Use of carbon-coated tracking plates to derive indices of Norway (common) rat activity for burrow-nesting seabird colonies in upland habitats.

Background and rationale

Population indices are a useful proxy for population size where the exact number of animals within an area cannot be reliably or easily determined (Cattadori et al. 2003; Engeman 2005). The chosen index (for example tracking rates, faeces deposition, capture rates, bait consumption or visual observations), gives a relative indictor of population size for comparison between populations or trends within populations (Engeman 2005). For rodents and other small mammals, direct survey methods include index trapping, where trapping success (as a percentage of traps set) gives a measure of relative abundance (Gillies 2013a; Gillies 2013b; Hansson 1967); disadvantages of this method include the need for direct contact with live or dead rodents (Whisson et al. 2005) and variability in trapping success due to seasonal variation in availability of alternative food (in the case of baited traps), thus they provide a relatively coarse index of abundance for rodents (Gillies 2013a).

Indirect survey methods for rodents and other small mammals include tracking devices which record footprints, and use of non-toxic baits or lures including wax blocks (which often have added flavourings e.g. cocoa, or coloured or fluorescent dyes) and oil soaked chew cards or sticks (e.g. Whisson et al. 2005). Baits and lures are subject to some of the disadvantages of trap use, including seasonal variations in availability of alternative food and animal behaviour which may impact on their uptake by the target animals, whereas passive devices, which record footprints of the animals passing over them for example, are less subject to these effects (Quy et al. 1993). By developing a systematic approach and scoring system, Quy et al. (1993) calibrated carbon-coated tracking plates against robust estimates of Norway rat population size on farmsteads and suggested that the approach could thereby provide abundance estimates for rats living in and around farm buildings in addition to a relative index of population size.

When using tracking plates in and around buildings a 10m x 10m grid is superimposed on a map of the site, the site is then surveyed for signs of rat activity and tracking plates are placed length-wise on well-defined (active) rat runs at a maximum of four plates per 10m grid square; if no obvious rat runs exist the plates are placed where rats would be expected to walk, e.g. along walls or in narrow gaps between large objects or gaps between vegetation (Quy et al. 1993).

Tracking plates were used to obtain indices of rat activity for three Manx shearwater colonies on Rum during 2010-2013 (2-3 times per year) as part of an investigation of potential impacts of Norway rats on breeding success of Manx shearwaters (Lambert et al. 2015). The transects were located such that they sampled different features of the mosaic of upland habitats within each study site, i.e. the gravelly, boulder-strewn areas, grassy plateaus, watercourses and ‘shearwater greens’. For consistency between years, and in the absence of any evidence that the distribution of rats had changed within the study sites over time, the same survey route was used for subsequent surveys at each study site on Rum from 2010-2013. It is appropriate to repeat the previous survey routes between years if there is no reason to suspect that the distribution of rats has substantially changed; it is important to remember that the survey technique is not random and should be targeted towards any known areas of rat activity within the study

area, or if there are no obvious areas of rat activity, areas likely to be frequented by rats if they were present.

Work funded by a SNH-SEPA PhD studentship during 2013 - 2015 confirmed optimum survey parameters for the tracking plate method for habitats encountered on the island; the PhD project also seeks to calibrate tracking plates against capture-mark-recapture (C-M-R) data for rats in upland habitats on Rum, and it is expected that from this calibration it will be possible to convert the activity indices to population estimates. It is therefore proposed that carbon-coated tracking plates will be used to monitor Norway rat populations on Rum, particularly within the Manx shearwater colonies, in order to characterise long-term risks of impacts by rats; specifically, how often do the rat activity levels reach those likely to cause impacts on Manx shearwater populations. It is expected that this will facilitate a robust assessment of the long-term risks to the security of this internationally important Manx shearwater breeding population, potentially through modelling of the effects of intermittent negative impacts.

The **Procedure for the use of carbon-coated tracking plates to derive indices of Norway (common) rat activity for burrow-nesting seabird colonies in upland habitats** describes the tracking plate method so that future indices of rat activity can be obtained that are comparable to previous surveys, and thereby establish a method for longer-term monitoring of rat activity within the shearwater colonies.

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Procedure for the use of carbon-coated tracking plates to derive indices of Norway (common) rat activity for burrow-nesting seabird colonies in upland habitats.

Contents

1. Materials required

1.1 Making the tracking plates

- Light-coloured vinyl floor tiles, e.g. 300mm x 300mm Tarkett Vylon Plus (Tarkett Ltd., Maidstone, United Kingdom); usually available in boxes of 50 tiles. Equivalent (light-coloured) tiles may be used, although it is preferable to avoid use of self-adhesive tiles or tiles with a textured surface; the textured surface is less suitable for application of self-adhesive film, if using self-adhesive floor tiles (which usually have a peel-off paper backing) apply the clear self-adhesive film to the self-adhesive side otherwise the tracking plates will tend to stick together when stacked for storage
- Clear, self-adhesive book binding film (sticky-back plastic); widely available from stationary suppliers, usually 500mm widths (in 3m or 5m rolls) with a paper backing
- Template to score 100mm wide sections of the vinyl tiles
- Scissors to cut book binding film
- Sharp safety knife (Stanley or equivalent craft knife) to score vinyl tiles
- Clean soft cloth to smooth surface of film

1.2. Using the tracking plates

- Industrial denatured alcohol (IDA) formerly known as Industrial Methylated Spirit (IMS); **note that authorisation to receive and use IDA may be required from HM Revenue & Customs[1] and a log of IDA received and used must be kept**.
- Carbon powder (e.g. carbon, activated, Chorcarb 130 powder (EC number 231-153-3), Alfa Aesar, Heysham Lancashire, UK. (See https://www.alfa.com/en/content/msds/english/L17565.pdf for Materials Safety Data Sheet).
- Stiff paint brush (2-3 inch width)
- 1ltr plastic jug for mixing IDA and carbon powder
- 1ltr Trangia (or equivalent) safety fuel bottle for transporting small quantities of IDA in the field
- Hand-held GPS unit to locate transect start and finish points
- Stiff fencing wire and pliers to make securing pins

2. Method

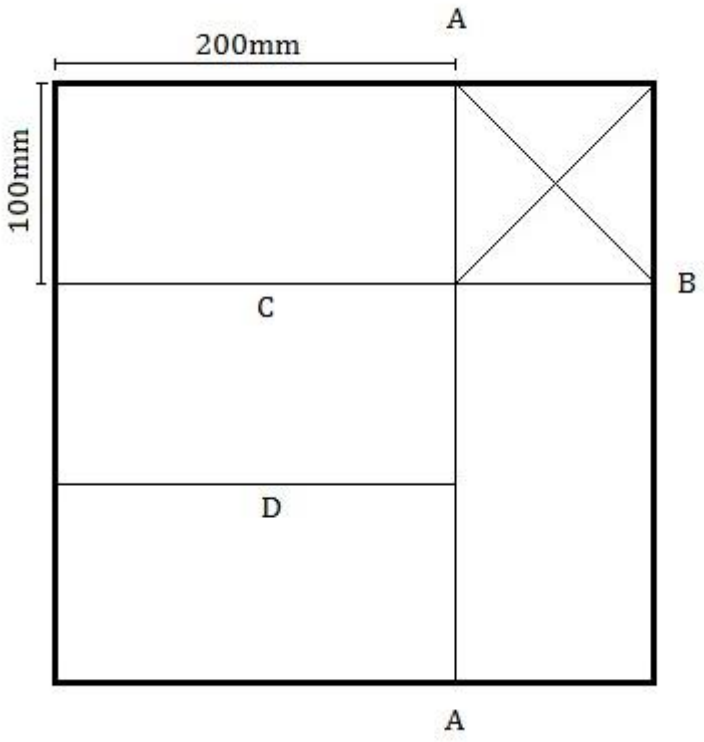
2.1. Making tracking plates

The first stage is application of the book binding film to the floor tiles. The film prevents carbon staining of the tile surface and thus makes the tiles easier to read. The easiest way to apply the film is to lay a floor tile over the paper covered side of the film and draw round it with a pen or pencil then cut the film to size with scissors. Carefully peel back the paper backing to expose a strip of self-adhesive film about 1cm wide along one edge; stick this carefully against one side of the floor tile and smooth it down with a soft cloth to remove any air bubbles. Then, working from the stuck edge, slowly and evenly peel back the remainder of the backing paper, smoothing the film down with a soft cloth to remove air bubbles until the tile is completely covered with the film. Lightly scrub the surface of the applied film using a nylon scouring pad to provide a key for the carbon powder.

Next, cut the tile into 200mm x 100mm sections. This can be done using a template and sharp knife to score the surface of the tile 100mm from the edge along line A (Figure 1); the tile should then snap easily along the scored line to separate a 300mm x 100mm piece. This piece can then be cut along line B using the template to remove the 100mm x 100mm waste piece (X) leaving one 200mm x 100mm tracking plate. The remaining large section of tile can then be cut along lines C and D to make a further three 200mm x 100mm tracking plates.

[1]https://www.gov.uk/government/publications/excise-notice-473-production-distribution-and-use-of-denatured-alcohol/excise-notice-473-production-distribution-and-use-of-denatured-alcohol#authorised-uses-of-denatured-alcohol

Figure 1. Cutting a 300mm x 300mm vinyl tile to make four 200mm x 100mm tracking tiles. Self-adhesive film should be applied to the tile before cutting.



2.2. Preparing the tracking plates for use

Once enough tracking plates are available for the survey (a minimum of 140 per site is recommended, although it is a good idea to have a second set to replace marked plates if they cannot be re-painted *in situ*) the plates can be prepared for use. **This must be done in a dry atmosphere, ensuring adequate ventilation when indoors**. First, make a suspension of activated carbon powder in industrial denatured alcohol (IDA) at a concentration of 10g of carbon powder in 100-150ml of IDA. It is convenient to do this in a 500ml plastic mixing jug (as any surplus can be poured into a suitable container for future use); place a heaped tablespoon of carbon powder (approximately 10g) into the jug and add 100ml of IDA. Then, using a clean, dry, stiff-bristled, 2-3 inch wide paintbrush, mix the carbon powder and IDA together in the mixing jug. Next, take a stack of around 10 tracking plates in one hand, dip the end of the paintbrush in the carbon-IDA mix and paint the surface of the first tracking plate. It is usually best to keep the amount of liquid on the paintbrush to a minimum; if the plates are new it may be necessary to increase the concentration of carbon powder, or tilt the jug slightly to take more concentrated solution from lower down after it has settled slightly, to achieve an even, thin layer of carbon (it does not need to be thickly covered). If the plates have previously been used they will already have a layer of carbon, and the painting process is essentially a matter of re-dissolving and re-distributing it to remove any previous footprints or other marks; this can be done using a small amount of liquid on the brush and a firm circular action to remove all previous marks in the carbon layer, finally smoothing out the surface with even brush strokes. Place the first painted plate on a dry even surface; in good weather, or in dry conditions indoors, the IDA will quickly evaporate leaving the carbon on the surface of the tile. Repeat for the remaining tracking plates in hand, and then the remaining

tracking plates. The plates must be allowed to fully dry or the carbon surface will be more easily damaged during transportation; the carbon will also be washed off by rain if not completely dry.

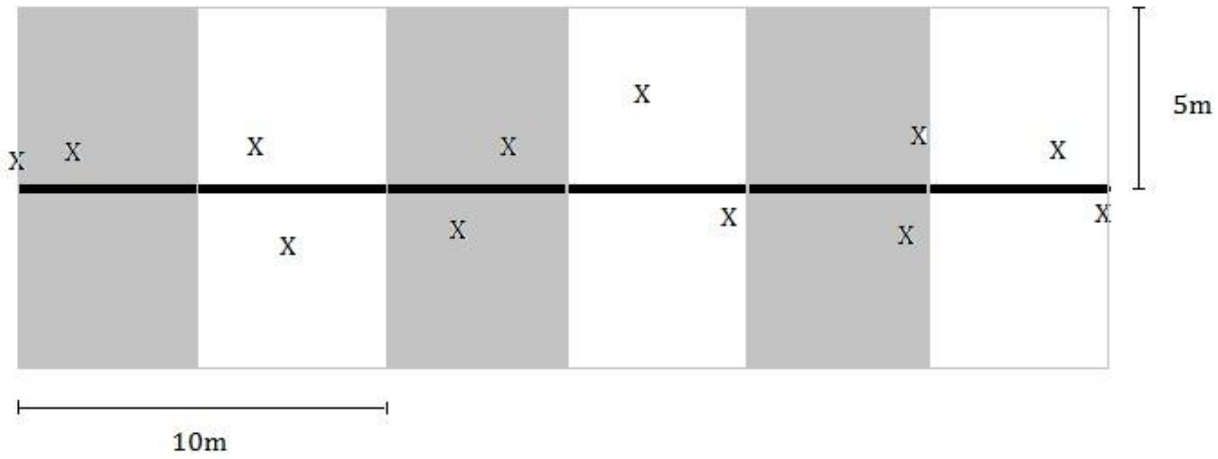
2.3 Transporting the tracking plates

If prepared in advance, stack the fully dry tracking plates for transport. If the tracking plates need to be transported in bulk (by rucksack for example) some distance from the site of preparation, they can be wrapped in cling film in batches of 20-30; this prevents the plates from rubbing together which would damage the carbon layer. The tracking plates may also be prepared near the survey site in dry weather where a suitable reasonable flat area is available to lay the painted plates out to dry. At the survey site, transfer the tracking plates to a bucket or other suitable carrier, taking care not to damage the carbon-coated surface.

2.4 Deploying the tracking plates

Go to the start point for the survey route. The start and finish points for each transect at each site should be available on a hand-held GPS unit to aid navigation, although ground markers may also be used to identify start and finish points. Set out 12 tracking plates (carbon side facing up) in six pairs (to make them easier to re-locate) at approximately 5m intervals (Figure 2). Within the transect, the tracking plates should be placed flat on the ground (rats may be deterred if the plate moves when trodden on) where they are most likely to be walked over by rats, i.e. on rats runs, or where rats would be expected to move if they were present i.e. gaps between rocks and vegetation and near to other features likely to channel movement of rats, such as watercourses, deer or goat trails.

Figure 2. Example layout for a set of 12 plates along a 30m transect within the tracking plate survey route. Centre (black) line shows hypothetical line of transect; shading denotes 5m intervals and 10m width.



If weather conditions are windy, and particularly in exposed conditions, it may be necessary to secure the plates to the ground using two metal pins; one at each of two opposite corners (Figure 3). The pins should be made from stiff galvanised fencing wire by cutting 5-10cm pieces (it is useful to have different lengths

available) and making a right-angled bend using pliers; the wire should be dull (weathered) as shiny wire will be more obvious to rats and could deter them from walking over the tracking plates.

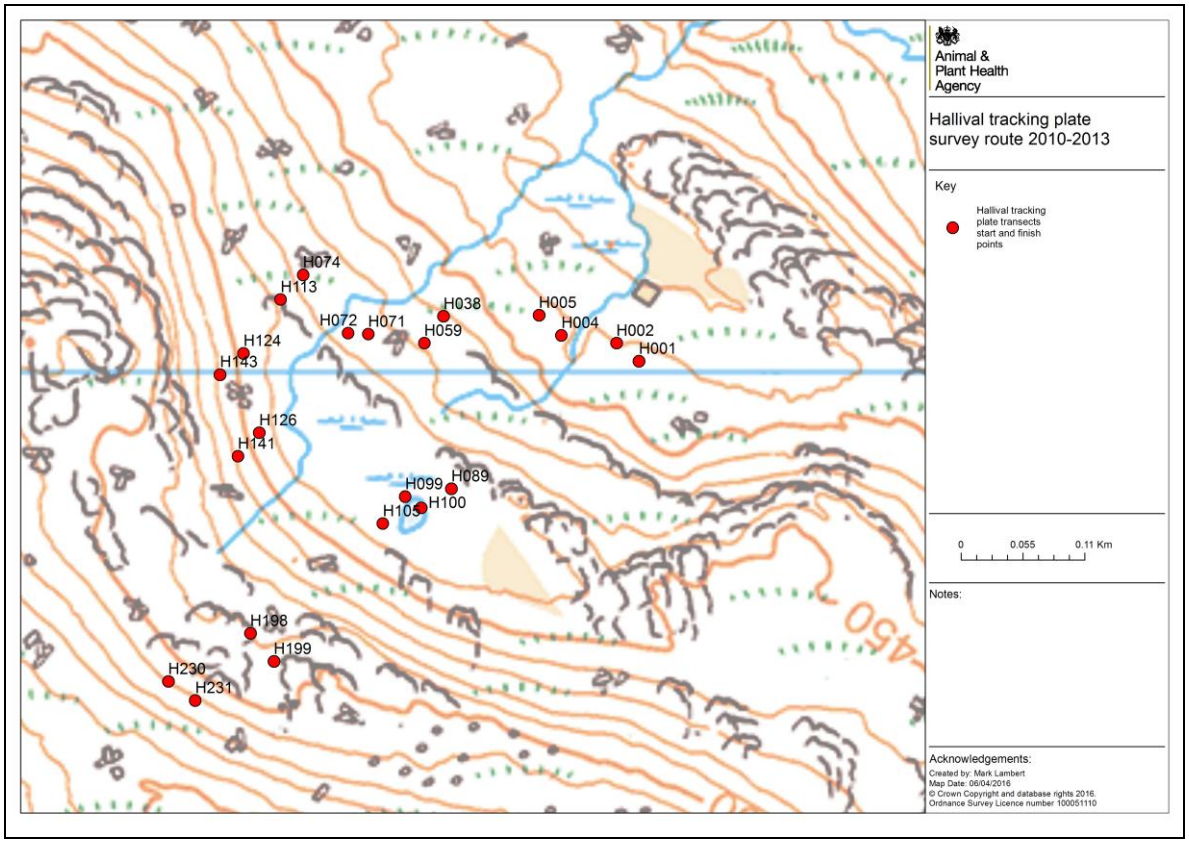
Figure 3; (left) tracking plate secured by two galvanised wire pins to prevent disturbance by wind (arrow indicates position of one of the pins), and (right) tracking plate (shown by arrow) in position by water course (linear features in the landscape such as streams, banks, ditches and animal trails are likely to be corridors for movement of rats).

For the 2010-2013 surveys 11 transects (a total of 132 plates) were used; Figures 4-6 show the location of the transects previously used at the Hallival, Askival and Clough's Crag study sites (the start and finish points for the transects are given in Appendices A-C; note that the distance between H071 and H072 at Hallival is less than 30m and the transect extended beyond H072). Subsequently it has been determined that using 140 plates improves the precision of the activity index (S. Carlisle, pers comm.), hence it is recommended that 12 transects (144 plates are used for future surveys).

2.5 Checking and scoring tracking plates

Tracking plates should be checked during the day following deployment. Score each plate according to the percentage of the surface covered by prints, i.e. estimate the percentage of the area of carbon removed. Record a score of 0-4 for each tracking plate in accordance with the method published in Quy et al (1993) (Table 1). Figure 7 shows a tracking plate marked by rats; this is an example of a plate that is at the lower end of the 26%-95% range (score = 2). Note the score on a suitable record sheet (e.g. Appendix D; waterproof paper recommended) or in a waterproof notebook, which is a more practical option in the field in windy conditions.

Figure 4. Start and finish locations for tracking plate transects used at the Hallival study site 2010-2013; Point H001 (the starting point for the route) is near the current location of the shearwater research hut.



Mice and shrews will mark the plates if they walk on them; their footprints are noticeably smaller than rats (Figure 8). Also note these on the record sheet or notebook, although it is not necessary to record a score for mouse or shrew prints; use M to record mouse activity and S to record shrews (+M, +S if the plate is marked by multiple species, e.g. 1+M if the plates scores 1 for rat prints but also has mouse prints). Replace marked tracking plates with unmarked ones, or re-paint marked plates *in situ* in dry weather conditions. Repeat the checks each day for 3-4 days. If a plate is unreadable, i.e. if it has been windblown upside down, or the surface is largely obscured by other animal prints, record an 'X'. As a general rule, if more than 10% of the plates are unreadable the survey for that day is not valid, i.e. if using 144 tracking plates and on one day 15 or more plates are unreadable, the data for that day are not valid and the survey should be extended in order to collect valid data for at least three days. On the final day of the survey the tracking plates should be collected and stored for the next survey. If they are wet when collected it is a good idea to dry them before storage, e.g. by laying them out in a dry area.

Table 1. Scoring system for tracking plates (Quy et al. 1993).

Percentage of tracking plate covered by rat footprints	Score
0	0
1-25	1
26-95	2
96-100	3

Figure 5. Start and finish locations for tracking plate transects at the Askival study site 2010-2013.

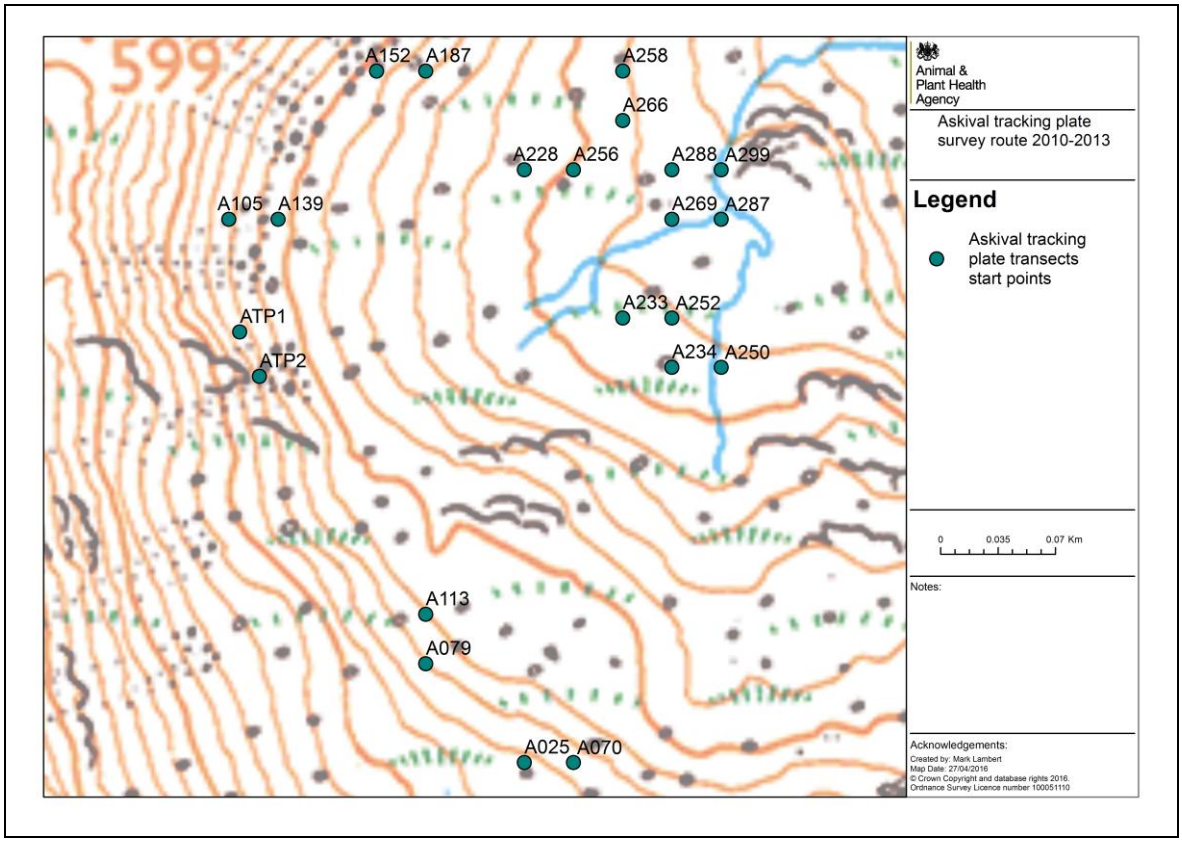


Figure 6. Start and finish locations for tracking plate transects at the Clough's Crag study site 2010-2013.

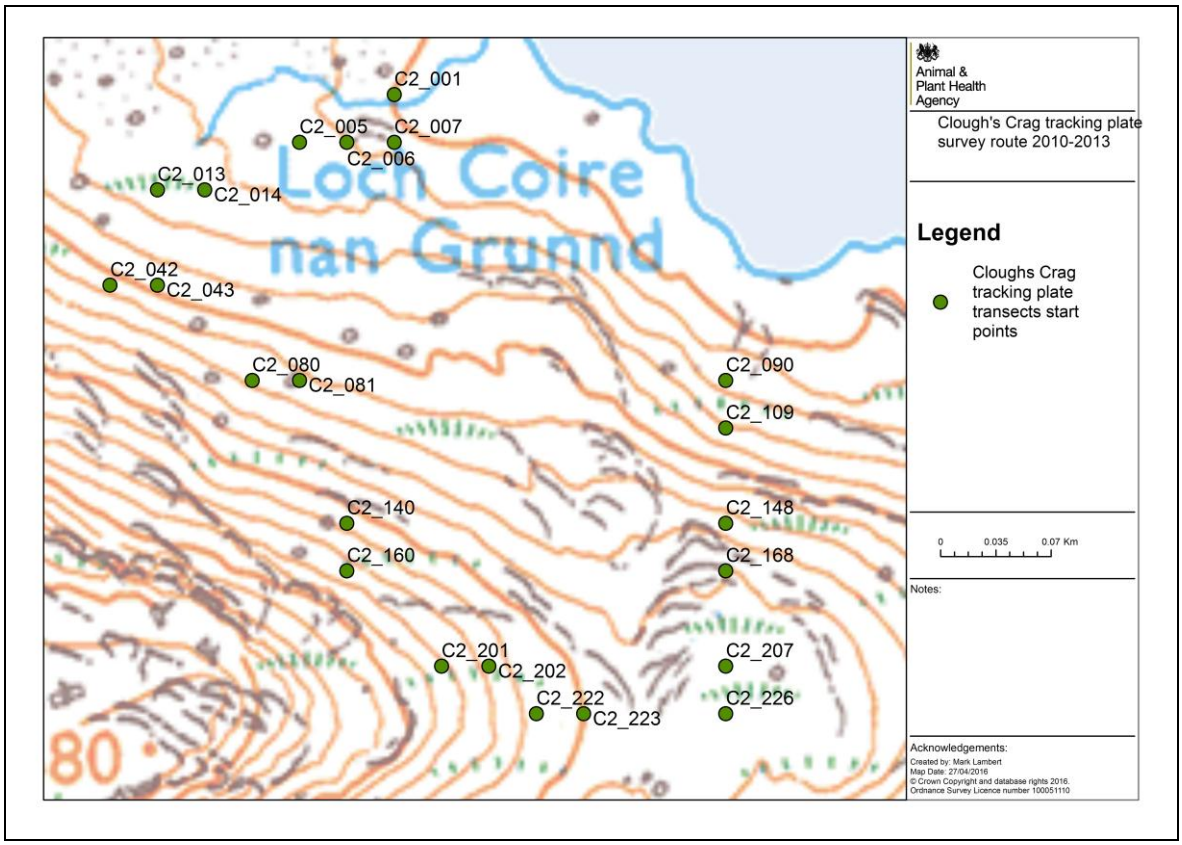


Figure 7; tracking plate marked by rat footprints (left image), and (right image) close-up showing a rear footprint; a probable front footprint (partially outside the red circle) overlaps the rear footprint. It is not necessary to record individual footprints; the plates are scored according to the percentage of the surface covered with prints (see main text for details).

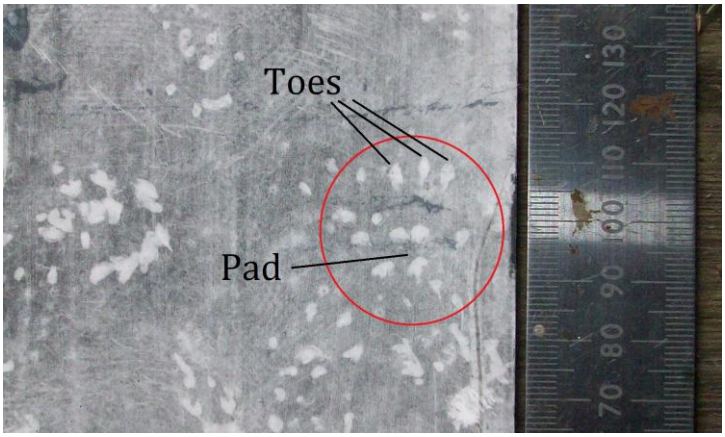


Figure 8; tracking plates marked by (left image) woodmice (*Apodemus sylvaticus*) and (right image) common shrews (*Sorex araneus*) or pygmy shrews (*Sorex minutus*).

3. Data analysis

Adhere to good record management principles and any applicable information management policies, which might include transcribing the data to a secure master copy of the record sheets at the end of each day. For each day, calculate the sum of the tracking plate scores. At the end of the survey calculate the average daily score; this is the index of rat activity. The activity index can be used as a relative indicator of differences in rat populations between sites and over time because surveys are systematic and repeatable; in particular the density of tracking plates must always be the same in the areas surveyed (4 plates $10m^{-2}$), a minimum survey duration of three (ideally consecutive) nights is required with a valid sample for each night, and the survey should cover the areas in which rat signs are visible, or if no rat signs are visible, an adequate number of plates must be used to ensure valid comparisons between sites and time periods. Quy et al reported that the mean activity index for 14 farms in central southern England was 98.0; activity indices for upland habitats surveyed using the method have so far been lower, the highest activity index found for the three 2010-2013 Rum study sites was at Clough's Crag where the activity index in August 2013 was 22.0 (Lambert et al. 2015). This level of rat activity appeared to be associated with a significant reduction in Manx shearwater breeding success. Data from future tracking plates surveys will indicate how often levels of rat activity reach these levels at Clough's Crag and at other sites surveyed by the method.

Lambert M, Carlisle S, and Cain I. 2015. The role of brown rat (*Rattus norvegicus*) predation in determining breeding success of Manx shearwaters (*Puffinus puffinus*) on Rum. Scottish Natural Heritage Commissioned Report No. 697.

Appendix A. British National Grid reference points for start and finish points used for tracking plate transects at Hallival 2010-2013; 12 tracking plates were used for each of these 11 transects, i.e. 132 tracking plates in total.

ID	Transect	X	Y
H001	1	139665	797011
H002	1	139645	797027
H004	2	139596	797034
H005	2	139576	797052
H038	3	139491	797051
H059	3	139474	797027
H071	4	139424	797035
H072	4	139406	797036
H074	5	139366	797088
H113	5	139346	797066
H124	6	139313	797018
H143	6	139292	796999
H126	7	139327	796947
H141	7	139308	796926
H199	8	139340	796743
H198	8	139319	796768
H230	9	139246	796725
H231	9	139270	796708
H105	10	139437	796866
H099	10	139457	796890
H100	11	139471	796880
H089	11	139498	796897

Appendix B. British National Grid reference points for start and finish points used for tracking plate transects at Askival 2010-2013; 12 tracking plates were used for each of these 11 transects, i.e. 132 tracking plates in total.

ID	Transect	X	Y
A288	1	139761	795856
A299	1	139791	795856
A269	2	139761	795826
A287	2	139791	795826
A258	3	139731	795916
A266	3	139731	795886
A256	4	139701	795856
A228	4	139671	795856
A187	5	139611	795916
A152	5	139581	795916
A139	6	139521	795826
A105	6	139491	795826
ATP1	7	139498	795758
ATP2	7	139510	795731
A113	8	139611	795586
A079	8	139611	795556
A025	9	139671	795496
A070	9	139701	795496
A234	10	139761	795736
A250	10	139791	795736
A233	11	139731	795766
A252	11	139761	795766

Appendix C. British National Grid reference points for start and finish points used for tracking plate transects at Clough's Crag 2010-2013; 12 tracking plates were used for each of these 11 transects, i.e. 132 tracking plates in total.

ID	Transect	X	Y
C2_001	1	140299	795703
C2_007	1	140299	795673
C2_005	2	140239	795673
C2_006	2	140269	795673
C2_013	3	140149	795643
C2_014	3	140179	795643
C2_042	4	140119	795583
C2_043	4	140149	795583
C2_080	5	140209	795523
C2_081	5	140239	795523
C2_140	6	140269	795433
C2_160	6	140269	795403
C2_201	7	140329	795343
C2_202	7	140359	795343
C2_222	8	140389	795313
C2_223	8	140419	795313
C2_207	9	140509	795343
C2_226	9	140509	795313
C2_148	10	140509	795433
C2_168	10	140509	795403
C2_090	11	140509	795523
C2_109	11	140509	795493

Appendix D Tracking plate recording sheet

Site Name: Start Date (Day 0):

	Day 1	Day 2	Day 3	Day 4
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For rat footprints enter score; no prints = 0; 1-25% of plate covered = 1, 26-95% =2, 96-100% covered = 3

For mouse footprints enter ‘M’, if rat and mouse prints both present enter score for rat prints + M (e.g. ‘1+M’)

Appendix D Tracking plate recording sheet (continuation)

Site Name: Start Date (Day 0):

	Day 1	Day 2	Day 3	Day 4

	Day 1	Day 2	Day 3	Day 4

	Day 1	Day 2	Day 3	Day 4

For rat footprints enter score; no prints = 0; 1-25% of plate covered = 1, 26-95% =2, 96-100% covered = 3

For mouse footprints enter ‘M’, if rat and mouse prints both present enter score for rat prints + M (e.g. ‘1+M’)