ANNEX 3: RODENT SURVEILLANCE AND IDENTIFICATION

Contents

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1 Why and when is rodent surveillance useful?

1.1.1 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 Annex 2, Section 3);

b) During the latter stages of the **eradication operation** to detect any individuals not killed by the initial baiting regime. To ensure the success of eradication, 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).

1.1.2 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).

1.1.3 **If a rodent is detected** at any point after the eradication, you must be prepared to **respond immediately**. Guidance is given in Annex 4 (Biosecurity) and Annex 1 (Eradication operation).

1.1.4 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.

1.1.5 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.

1.1.6 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 Surveillance methods

2.1 Overview

2.1.1 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.

2.1.2 Use as many types of device as the logistics of your island and resources allow (see Table A3.1). 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.

2.1.3 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.

2.1.4 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.

Table A3.1 - 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 Annex 2 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 they are functioning correctly • Potentially high non-target risks
Trap station (live)	• 3 to 5 nights per month • **Guidance in Annex 2 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 Permanent plastic stations

2.2.1 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.

2.2.2 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.

2.2.3 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.

2.2.4 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, aiming for natural soap, without perfume added, where possible.

2.2.5 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 cost around £10 each. This does not include the costs of postage.

Figure A3.1 - Permanent plastic station raised from the ground to prevent access to non-target species. Right: Permanent plastic station (© Sophie Thomas, RSPB), opened to show a chocolate wax detection block (© WMIL).

2.3 Rodent motels

2.3.1 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, due to cost, plastic devices are generally used for the bulk of permanent surveillance stations.

2.3.2 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 flavoured wax detection block.

2.3.3 Rodent motels should measure around 530 mm square with an internal height of 140 mm. Two 55 mm 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 and encourage a rodent to set up home.

2.3.4 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.

2.3.5 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 A3.2 - A wooden box suitable for use a rat motel, showing entrance holes, arrangement of internal baffles and an example of a good location. Left photo: © Alastair Wilson. Central and right photo: © WMIL.

2.4 Tracking tunnels

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

2.4.2 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.

2.4.3 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 80p each (2017 prices and exchange rate). Time and postage costs from New Zealand need to be considered. Their website provides useful information on how to identify prints as well as set the tunnels.

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

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

2.4.6 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 A3.3 - Gotcha tracking tunnels, above, A, B (Morton & Cole, 2013). Mammal Society tunnel (below left, © www.mammal.org.uk) and tracking tunnel plate baited with peanut butter (below right) © Sophie Thomas, RSPB.

2.4.7 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 (or commercial lino). The IDA evaporates to leave a thin layer of carbon powder on the tile, which is weather proof once dry, however will only last a few days at most in adverse weather conditions. 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 A3.4 - Brown rat footprints recorded on a carbon-coated tracking plate. Photo: © National Wildlife Management Centre (Animal and Plant Health Agency).

2.5 Wax blocks

2.5.1 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). Alternative flavours should be investigated – if a local plant or flower is being eaten, this could be added to wax blocks. Aniseed flavour is attractive to black rats and cinnamon for mice.

2.5.2 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 A3.5 – Left: large and small chocolate wax blocks. Right: blocks in production using silicon ice cube / cupcake moulds © WMIL.

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

Will make approximately 30 large (30g) or 60 small (15g) 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/muffin tray (12 large cup or 24 mini cup)
- Wooden spoon for mixing
- Heatproof glass jug for pouring
- Standard white wax candles OR paraffin wax pellets (can purchase in 10 and 20/25kg sacks) here or here
- Various flavourings

Chocolate wax:

Ingredients:

12 standard white wax candles OR 900g of paraffin wax pellets

5 heaped tablespoons of **pure cocoa powder** – **N.B. Do not use drinking chocolate as it burns**

[For alternative flavours, essences can be purchased, as well as dyes to colour the blocks to make them more distinctive and teeth marks easier to see].

Instructions:

1. Melt candles or wax pellets in pot (remove wicks if using candles) add cocoa powder and stir thoroughly to mix.
2. 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 an electric or battery-powered 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 OR 900g of paraffin wax pellets

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 or wax pellets in pot (remove wicks if using candles) 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 OR 900g of paraffin wax pellets

½ jar of smooth peanut butter *[alternatively can use peanut essence].*

Instructions:

Melt candles or wax pellets in pot (remove wicks if using candles) 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.

2.6.1 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.

2.6.2 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.

2.6.3 **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. This has been found to be particularly useful in tropical climates where wax blocks melt easily. More information and recipes are available, please contact Sophie.Thomas@rspb.org.uk.

2.7 Visual searches

2.7.1 Searches for rodents or rodent sign can be conducted at any time or place on the island and require no equipment. See 3.3 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 Annex 4, Biosecurity for further information).

2.7.2 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).

2.8 Trail cameras

2.8.1 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 A3.6 - Trail cameras were used to confirm rat incursion on Coquet Island in 2017 (© RSPB and Newcastle University).

2.9 Traps – Live capture and kill

2.9.1 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.

2.9.2 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.

2.9.3 If you do use traps, you must adhere to the guidance provided in Annex 2.

2.10 Hair traps

2.10.1 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. See section 2.10.2.

2.10.2 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.

2.10.3 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. If Velcro™ is not available, sticky tape can be used as an alternative but is less effective.

2.10.4 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.

2.11 UV light

2.11.1 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 limited to use on islands where no other mammal species are present.

2.12 Rodent identification

2.12.1 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.

2.12.2 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. See Table A3.2.

Table A3.2 - 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 (but smaller than wood mouse)
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)	Neophilic (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, human materials (e.g. newspaper, cardboard), leaves, feathers	Usually vegetation (twigs, leaves) or feathers, but can use paper/card	Vegetation, feathers, human materials (e.g. newspaper)
Approximate life span	12 to 24 months	12 to 18 months	12 to 18 months
Approximate 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)

2.13 Sightings & corpses

2.13.1 'Black' rats can look very similar to 'brown' rats: most black rats are brown in colour rather than black. Although black rats are rare and localised 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 well as on ships which have travelled to UK waters from parts of the world where black rats are more common. As such, there is an ongoing biosecurity risk from black rats as well as brown rats and you should be familiar with identifying them.

2.13.2 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.

2.13.3 Wood-mouse *Apodemus sylvaticus,* a native species to the UK, can be identified from a house mouse as they are a brighter brown with bigger ears and eyes and have a longer tail than a house mouse.

2.13.4 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 A3.3 - 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 A3.7 - Colour phases of rats found in the UK. Rats trapped and photograph taken on St Helena, a UK Overseas Territory. 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. Photo © WMIL.

2.14 Droppings

2.14.1 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 A3.8 - Droppings of UK invasive rodents. Images: from Morton & Cole 2013.

2.14.2 **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.

2.14.3 **Shrew** droppings – in theory, at a typical 2-4mm long and 1-2mm thick, these should be smaller than rat or mouse droppings. However, evidence from rat surveillance during the eradication on St Agnes and Gugh (Isles of Scilly) demonstrate shrew droppings can be much larger than this. Shrew droppings will be largely comprised of insect remains and are of a sandy consistency, whereas you would expect mouse and rat droppings to contain a wider array of food sources. Rat droppings usually contain fur as they are extensive groomers.

2.14.4 **Vole** droppings are fairly uniform, cylindrical and tend to be rounded at both ends and usually greenish when fresh. 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 told apart, but their uniform nature may help distinguish them from mouse droppings, which are more variable.

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

2.14.6 **Invertebrates** such as **rose chafer beetles** may produce large piles of frass that might be mistaken for a rat latrine (see Figure A3.10). However, they are likely to be more uniform, and far more prolific than a rat latrine.

Figure A3.9 - Invertebrate droppings – rose chafer frass observed on St Agnes and Gugh during the rat surveillance following eradication © Alastair Wilson.

2.14.7 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. Label the sample appropriately. See Annex 2 for more details.

2.15 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 the edge
	

Figure A3.10 - Rodent teeth marks. All photos © WMIL.

2.15.1 **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.

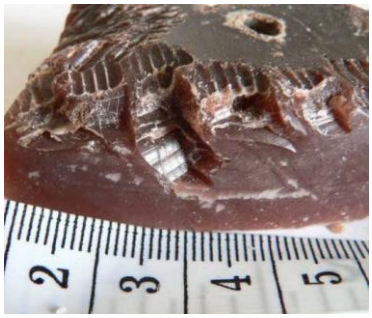
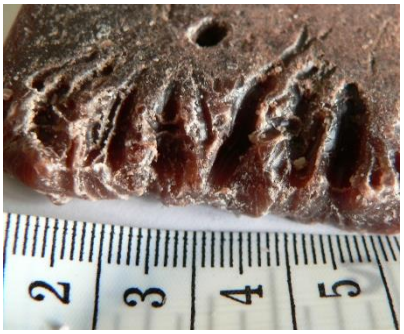
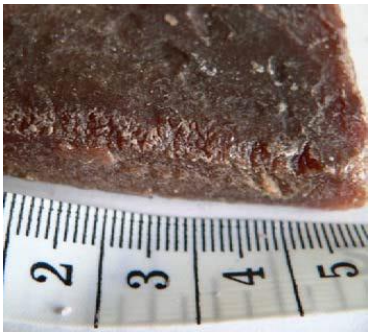
Rabbits	**Birds**	**Shrews**
Rabbits can have split incisors, making four parallel grooves that are similar to rat sign. There would be two large bite marks from the bottom teeth (larger than the 1mm groove for a rat) per four grooves.	Birds tend to leave deep gouges which start at a point and are triangular. 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 A3.11 - Teeth marks of common non-target species. All photos © WMIL

2.16 Footprints

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

Figure A3.12 - 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 A3.14). http://www.pestdetective.org.nz/ is a good resource for identifying sign.

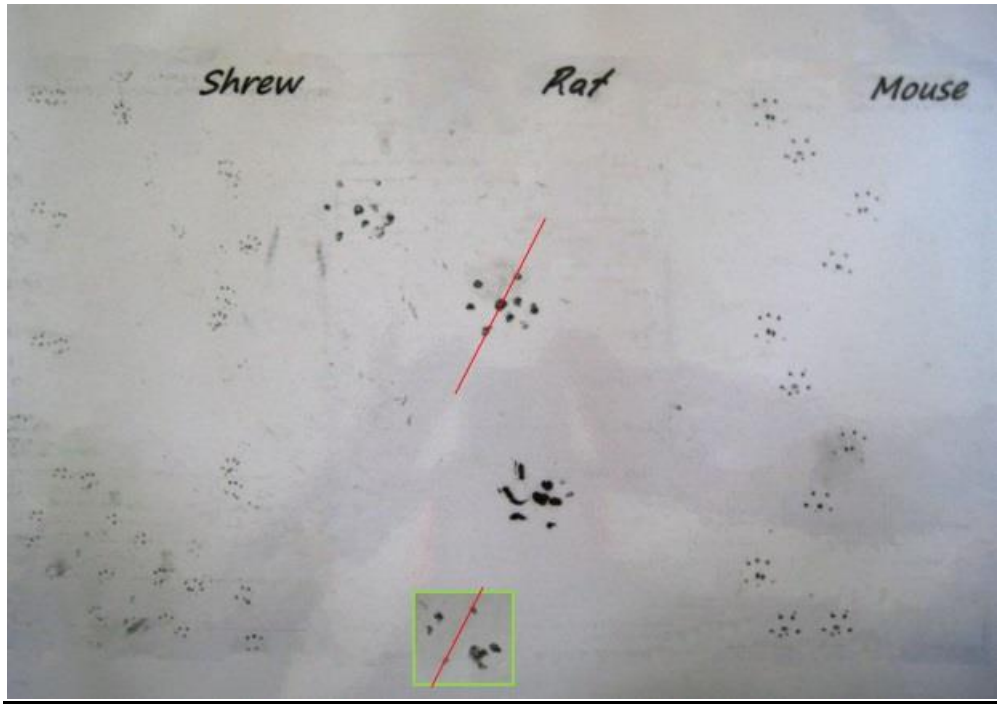


Figure A3.13 - Size comparison of rat, house mouse, shrew and squirrel (inset green box) prints: © WMIL and Sophie Thomas/RSPB.

2.16.1 Rat prints are similar in size to squirrel prints, but can be distinguished by drawing a line between the first and last toes: on rats. 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 A3.14 - Rat prints in sand (above left), mud (above right) compared to tracking plate (below). Top right photo and below photo: © WMIL. Top left photo: © Sophie Thomas/RSPB.

2.17 Nests and other signs

2.17.1 Rodent nests are usually formed of vegetation and human materials (such as newspaper etc.) stacked into a ball where newborns will spend the first several days. They are often in warm, dry and dark locations.

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

Figure A3.15 - Burrow system of brown rat on coastal cliffs. Search for other signs around the entrances to a burrow system, such as droppings. © Sophie Thomas, RSPB.

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