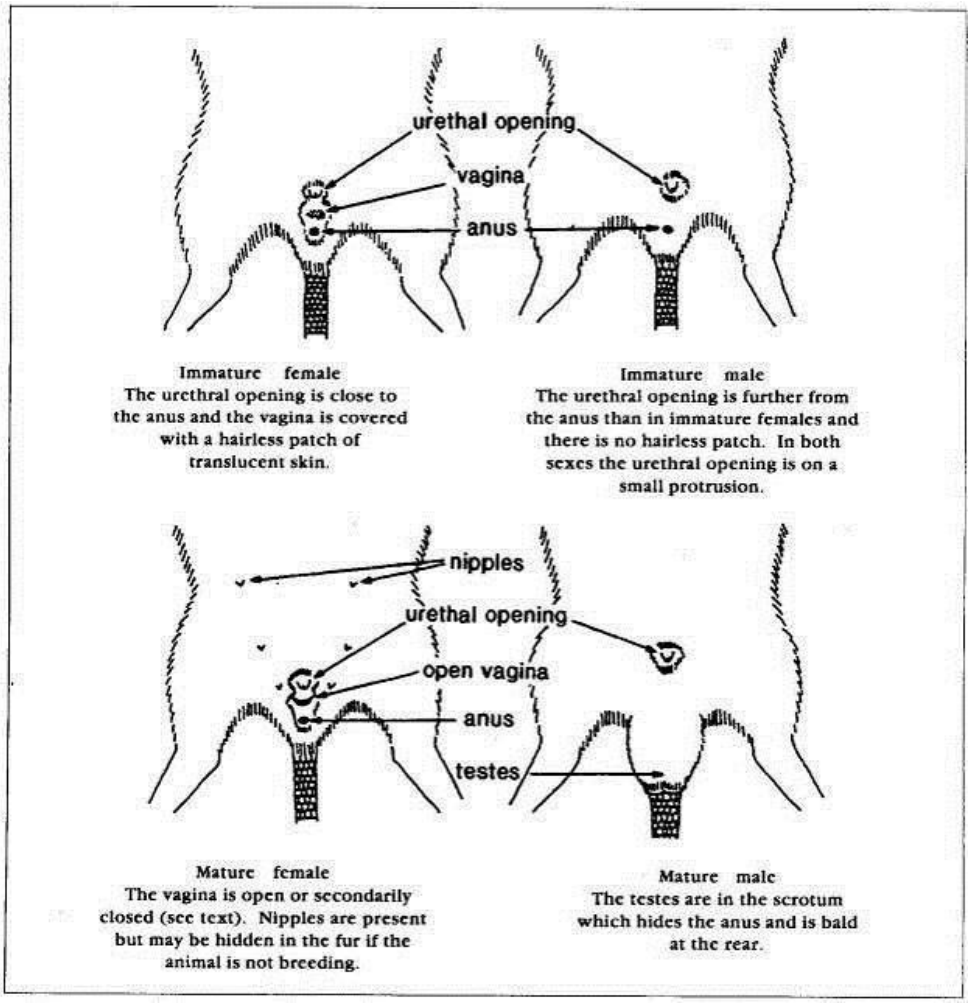

Figure 3.3 Guide to rat breeding condition. Secondarily closed vaginas can be easily opened with a probe, those of immature rats cannot. From Cunningham & Moors (1996)

3.5 Guidance on the collection of DNA samples

Adapted from Russell (2006) (contained within New Zealand DOC, 2008)

Sample collection

DNA can be found on almost any item that has been in prolonged contact with a living body. For island biosecurity purposes the best sources of DNA are from bodies (tissue), hair or faeces. DNA can only survive outside of living organisms if it is preserved correctly. For island biosecurity purposes DNA will become very hard to isolate after the sample has been exposed for more than 3-4 weeks.

- Collect samples from at least 20 individuals per target species for each DNA study: more is better.
- For each rodent, cut off a 3-4cm length of tail using sterile equipment (scalpel/knife/scissors), place it in a collecting vial and immerse it in 70-95% ethanol (the higher % the better). ANY piece of flesh can be used if the tail is not intact.

- NEVER mix samples from different individuals in the same vial. Ensure blood or tissue from one individual never contaminates the sample of another (from a dirty knife/scissors/gloves etc).
- The closer the sample is taken to the rodent's death, the better.
- If possible, keep the sample refrigerated.
- If you cannot use ethanol, samples should be frozen - triple bag each sample.
- Label your samples properly with date, type of rodent, location (preferably GPS-ed), collector and part of the rodent sampled. Consider double labelling on both the outside and inside of vials.
- Procedure for faeces – faeces should be preserved in ethanol or frozen. Collect as much as is available (i.e. 20 droppings are more valuable than just one).
- Procedure for hair – microscopically visible features on the hair itself may allow for species identification, however, by preference you want to pluck hair so as to obtain hair follicles. Aim for at least ten hairs and obtain guard hairs if possible. Hair needs only to be wrapped in paper and placed in a paper envelope with some silica desiccant beads.

Analyses

It is important to choose the right type of genetic analysis. Methods for identifying the species may be different to those for identifying the likely origin of an individual for example.
DNA can be used to determine where an individual has come from. Generally microsatellite markers are the most informative at the population (island) level. You will need genetic samples from all likely locations that you think an individual might have come from; otherwise you can only tell that it didn't come from the place(s) from which you collected samples.

Contamination

Contamination from different species is not a major issue in DNA analysis. If a person has touched rodent faeces then the DNA extracted from them will still clearly appear as rodent DNA. This will be obvious to the scientist doing the analysis. Contamination from the same species, however, is a major issue: ensure equipment is thoroughly cleaned/sterilised after each sample is taken.

Costs

Costs will depend on who you get to perform the analysis for you, what type, how well preserved the DNA is, and whether the laboratory is set up for analysing this species. As an indication, to analyse one rat sample is likely to cost more than £100. To analyse many samples costs may go down to as low as around £25 a sample. If the lab is already doing some work on this species, then costs may be lower still. Most costs are in buying start-up chemicals specific to the species you are working on so analysis may be cheaper if a laboratory is already set-up for rodent DNA analysis. You may be able to get some analyses done for free, e.g. if the samples can be used by a researcher or student in their work.

While the financial cost of such DNA analysis can be significant for larger islands or those with multiple possible source locations (where more sampling is required), it is far lower than the financial and social costs of having rodents quickly reinvade an island.

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3.6 Rodent trapping equipment

- Kill traps (break-back traps are the usual choice) (e.g. 150)
- Trap covers (half the trap number, if setting in pairs – every trap must be covered)
- Lures/ non-toxic bait, such as peanut butter (e.g. 450 'doses' for three nights of trapping: assume you need to replace each night)
- Wire/sturdy tent pegs to secure every trap / cover
- String to tie the traps to the tent pegs (to prevent them being dragged away by injured rats)
- Marking poles & flagging tape (to help locate traps)
- Plastic tags (to number traps) and warning labels
- GPS device
- Notebook & pencils/pens
- Nitrile gloves
- Vernier callipers
- Scales/ balance for weighing rats – electronic or spring balance or even basic kitchen scales
- Ruler/tape measure
- Sharp scissors, knife, scalpel
- Forceps
- Collecting vials (e.g. at least 30) and sealable bags (e.g. zip lock bags)
- Ethanol
- Sterilising equipment

3.7 References and sources of further information

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