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Surveying Badgers

Stephen Harris, Penny Cresswell and Don Jefferies

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Introduction

There have been many badger surveys in Britain at both the local and national level. The first national initiative was organised by the Mammal Society in 1963, with the aim of recording the number of badger setts, the distribution of badgers, and some data about the habitat requirements of badgers in Britain. This survey was a great success, in that it stimulated interest in badgers and recorded a lot of information about the distribution and habitat requirements of badgers. It also motivated a large number of detailed local badger surveys, which are summarised by Cresswell, Harris & Jefferies (1989); the results of the Mammal Society's survey are detailed by Neal (1972) and Clements, Neal & Yalden (1988), and also discussed by Neal (1977, 1986).

In the twenty-six years since the start of the Mammal Society survey, we have learnt a great deal more about the biology of badgers, thanks particularly to the detailed long-term studies of Hans Kruuk and his colleagues in Oxfordshire and Scotland, and to Chris Cheeseman and his colleagues in Gloucestershire. We now know that badgers live in complex social groups, each occupying a well-defined territory, and that within each territory there are a number of different types of setts. Kruuk (1978) grouped these setts into three types (main, annexe and outlying). Most importantly, he found that each badger social group usually has only one main sett; hence by counting the number of main setts, you can determine the number of badger social groups in an area. Kruuk (1978) also showed that in the best badger habitats there can be up to six badger social groups per square kilometre.

However, it must be remembered that most of the detailed studies on badgers have been made in areas with high population densities. At low densities territoriality diminishes, and badgers may not form such stable social groups.

The work of Kruuk and Cheeseman highlighted some of the shortcomings of the original national badger survey, in particular the failure to distinguish between the different types of setts. Small one-hole outlying setts were recorded in exactly the same way as eighty-hole main setts, and were included in the total number of setts recorded in a particular county. Furthermore, since there was no clear definition of what actually constituted a sett, some recorders would group several small setts close together into a "sett complex", whilst others would treat them separately. This meant that there was no uniformity between county recorders, nor even between records collected within the same county by different recorders.

With the benefit of this experience, two recent badger surveys have been organised so that individual setts were classified into the three categories recognised by Kruuk (1978), with a fourth type (subsidiary) also recognised. Thornton (1988) surveyed badger densities in parts of Devon and Cornwall as part of a study of the epidemiology of bovine tuberculosis in badgers, and Cresswell, Harris & Jefferies (1989) organised a new national badger survey. This was a joint initiative between the Nature Conservancy Council (NCC) and the Mammal Society, funded largely by the NCC. The authors selected

one kilometre squares on a grid, and asked a volunteer to survey the entire square for signs of badgers. In all, 2455 one-kilometre squares were surveyed, from which they calculated that there were about 42,000 badger social groups in Britain. They also amassed data on the distribution and habitat requirements of badgers in different parts of Britain.

This second national survey had a number of aims, and these are described in detail in the report (Cresswell, Harris & Jefferies, 1989). Of particular relevance here is the intention to repeat this survey at regular intervals, using exactly the same techniques, so that future changes in badger numbers can be monitored. One of the problems with the initial Mammal Society survey was its extended time period; records were collected over twenty-five years, which, coupled with the lack of uniformity of approach, meant that it was difficult to quantify badger population changes. It is hoped that the NCC survey, for which the original field data were collected within a two year period, will provide a much more reliable baseline against which to monitor future changes.

Thus we now have an accurate picture of the present status of the badger and can measure changes from this baseline. This is vital because the countryside may soon change rapidly. There are likely to be large changes in agricultural practices, new homes built in and around villages at a greater rate than ever before, planting of new woodlands and increases in leisure facilities such as golf courses as land uses alter. There are also direct threats from increasing road traffic and from badger digging. The badger is a species whose population could change markedly, and we need to monitor the situation both locally and nationally.

Repeating the national survey every seven to ten years will provide the overall and long term picture for Britain as a whole, but local surveys will be an important part of the monitoring scheme and will depend on the help of well-informed volunteers. They will provide useful interim assessments between the national surveys, and can tell you (the surveyor) and us (the national organisers):-

(i) whether the badger population is changing, particularly if the change is dramatic, without waiting for the next national survey,

(ii) help identify the factors causing a population change, and

(iii) pinpoint the exact time of the change; this is of considerable help in determining the cause of any changes.

However, to add to the store of data for monitoring badger populations, it is important that local surveyors adopt standardised methods that will allow direct comparisons on both a local and a national scale.

This booklet provides guide-lines on the different approaches to surveying badgers, and indicates the sorts of problems associated with each type of survey. Our aim is to explain the different options available, and to suggest what to record, so as to make your survey as useful as possible, both now and in the future. Although your objectives

may differ slightly from those of other badger recorders (and you may want to record more than we suggest), it is most important that local surveyors adopt a consistent and coordinated approach to badger surveying to ensure that it is of value for future generations. In the past much valuable effort has been dissipated because of a lack of consistency of approach. It is hoped that this booklet will provide both guide-lines and stimulus for local recorders to help monitor the badger population.

Why survey badgers?

There are several reasons why you might wish to undertake a badger survey, and the techniques you adopt will depend on your objectives. The main goals of most local surveyors include one or more of the following:-

1. To undertake a total county/area survey to record every possible badger sett, and probably also some basic information on badger habitat requirements. On a county scale, you can look at interesting questions such as whether the setts are concentrated in particular areas, and whether this is related to geological or other features.

2. To estimate badger densities in a particular area or county, possibly by doing surveys of pre-selected areas and then extrapolating the results to cover the unsurveyed areas. This is a stratified survey.

3. To undertake a survey of a small area threatened by e.g. a major road scheme or housing development.

4. To visit regularly and monitor the badger setts in a selected area for a protracted period to record changes in numbers e.g. in response to land use changes, digging or other forms of persecution.

5. To guard a small number of setts which are at particular risk from badger digging or some other form of interference.

Remember that whatever type of survey you adopt, you must obtain the landowner's permission to search areas other than along a public footpath. If you are aiming to monitor or guard some local setts, the landowner's support is vital. Whatever your goals, alienating local landowners will not help.

1. A total sett survey

A total sett survey is the hardest objective to achieve. It is particularly difficult when there is no clear work plan and no precise time scale in which to complete the work. Such a survey can easily drift along in an aimless manner, rapidly lose impetus and the enthusiasm of the helpers, and may eventually peter out without really achieving very much.

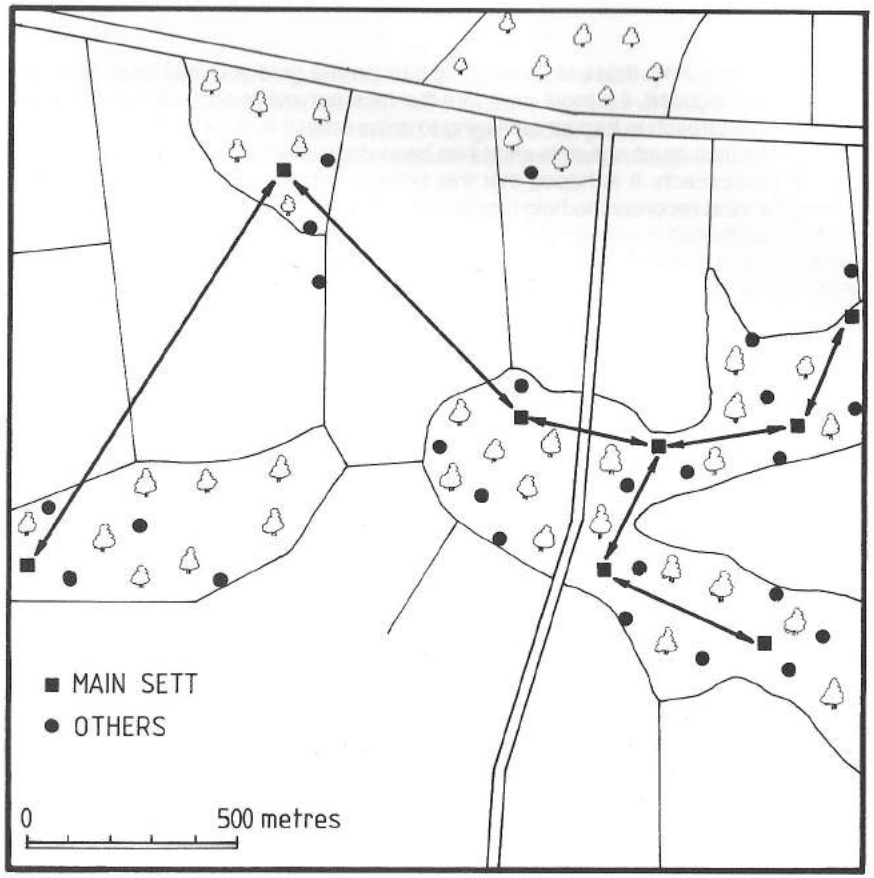


Fig.1. *How to measure the nearest neighbour distances between main setts assuming that the whole area shown on the map has been surveyed, and you are sure that no other main setts are present. These distances should be plotted out as shown in Fig. 2.*

The problems are exacerbated if the original aim is to survey a whole county. If a total sett survey is your main goal, try to plan the work methodically. Firstly, organise groups to visit areas to look for setts or to validate potential records. If a specific area is chosen, the survey can be structured so that it is conducted methodically by concentrating on a small area in the first instance, and then expanding to cover a greater area, and finally the whole county only if or when the manpower is available.

The other problem with a total sett survey is the difficulty of interpreting the data. For a total sett survey, the aim is usually to record as many setts as possible. The incentive

for the recorders therefore is to search the most likely areas for setts; these give the greatest return and help maintain interest. Many surveys have been done in this way, but when the survey report is published the authors tend to conclude that badgers are most common in certain areas, or in particular types of habitat. Since the survey was biased towards searching these very areas or habitat types, it cannot be used to show a preference. Such conclusions can only be drawn from a stratified survey.

An alternative way of approaching a total survey is to triangulate from known main setts. If, for example, you have located a few main setts in a small area (and are sure that you have not missed any), measure their distances apart on a map (Fig. 1). This will give you the "nearest-neighbour distance" (Fig. 2), and you can then concentrate your search for more main setts in likely sites at that distance. A sample of about a dozen main setts, all at similar distances apart, will give you a reliable estimate of badger density in that area. You can then repeat the exercise in different areas or habitats, and compare their nearest-neighbour distances. Sampling the main habitat types in your survey area will soon enable you to calculate the total number of badger social groups.

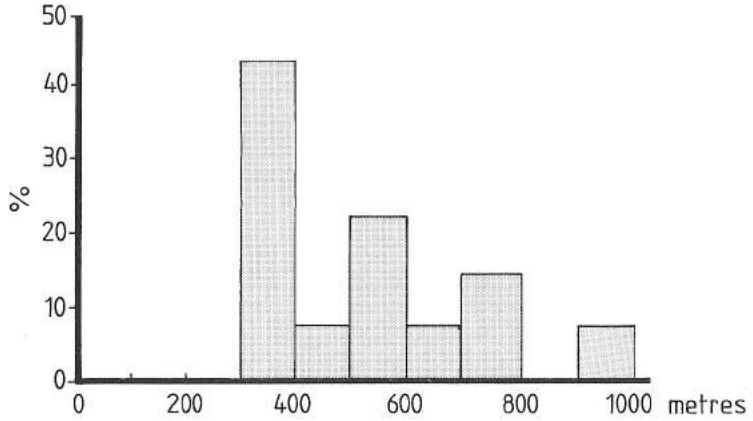


Fig.2. *Nearest neighbour distances for main setts in an area of similar badger density to that shown in Fig. 1. In this area badgers are common and the minimum nearest neighbour distance is 300 metres; the mean is 525 metres, and this can be used as a measure of population density.*

If in one area you get a very irregular pattern of nearest-neighbour distances something may be wrong: you may have missed setts, persecution may have removed groups of badgers, or the habitat may not be uniform over your sampling area.

2. A stratified survey

A stratified survey has many advantages, particularly for an initial survey, since you can obtain a good over-view of your local badger population for considerably less effort than is required by a total sett survey. A stratified survey involves searching a cross-section of areas across the county; the number and size of the sample points can be selected to suit the manpower and time available. For the recent national badger survey organised by the NCC, one kilometre squares were surveyed. These are convenient-sized sample units, since in many areas a square can be surveyed by one person in a single day, although this might not be true in areas of very high badger density. However, with groups of people working together, it may be more efficient to survey two adjacent one kilometre squares or even tetrads (two by two kilometre squares). For the best sampling strategy, the sampling points should be equally spaced on a grid, and again the size of the gaps between sampling points will depend on the available resources. Do not set yourself over ambitious targets; it is easy to be daunted by taking on too much. Aim low to begin with; if things go well it is easy to add extra sampling points to your survey grid.

One of the great benefits of a stratified survey is the ease with which the data can be analysed. Since entire areas are searched to a uniform standard, you have both presence and absence data. This allows you to determine the sorts of habitats that badgers select and avoid, and also to calculate badger densities in different areas of the county or in different types of habitat. There is no bias in your sample, so your conclusions will not suffer the limitations that are often inherent in total sett surveys. A stratified survey is clearly the best approach if you want to analyse your data in an objective manner.

3. Surveying a threatened area

Surveys of areas threatened by a housing scheme or similar developments are small scale, limited operations. They are usually undertaken in response to a specific problem; the booklet by Harris, Jefferies & Cresswell (1988) discusses how to deal with setts threatened by developments, and the sort of information that needs to be recorded during the initial survey.

4. Monitoring badger setts

Monitoring selected setts over a protracted period is usually undertaken to record badger population changes or to evaluate the effects of illegal digging. In the latter case the aim may also be to provide expert evidence in court in the event of a prosecution. Providing expert evidence is complex, and there are many pit-falls. The National Federation of Badger Groups (NFBG) (c/o John Taylor, 16 Ashdown Gardens, Sanderstead, South Croydon, Surrey CR2 9DR) has published guidelines for assisting in badger prosecution cases, and these should be consulted. From the surveying side, it is important that you keep a record of all your visits to the setts, details of activity, whether you think badgers are in residence and notes on any signs such as fresh tracks, bedding, digging

etc. It is also important that you visit the setts regularly, preferably at least four times a year. If you watch at the sett, keep a record of the number of badgers seen.

For monitoring badger setts, a camera is very useful. Examination of a series of photographs taken from fixed positions over the years can tell you a lot; photographs that were taken before the sett was attacked by badger diggers can show the extent of any damage, and may be useful evidence in court. A series of photographs over the years also provides a good record of changes in sett activity and the pattern of use.

5. Guarding a small number of setts

The same criteria apply as for (4). You will need to survey your setts regularly; at least monthly, perhaps even weekly or daily. That way you may be able to work out at what time of the year, what time of the week, and how often diggers attack your setts. Besides providing valuable data on the pattern and extent of digging and disturbance, it will also help you plan your wardening. For instance, if badger digging in your area is largely a weekend activity, your problems are lessened. In areas where it is done by unemployed people at any time of the week, wardening is particularly difficult. It is also important that you keep detailed notes on each visit in a format that can be used as evidence in court, should a sett be dug and a prosecution result. Consultation with the NFBG (p.8), or the local Royal Society for the Prevention of Cruelty to Animals (RSPCA) officer (see your local telephone directory), will be invaluable in providing guidance here.

What to record

1. When to survey

The best time to survey is during the winter months. For structured field work you should plan to start after the vegetation has died back, and finish when the spring flush gets underway. This gives you about six months. If you try to survey outside this period you will undoubtedly miss many small setts, particularly if they are not in use at the time, and in thick vegetation you may even miss larger, active setts. However, if you are faced with surveying an area under threat from a development, you have little choice on the timing, and will have to make the best of the situation.

2. Is it a badger sett?

Firstly, you have to decide what constitutes a badger sett. If you are unsure whether a hole has been dug, or has been used, by a badger then consult a good field guide that will show the differences between badger, fox and rabbit holes. Some good tips are given in Bang & Dahlstrom (1974). Badger holes are usually at least 250mm (10 inches) in diameter, and are rounded or flattened oval in shape. Fox and rabbit holes tend to be smaller and are often taller than broad. However, when making this judgement it is important to look at the size and shape of the tunnel itself and not the entrance hole, since even the entrances to rabbit holes may be very large in soft or loose soil due to collapse around the opening. Other useful pointers to the presence of badgers are hairs on rootlets or amongst the spoil, the presence of latrines or bedding, or footprints in freshly dug soil. Rabbit holes usually have rabbit droppings ("currants") on the spoil, may have tufts of rabbit fur from grooming or fighting, and there may be signs of rabbit grazing around the holes. Fox holes usually have a characteristic odour, footprints and hairs in the freshly dug soil, and often scats or prey remains outside; badgers seldom if ever bring prey remains back to the sett. Remember that the presence of rabbits and/or foxes does not rule out the possibility that you have found a badger sett; both species may occupy a temporarily uninhabited sett, which should be recorded as a disused badger sett. Also, both rabbits and foxes may co-habit with badgers, living in different parts of an occupied sett. It may even be worth noting warrens and earths anyway, since they may later be taken over by badgers.

Once you have decided that a hole or series of holes was dug by badgers, it is important to decide what constitutes a single sett. If you have two groups of holes relatively near to each other, are they one sett or two? For the national survey, we used the term "sett" to describe either a single, isolated hole, or a series of a few or many holes that seemed to be connected underground. So if you think that your two separate groups of holes are or could be connected underground, call it one sett. There can be exceptions. For instance, setts dug in the banks of a ditch may have two separate series of holes on each side of the ditch with no underground connection. However, the entrance holes are only a few feet apart, and clearly form one sett complex. In contrast, two separate series of holes on either side of a deep railway cutting would count as two separate setts. As a rough guide, two discrete series of holes separated by at least fifteen metres, or closer if separated by a major obstacle, such as a steep ditch or a road, would be classified as two separate setts.

3. Recording the sett data

Once you have decided how many setts you have found, you want to record some data on the level of activity. Again for the national survey we recorded the following data:-

> **a. The number of well used holes:** these are clear of any debris or vegetation, are obviously in regular use, and may or may not have been excavated recently.
>
> **b. The number of partially used holes:** these are not in regular use and have debris such as leaves or twigs in the entrance, or have moss and/or other plants growing in or around the entrance. Partially used holes could be in regular use after a minimal amount of clearance.
>
> **c. The number of disused holes:** these have not been in use for some time, are partially or completely blocked, and cannot be used without a considerable amount of clearance. If the hole has been disused for some time, all that may be visible is a depression in the ground where the hole used to be, and the remains of the spoil heap, which may be covered by moss or plants.

These data on the level of activity are very useful; they help you decide on the category of sett (see below) and also give you an idea of any changing patterns of sett usage. Although the number of active holes recorded at any one visit cannot be used as a direct guide to the number of badgers in residence, the changing pattern of activity in the setts in a particular area will give you a very good indication of the changing fortunes of the badgers.

Finally, you should try to classify the sett into one of the four types listed below. At first you may find this a little daunting, but in many ways it is the most important piece of information to record, since it will help indicate the importance of that particular sett to the local badgers. Also, by counting the number of main setts, you can get a good idea of the number of badger social groups, and hence the actual number of badgers in the area (p.20). As a guide to classifying each sett the following criteria should be useful:-

> **a. Main setts:** these usually have a large number of holes with conspicuous spoil heaps, and the sett generally looks very active. There will be well used paths to and from the sett and between sett entrances. Although normally the breeding sett and in continuous use, it is possible to find a main sett that has become disused due to excessive interference or some other reason; it should be recorded as a disused main sett. Disused main setts are particularly common in areas of low badger density.

b. Annexe setts: these are close to a main sett, normally less than 150 metres away, and are usually connected to the main sett by one or more obvious well-worn paths. They usually have several holes, but may not be in use all the time, even if the main sett is very active.

c. Subsidiary setts: these often have only a few holes; three to five might be an average number in most areas. They are usually at least 50 metres from a main sett, and do not have an obvious path connecting with another sett. They are not continuously active.

d. Outlying setts: these usually have only one or two holes, often have little spoil outside the hole, have no obvious path connecting with another sett, and are only used sporadically. When not in use by badgers, they may be taken over by foxes or even rabbits.

You should record every sett you find. Even if it is totally disused, and only the old spoil heaps are visible, it is still a valuable record of a sett that has been lost. You may also be in for a surprise; setts that have been disused even for a couple of decades often still have the tunnel system intact, and are sometimes opened up and used by badgers with very little work. Also, you should record setts that are currently occupied by other animals. Any sett may be re-occupied by badgers. For each visit to a sett, record whether you think badgers are still using it, and if you find evidence of fresh digging, footprints, hairs, fresh dung etc. record this. It is valuable evidence of occupancy by badgers, and may be important corroborative data if there is a prosecution of someone found digging or disturbing the sett.

4. Recording badger signs

You may find it useful to record signs of badger activity in the area you search, particularly any well-used badger paths and latrines. If you are surveying pre-selected areas for signs of badgers, it is very useful to mark all the paths and latrines on a large scale map, preferably scale 2.5 inches to the mile (1:25,000). This will be of great value when you come to interpret your results. It helps confirm the category you have ascribed to each sett, it highlights areas of badger activity and may suggest areas where you have missed a sett. It may also help you to mark the likely territorial boundaries of each group of badgers. This is particularly useful when you are trying to estimate the number of badgers in an area or when trying to assess the effects of a road or housing development on the local badger population.

In areas of reasonable density, badgers are territorial. They mark their territorial boundaries with large latrines, and patrol the boundaries of their territory on conspicuous paths. Latrines are collections of dung pits, and the boundary latrines are larger and more conspicuous than those within the territory. Also, most latrines (about 70%) are within 50 metres of a territorial boundary (Fig. 3). So marking latrines and pathways on a large scale map may show you the likely boundaries of each group's range and also the main areas used for foraging. Neal (1986) has useful photographs showing what a typical boundary latrine looks like. Remember that although winter is the best time to

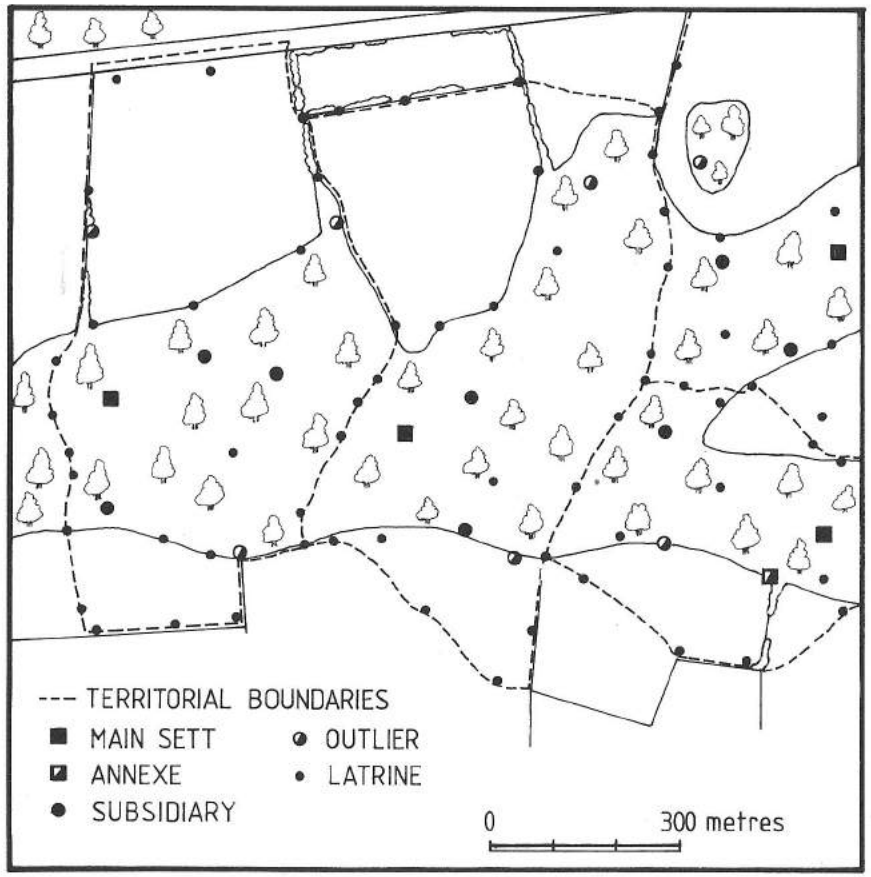


Fig.3. *Distribution of sett types, latrines and boundaries of badger territories in an area of Gloucestershire. The boundaries are often marked by conspicuous paths, and the boundary latrines are larger than those within the territory.*

survey for badger setts, latrines are most heavily used in the early spring, and so this is the best time to do a latrine survey.

5. Recording signs of interference or digging

Digging and/or interference with setts can occur anywhere in the country, and is a particular problem in some areas (Cresswell, Harris & Jefferies, 1989). We do not know whether the incidence of digging is increasing, or whether with more recorders we are just finding more dug setts. Recording any signs of interference with badger setts will

allow local groups to monitor the extent of any problems in their area. Remember that disturbance or temporary light blocking of a badger sett is not illegal, but any form of digging is prohibited by the Badgers Act, 1973 and the Wildlife and Countryside Act, 1981, with the Amendment of 1985. Any form of intentional killing of badgers or cruelly ill-treating is of course illegal under the same Acts. First of all, you must differentiate between the various forms of sett interference:-

a. Hole blocking by children: setts on the fringe of urban areas are often subjected to mischievous interference by children. This can take the form of enlarging hole entrances to form "hides", or blocking holes with logs, stones or other debris. Although usually not done with the deliberate intention of harming the badgers, this form of interference, if continual, can with time lead to decreasing usage of the sett and even its eventual abandonment.

b. Hole blocking by fox hunts: earth stopping is not practiced by all hunts, but many do stop all known fox and badger holes in an area just before a fox hunt. This form of interference is confined to the winter months; most hunts operate from September/October to March/April, depending on the state of the crops and local practice. According to guidelines issued by the Master of Foxhounds Association, badger setts should only be blocked with loose soil, and should not be blocked with oil drums, road cones and such foreign objects. Plastic sacks should only be used if they are removed immediately after hunting. If you find setts blocked in such a way, consult the local landowner to establish who is at fault; if it is the local hunt, photograph the sett, then open the holes and report all such instances to the NFBG (p.8).

c. Sett blocking or destruction by the local landowner or keeper: although many landowners are sympathetic towards badgers, some are not, and may try to destroy setts which they consider to be a nuisance. Setts may be deliberately ploughed-up if they abut arable fields, flattened and destroyed with heavy machinery, blocked with plastic sacks filled with soil, or filled with noxious substances such as slurry. They may also be gassed, either with "Cymag" or by connecting a hose to a tractor exhaust. If you suspect gassing, search the area nearby; empty "Cymag" tins are sometimes left in or near the sett. If you find a sett which has been interfered with in such a way, and you suspect the local landowner or keeper, then consult the local officer of the NCC or RSPCA. They are usually the best people to talk to the landowner, to confirm if an offence has occurred, and to instigate any legal action that may be appropriate.

d. Sett digging: to dig a badger out of a sett, a terrier is first used to locate an animal underground. The dog marks its position by "baying", and ensures the badger does not move off whilst the people dig down to it. In the past diggers would locate the position of the badger under-

ground by listening to the barking of the dog, but nowadays a radio collar is often fitted to the dog. Since the radio collar means that the position of the dog can be located very accurately, most setts have only a single hole dug straight down into a tunnel, and it is from here that the cornered badger is extracted or killed. Usually all that is left is a single "crown hole", but occasionally diggers may follow a tunnel backwards, leaving a long trench, or at least evidence that a trench has been dug, since they usually "back- fill" as they follow the tunnel. The hole that has been dug may be left open, or it may be filled in afterwards, so that all that is left is a shallow depression in the ground with spade marks to show what has happened.

Whatever form of interference you find, it is important to make accurate descriptive notes at the time, and to take photographs if possible. Try to determine the type of interference, the extent of any damage e.g. how many holes are affected, or how much of the sett was destroyed, how recently the event occurred, the level of activity remaining at the sett (and in particular whether any badgers are still using it), and some assessment of the seriousness of the interference. Recording these data must be subjective, since there are no objective criteria that can be laid down for everyone to follow. However, thorough field notes will allow other people to assess what has happened, and if you continue to monitor the pattern of events at the sett following the interference, it will help you to decide retrospectively how much damage was done. Prior fixed-point photography (see p.9) is of obvious benefit for monitoring the consequences of any interference.

6. Recording habitat data

Recording habitat data for each sett you find can be very useful, but it can also be time consuming and is not very informative unless it is done carefully. After all, the initial Mammal Society sett survey report (Neal 1972) included a table with habitat data for 4,313 setts, and Neal (1986) provided an update based on 12,025 setts; you will not match these sample sizes! These national results are presented by county, and give an indication of the sorts of habitats of particular importance to badgers in different areas of Britain.

If the survey you are planning is stratified, or is a total survey in which you are methodically searching all available pieces of land, then you can collect meaningful habitat data, but this may still be of limited value unless you present your data sensibly. For instance, if you completely search an area and find that 70% of all setts are dug in woodland, 20% in hedgerows and 10% in fields, does this mean anything? Are the badgers selecting woodlands? If the habitats in the area you search are 70% woodlands, 20% hedgerows and 10% fields, the badgers probably are being unselective in where they choose to dig their setts. However, if the area is 15% woodland, 5% hedgerows and 80% fields, then clearly the badgers are being highly selective. So not only do you need to know something about the habitat types occupied by the badgers, you also need to know

something about the availability of each habitat type before you can talk about habitat selection by badgers.

For the national survey, we recorded habitat data from every one kilometre square that was surveyed, irrespective of whether any badgers were present. This is one approach that you could adopt locally. If you search pre-selected areas for badgers, record simple habitat data in all the areas searched. It is slightly more time consuming that just searching an area for badgers, but ultimately will give you more objective information. Not only does it show you which habitats the badgers are selecting, it also helps you understand just how much your local countryside is changing. An example of how such data can be used is given by Cresswell, Harris & Jefferies (1989), and a complete list of the habitat data recorded for each one kilometre square searched in the national badger survey is given in Appendix 1.

7. Recording soil and geological data

You may also wish to record the types of soils and geological formations in which the badgers build their setts. Geological data are best extracted retrospectively from maps, and copies of the local geological maps can probably be obtained from your local museum. For soils, things are not so simple; the only complete coverage is by the 1:250,000 maps, but these are far too small a scale to be of use, and also the soil maps for England and Wales are totally incompatible with those for Scotland, and so no uniformity can be achieved for the whole of Britain.

Recording soils from maps therefore poses a problem. Instead it is best to use field data obtained by recording the texture of the soil in the spoil heaps of the sett. Appendix 2 gives a key on which to base this assessment, but remember that soil texture is only a broad soil grouping, and you cannot easily estimate the availability of these soil groupings in the survey area and hence quantify any badger preferences.

8. Vulnerability of the sett

If you are trying to establish which setts are or may be threatened in the future, or decide on an order of priority for wardening your local setts, you may wish to score its "vulnerability", and the following is a guideline to the factors to record:-

Ease of public access.
How obvious is the sett?
Any evidence of interference so far (p.13)?
Are there any local developments nearby (housing, road improvements, etc.)?
How often should the sett be visited?

These data can only be recorded in a subjective manner, and it is not possible to specify how to score them. However, even a subjective assessment will enable you to decide how vulnerable your local setts are, and such an approach is particularly useful

when your main survey aim is either monitoring the badger setts in an area or guarding a small number of setts which are particularly at threat. The attitude of the landowner to the badgers may be particularly important in helping you assess the vulnerability of a particular sett, and this should also be recorded.

9. How to record your data

Before you design your recording form, think about the sort of data you want to record, and in particular how you want to record information from repeat or subsequent visits. If you are surveying a pre-selected area, it is useful to use a large scale map e.g. 2.5 inches to the mile (1:25,000), since this gives enough detail to show field boundaries, etc. This helps you to record accurately the position of each sett. It is also a useful scale on which to record any habitat data, since all major land-use features can be marked on the map. A separate data sheet can then be used to record all the additional data about size of the sett, levels of usage, interference, any additional information on habitat, and soils and/or geological data.

You will probably also need to make an accurate sketch map to record the exact site of the sett, even when the general position of the sett has already been marked on a large scale map. This will enable you to mark important features that will help you find the sett again, perhaps many years later. Accuracy and detail are important, since it may be someone else who visits the site at a future date, many major landscape features may have been changed, and finding the sett or where it had been can be difficult. Perhaps one sett has been destroyed and a new one dug nearby. You can only be sure that this has occurred if you have very detailed notes on the locality of the first sett. Mapping everything accurately on squared graph paper is a useful way to keep a detailed record of the position of the sett, any relevant landscape features and the positions of all the holes.

The format of your recording form will depend on individual preference; Appendix 3 gives an example. It is useful if a record is completed for each visit to a sett, even if you don't think there has been much change since your previous visit. You may need this additional data in the event of a prosecution or it may be of value in showing you the changing pattern of sett usage in an area. It will also help you to assess the long-term effects of any interference or digging at a sett.

The way forward: now try it yourself

We have talked about various possible types of badger survey, each with different aims and hence different approaches, the sorts of data that can be recorded in the field and how some of these data can be analysed. We have also tried to point out some of the pitfalls, to ensure that the maximum benefit is obtained for your effort. It is all too easy to think "I'll do a badger survey", start recording information without any clear rationale, and then, after a lot of hard work, wonder how to use the information that has been collected. This is the commonest problem with field studies that have been carried out, especially when using volunteers. Only at this stage may you discover that you have not recorded some crucial piece of information. So the planning stage is vital. Think about what you want to achieve, read other local badger survey reports, talk to other local recorders, and read the national survey report by Cresswell, Harris & Jefferies (1989).

To help with the planning stage, the following is a check-list of the most important points:-

1. Take a field note book with you every time you go out surveying; you must make accurate records in the field and not try to compile notes from memory on your return home.

2. Classify each sett into one of the four categories listed on pp.11 & 12.

3. Record the number of active, partially-used and disused holes as described on p.11.

4. Describe and try to monitor the level and effects of the sorts of interference listed on p.14.

5. Mark the position of each sett on a large scale map. A useful addition is to make a sketch map on graph paper showing the position of holes in relation to other features such as trees, ditches and fences (p.17).

6. For each visit you make to the sett, record points (2) and (3) above, so that you can monitor the changing patterns of badger activity over a period of time, and can also retrospectively assess the results of any interference on the badger population (p.15).

7. Think carefully about the data on habitat, soils and geology you wish to record. Just recording the habitat around each sett is often not very informative (p.15), but it can be useful so long as it is not used to show habitat selection or habitat preferences of badgers without reference to availability. Guidelines on the sort of habitat data to record are given in Appendix 1, and if you use this classification, then your findings can be compared directly with the national results.

8. Think about the time scale of your survey, and how this will affect the analysis. You may be collecting data over a long period, but it is very difficult to analyse if some setts were surveyed ten, fifteen or twenty years before others. Some setts may be visited once in ten years, others two or three times a month. Look at the manpower available to help you, and set yourself the goal of visiting every sett at least once in three years. It would also be useful for comparative purposes to revisit setts at the same time of the year, so that seasonal differences in activity do not confuse any long-term monitoring. Remember that from December badger activity levels decrease and by visiting setts at this time of year you can get a very false impression of a decline in badger numbers. As time progresses and your data base increases, you can then look at the changing state of your badger population in each three year period; the number of setts lost, the reasons they have gone, the differing fates of setts in woodland compared with those in farmland in relation to changing patterns of agriculture, land use, etc. In areas where you are trying to monitor the extent and nature of any digging, much more regular visits will be required.

9. When you come to analyse your results you should also think carefully about any biases that may creep into your conclusions, and careful planning at the start of the survey will help you avoid some of the potential problems. For instance, if you are surveying in southern England, you may be worried about the number of badger setts being lost to road and housing developments. If you have found and recorded 200 setts during your survey work, and ten of these are lost to housing developments in the next five years, then you know that you are currently losing two of your setts each year to developers (i.e. a 1% loss per annum). But if in addition to the 200 setts found during your survey, another 20 setts are reported to you only because they are being threatened by developers, you must not include these 20 in your calculations of the rate of sett loss, otherwise you will bias your results. The actual rate of sett loss must only be calculated from your random sample of 200. So when you start to collect your data, treat records collected by a random/stratified survey separately from setts that are only reported to you because they are being threatened, damaged or destroyed. Take care with your analysis; discuss your results and conclusions with other people and ask for their critical appraisal.

10. You must publish your results (but obviously not the exact sett locations), since they will be an historical record of the status of your local badger population. Many professional biologists of today read and use the reports of local naturalists published a century ago. If you do not publish, there is no record of your work. Most counties have an established natural history society with a journal that would welcome your report. Details of how to prepare your data for publication can be obtained by consulting copies of the journal at your local museum or natural history society library. It is also very important to send copies of any local survey report, published or unpublished, to the NCC. Also, ensure that copies of your raw data

are deposited with the local museum or natural history society archives, and not just hidden in your attic.

Further suggestions for enthusiasts

Not only can local badger groups contribute to our knowledge on the distribution of badgers, but they can also add to our knowledge of badger biology, particularly in areas where badgers are living at medium to low densities. Here are a few suggestions of things to do once your initial survey is completed:-

1. Once you have some idea which are the main setts in a particular area and the ranges of some social groups (p.12), try to organise simultaneous watches on all the active setts belonging to a particular group of badgers to assess how many badgers are present, and how many cubs are produced. This is best done in May/June, before the vegetation gets too thick, and when the badgers are all likely to emerge soon after dusk. With care, and over a period of time, you may be able to help collect some valuable data on the litter sizes and breeding success of badgers in different parts of the country. In the national survey, Cresswell, Harris & Jefferies (1989) calculated that there were 42,000 badger social groups in Britain. Their estimates of the total number of adult badgers (245,000) and the number of cubs born each year (102,000) are based on data from three high density studies; to apply such figures to badgers living in East Anglia, the Lake District or the Midlands may well be wrong. We need to know a lot more about the population ecology of badgers, and studies on your local badgers can be particularly valuable in this respect.

2. In the spring, try organising regular watches for cubs. If you can record the first time the cubs come above ground, you can help contribute to our knowledge on variations in the breeding season of badgers in different parts of the country.

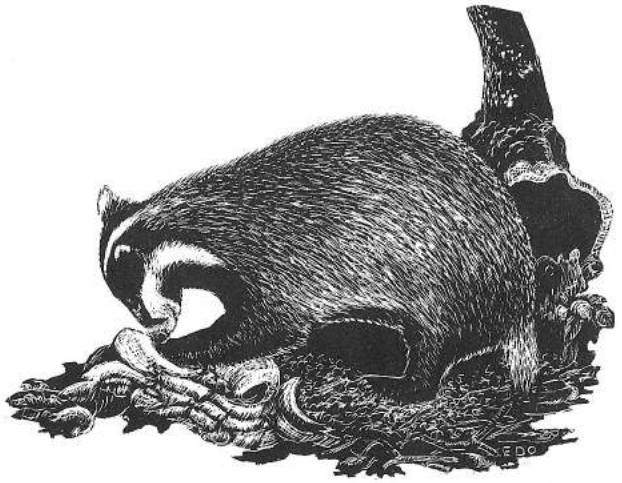
3. Marking latrines and pathways on a large scale map, as described on p.12, will show you the territorial boundaries of selected groups, and this will tell you a lot about badger territory sizes in your area, particularly in different habitat types. Again most of our data on badger territories is based on a few studies of badgers living at high densities; we need to know a lot more about constancy of sett occupation, variations in territory size and patterns of latrine use at low densities, and in a variety of habitat types.

4. If a sett is lost to developers, try and arrange to be there when the sett is excavated. You can then ensure that all the badgers have vacated the sett, and can map the size and course of the underground tunnels in relation to what you recorded above ground. We still know little about the underground architecture of badger setts, particularly in relation to different habitat types and social group size, tunnel lengths in different types of soil and in relation to the water table. Even simple data like the typical number and size of nest chambers in each of the four types of sett are unknown.

5. If you are surveying in a small area, record all the causes of known mortalities of your badgers. Map the positions of their bodies (e.g. road casualties in relation to paths crossing roads). You may be able to determine the importance of each cause of mortality, and by recording the sexes and approximate ages of the dead animals and relating these to your watches on the same groups, monitor the changing structure of your social groups over the years. You will also be able to find out the effects of the loss of e.g. the dominant boar, on the survival of the group.

6. Try to find any historical information about the larger setts in your area; you may be able to obtain an indication of their age. Local farmers, foresters, gamekeepers and older naturalists may have a fund of useful information on the past history of a particular sett. Such a fund of data may be useful when defending the value of a sett with planning authorities.

We still have a great deal to learn about the badger population in Britain; local badger groups can make a substantial contribution to increasing this knowledge. Remember that local badger surveys are not only extremely useful if done properly, they are also great fun!



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Appendix 1.
Habitat categories used during the national badger survey by Cresswell, Harris & Jefferies, 1989

For the national survey the following forty habitat categories were used; for each one kilometre square surveyed, each piece of habitat at least 50 metres in length or 500 square metres in area was recorded. The habitat categories were marked on a photocopy of a large scale map with coloured pencils. Although at first sight this may appear to be a little complex, it is very easy, and in most areas only half a dozen of the different habitat categories will be recorded.

1. **Hedgerows:** these are less than 4 metres high and less than 5 metres wide. Classify them as continuous if the gaps are less than 10 metres wide.

2. **Treelines:** a line of single trees (minimum of three) greater than 4 metres high and less than two canopy widths apart. Hedgerows are commonly associated with treelines.

3. **Semi-natural broadleaved woodland:** predominantly broadleaved trees more than 5 metres high with a semi-natural or natural growth.

4. **Broadleaved plantations:** predominantly broadleaved trees of any height which may or may not be native to the site and are of even age. Include orchards in this category.

5. **Semi-natural coniferous woodland**: predominantly coniferous trees of more than 5 metres high with semi-natural or natural growth.

6. **Coniferous plantations:** predominantly coniferous trees which have been planted.

7. **Semi-natural mixed woodland:** at least 25% broadleaved and at least 25% coniferous trees over 5 metres high with semi-natural or natural growth.

8. **Mixed plantations:** at least 25% broadleaved and at least 25% coniferous trees which have been planted.

9. **Young plantation:** young trees, up to 3 metres high, both coniferous and broadleaved, which have been planted.

10. **Recently felled woodland:** areas for which there is evidence that woodland has been recently felled.

11. **Parkland:** areas where tree cover is less than 30%, the majority of the trees are between 30 and 70 metres apart, and a minimum number of ten trees.

12. **Tall scrub:** between 3 and 5 metres high e.g. thickets of blackthorn, old hazel coppice, etc. N.B. stands of trees less than 5 metres high should be classified as woodland, not scrub.

13. **Low scrub:** woody vegetation less than 3 metres high e.g. young coppice, bramble thickets.

14. **Bracken:** land dominated by bracken with at least 75% cover.

15. **Coastal sand dunes:** includes all stages of succession where the vegetation is grass-dominated or wet dune slacks.

16. **Coastal sand or mud flats:** bare areas of sand or mud.

17. **Coastal shingle or boulder beaches:** includes shingle and boulder beaches and outcrops of bare rock on foreshores.

18. **Lowland heaths:** lowland heathland with at least 25% dwarf shrubs such as heather.

19. **Heather moorlands:** upland heathland with at least 25% dwarf shrubs such as heather and bilberry.

20. **Blanket bog:** areas of peat with the vegetation dominated by heather, cotton-grass or *Sphagnum*.

21. **Raised bog:** at least half the peat area raised into a shallow dome, and drier than blanket bogs.

22. **Marginal inundations**: swamps or fens but not coastal marshes.

23. **Coastal marsh:** consists predominantly of salt marsh vegetation, such as *Spartina*, sea asters, etc.

24. **Wet ground:** areas of wet land found in association with other habitats e.g. wet areas in a grassland field or flushes in upland areas.

25. **Standing natural water:** no evidence of damming.

26. **Standing manmade water:** artificially created reservoirs and impoundments.

27. **Running natural water:** no evidence of canalisation.

28. **Running canalised water:** a water course that has been artificially confined to flow in a certain channel.

29. **Upland unimproved grassland:** in upland areas, and will include some areas used for rough grazing and poor quality grassland such as purple moor grass.

They have not been improved by the application of fertilisers, herbicides or by drainage.

30. **Lowland unimproved grassland:** may be regularly grazed or mown, or totally neglected. Should not have been improved by the application of fertilisers or herbicides to significantly alter the composition of the sward. Includes herb-rich grassland such as downland, cliff tops, etc. Neglected grassland that had reverted from categories 31 and 32 was included in this category.

31. **Semi-improved grassland:** grassland which has been slightly modified by fertiliser or herbicide application, or by heavy grazing pressure and/or drainage.

32. **Improved grassland:** grassland that has had regular treatments of artificial fertilisers and herbicides N.B. this should not include monoculture grassland i.e. grassland leys (see 33).

33. **Arable:** all classes of arable land, including grassland leys and horticulture. A grassland ley is defined as short-term grassland, and will usually have been re-seeded less than five years previously. It is characterised by evidence of ploughing, bare soil between the grass plants, a scarcity of broadleaf plants, and is usually dominated by a single grass species, often rye grass. There are usually fewer than 5-10 species of plant per square metre. Category 32 consists of longer term grassland with a higher density of grass and broadleaf species, usually in enclosed land.

34. **Amenity grassland:** this includes well maintained non-agricultural grass, such as playing fields, recreation grounds and golf courses.

35. **Unquarried inland cliffs:** unvegetated rock over 5 metres in height and at an angle of at least 60 degrees. It includes scree.

36. **Vertical coastal cliffs:** as above but in coastal areas and mostly unvegetated.

37. **Sloping coastal cliffs:** at an angle of less than 60 degrees and mostly vegetated.

38. **Quarries and open-cast mines:** any excavation (gravel pits, chalk pits, etc.), including unvegetated spoil heaps.

39. **Bare ground:** bare soil or ground not covered by vegetation and which does not fall into categories 35-38.

40. **Built land:** any urban areas including gardens and transport corridors, and will include road and motorway verges.

These categories were used to describe the land use in an area. However, you may wish just to record the habitat in which each sett was found, in which case use the forty categories above, plus: woodland edge; river banks; railway embankments; roadside verges; dry ditches and other man-made embankments; others.

Appendix 2.
Classifying soils in the field

Soils can be classified in the field by texture. Particle sizes are classified in the soil survey of England and Wales according to the following system. Clays: particle size less than 0.002mm; silts: 0.002-0.06mm; fine sands: 0.06-0.2mm; medium sands: 0.2-0.6mm; coarse sands: 0.6-2.0mm; stones: over 2.0mm. The combination of these particle sizes determines the texture of the soil, and depending on the percentages of sand, silt and clay, soils are assigned to a textural class e.g. sandy clay, loamy sand, etc. These are not loose terms but define very precisely the proportions of sand, clay and silt in that textural class. But since you cannot easily measure the proportions of these particles in the field, soil texture can be assessed qualitatively by "feel" with the aid of a key such as the one below, compiled by Dr Sheila Ross at Bristol University. With a little practice, it can be applied with precision, and all soils can be classified reliably into the correct textural class, in a manner uniform with other recorders.

Key for soil texture determination in the field

A. Rub between fingers.

1. gritty - (B)
2. sticky - (C(i))
3. silky - (C(ii))
4. sticky and gritty - (C(iii))
5. silky and gritty - (C(iv))
6. none of these, but black - (D)
7. none of these, nor black - (LOAM)

B. Try to mould into a roll

(i) cannot - does not stick nor mark the skin = **SAND**

(ii) roll formed and marks skin

(a) roll breaks when bent double = **LOAMY SAND**

(b) roll does not break

(i) surface can be polished with thumb = **SANDY CLAY**

(ii) surface cannot be polished = **SANDY LOAM**

C. Roll soil into ball and polish with thumb

(i) sticky

(a) ball resists deformation = **CLAY**

(b) ball fairly resistant to deformation = **CLAY LOAM**

(ii) silky

(a) ball fairly resistant to deformation = **SILT**

(b) ball has little or no cohesion = **SILT CLAY LOAM**

(c) ball smooth; fairly resistant to deformation = **SILT LOAM**

(iii) sticky and gritty; can be balled and polished = **SANDY CLAY LOAM**

(iv) silky and gritty; can be balled but not polished = **SANDY SILT LOAM**

D. Peat

(i) firm, coherent, tough, not plastic, plant structures visible, often spongy = **FIBROUS PEAT**

(ii) may appear fibrous, soft, becoming paste-like under pressure = **PARTLY DECOMPOSED PEAT**

(iii) plastic when wet, powdery when dry, no plant remains visible = **AMORPHOUS PEAT**

Appendix 3.
Specimen recording sheets

Below are two examples of recording sheets. The first one is for the first time a sett is visited, the second one is for repeated visits. On the example given below, some simple habitat categories have been included. These will not be used for a detailed habitat analysis, but simply taken to indicate the sort of habitat in which the sett is to be found. Circling various characters on the list enables all the data to be recorded quickly, and also ensures that you do not forget to record anything.

BADGER SETT RECORD SHEET

Name of site: **Date of record:** **Grid reference:**

Owner's name, address and telephone no:

Sett site description (please circle relevant category):

Woodland Conifer plantation Scrub Hedge Ditch Field Garden

Quarry Embankment/cutting Other (specify)

Category of sett: Main Annexe Subsidiary Outlier

Number of entrances: Well used Partially used Disused

Signs of occupation: Bedding Hairs Tracks Dung pits Scratching posts

Geology: (to be added later from a map)

Soil texture in spoil heaps:

Vulnerability:

Ease of public assess.

How obvious is the sett?

Any evidence of interference so far?

Local developments nearby (housing, etc.)?

How often should the sett be visited?

Attitude of landowner:

Sketch map to show the position of the sett, other features, and nearby landmarks to enable location of the sett to be found easily. Add a scale to the map, and the distance/direction to the nearest landmark such as a town, local church or road.

Any previous history:

Recorders name (printed, not a signature), address and telephone no:

Please return to:

BADGER SETT REPEAT VISIT SHEET

Name of site: **Grid reference:**

Recorders name (printed, not a signature), address and telephone no:

Date of visit	Signs of occupation and/or number of badgers seen on watch	Number of holes well used, partially used and disused	Evidence of interference or digging