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THE STATUS OF THE BADGER (*MELES MELES*) IN HAMPSHIRE

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ABSTRACT

Hampshire is a county which is particularly fortunate in that it supports a rich diversity of habitats and species. However apart from a few local exceptions little work has been devoted to the study of the European badger (Meles meles). *The purpose of this project was to attempt to secure baseline information on the current status of the species in the county of Hampshire by investigating distribution and density. It was considered that the recording and collation of such data was essential if an effective programme of badger conservation and monitoring were to be undertaken. It was further thought that the availability of structured uniform data on a countywide basis would aid those engaged in larger scale survey projects.*

INTRODUCTION

In keeping with the rest of south-east England, Hampshire is a county which has become heavily developed and urbanised, particularly so within the last thirty years. Fortunately the greater extent of such progress has been well controlled and much of the county remains rural with a continuing dependence upon agriculture. The total population is in excess of 1.5 million with over half of this figure being concentrated in the southern coastal areas. Here there is now more or less unbroken development between Havant in the east and the western shores of Southampton Water, a distance of some thirty miles. With easy access to London, north-east Hampshire has also been subjected to urban growth with large populations established at Aldershot, Farnborough and Basingstoke. With the exceptions of Winchester and Andover, central and north-west Hampshire has remained far less developed and is an area of agricultural significance. Away from the coast much of the south-west of the county has also escaped large scale development, due chiefly to the presence of the internationally important New Forest. Despite the substantial pressures Hampshire remains one of the richest ecological areas in Britain. There is an exceptional variety of habitats which host equally rich collections of species. Amongst these are 10% of Britains ancient woodlands, over 40% of Britains lowland heath and many examples of fine chalk grassland and unimproved meadows. The county has 120 Sites of Special Scientific Interest.

Agriculture

Traditionally there has been a mixture of arable and dairy farming although there can be considerable local diversity. The old chalklands of central and northern Hampshire have been heavily cultivated, the landscape being characterized by large featureless field systems. Further south, farming is less intensive and more varied, market gardening is widespread. The poor quality of New Forest soils severely restrict most agricultural practices and consequently most farms here are limited to part time small holdings although there has been a recent small scale increase in cereal production. The area of the Thames basin generally consists of small scale mixed farming and in the eastern areas dairying and stock keeping predominate.

One factor which is common throughout the county is the significant swing towards arable farming, generally at the expense of pasture and grassland. Between 1974–1984 an additional 11,000 ha were given over to arable land, chiefly in the form of cereals and mostly to wheat. The change is most dramatic on the chalklands where in one district near Basingstoke arable land increased from 6,500 to 13,500 ha within ten years. During the same period 14,000 ha of grassland and pasture has been lost.

Current EEC directives suggest there will be continued change in many of our agricultural practices and farmers are now seeking alternative sources of revenue from their land.

Geology

Geologically, Hampshire can be divided into four separate formations each of which is briefly described in the following text. Additionally the river valleys of the Avon, Test and Itchen are also worthy of comment.

Thames Basin: Northern parts of Hampshire form the southern extremes of the Thames Basin. Large deposits of London Clay predominate but notable areas of Bagshot Sands and Bracklesham Beds also exist together with smaller tracts of Valley and Plateau Gravels. Small deposits of Reading Beds are also present. The soils of the London Clay are heavy and loamy but gradually increase in sand content towards the west. The area of Bagshot Sands and gravels are of typical poor quality and heavily podsolized.

Chalk Downlands: The chalklands cover the greater extent of central and north-west Hampshire progressing through lower, middle and upper levels, the latter being characterised by its heavy flint content. In many areas the upper chalk is capped by clay with flints, these are sometimes extensive. The middle and lower chalks vary in quality becoming less pure and more loamy at the lower levels.

Western Weald: The western fringe of the Weald is located in the central area of east Hampshire. The diverse geology comprises of Upper Greensand, Gault Clay and an assortment of sandy deposits dominated by Hythe and Folkestone beds. The well drained fertile Upper Greensand is most dramatic on its extensive escarpments which are broadly preceded by a belt of Gault. The Hythe and Folkestone beds are of poor quality but are easily worked and dry.

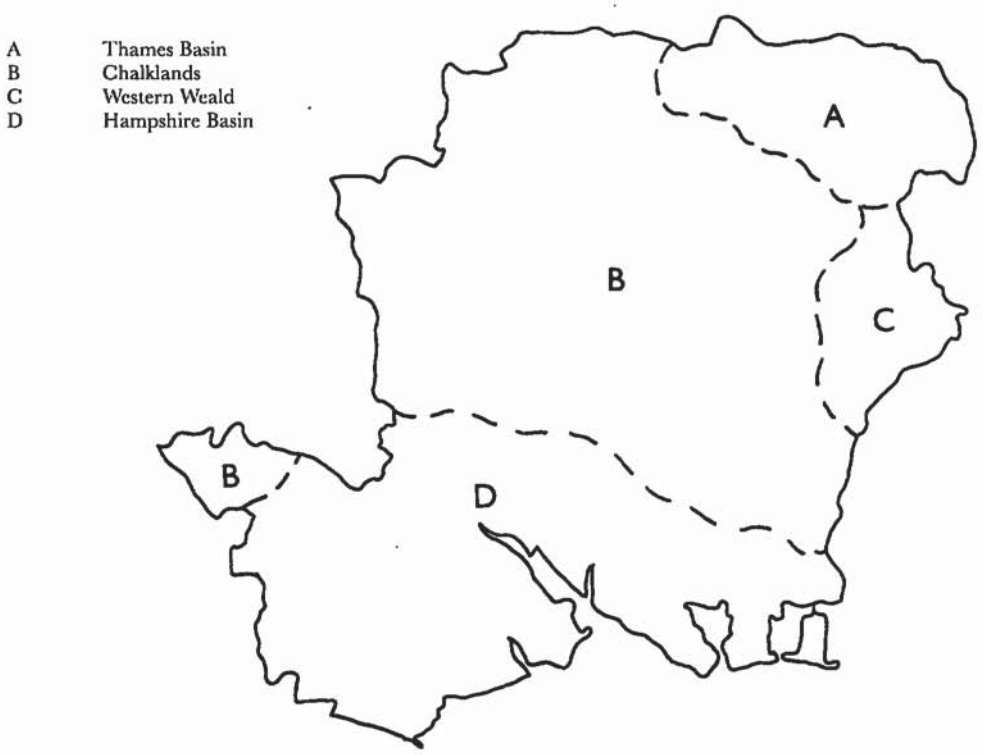

Fig 1. Geological regions of Hampshire.

Hampshire Basin: Situated south of the chalk downlands with a varied geological pattern. Large expanses of Bracklesham Beds and London Clay are present, the latter being loamy and less heavy in many parts. Areas of Bagshot Sand, Reading Beds, Plateau Gravel and Brickearth are also present. To the west of the area lies the New Forest; one of the chief reasons it survives in its present form is the very poor quality of its soils. These comprise of Barton Clay, Barton Sand and Plateau Gravels interspersed with smaller deposits of Valley Gravel, Bracklesham Beds and Bagshot Sand, the soils of which are all heavily podsolized. Elsewhere Bracklesham Beds and Bagshot Sands become more common, again accompanied by various deposits of gravel with some Barton Clay.

METHODS OF STUDY

In the last thirty years or so there have been numerous county based badger surveys conducted throughout Britain. Such studies not only provided valuable data on the status of badgers at the time but also formed an important foundation from which to monitor the changing fortunes of the species in these respective areas. Previously no work of this scale had been undertaken in Hampshire and most of the available data tended to be very localized. Even records from the Mammal Societys' national badger survey were scant and fragmented. This being the case it was necessary to conduct this survey more or less from scratch, initially collecting and collating all available records with those obtained from personal fieldwork.

Recording badger setts

The easiest and most practical method of determining the presence and distribution of badgers is to locate and record badger setts. Previous experience with Hampshire badgers provided a sound data base from which to start but it was clear that it would be necessary to make a distinction between different types of sett if records were to be of value. The classification of badger setts is best explained using the criteria established by Cresswell, Harris and Jeffries (1990):

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.

Annex setts: These are close to a main sett, normally less than 150 m 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.

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 m from a main sett and do not have an obvious path connecting with another sett. They are not continuously active.

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.

Stratified Sampling

Although a large amount of data was obtained in the form of individual sett records it was considered necessary to substantiate these with a more uniform system of surveying. The most suitable practice was that used in the 1986 national badger survey where a system of stratified sampling was adopted. The advantages and methodology of such surveying are fully described in 'Surveying Badgers' (Harris, Cresswell and Jeffries 1989). In brief, stratified sampling eliminates any bias as the points surveyed are uniformly distributed throughout the study area. In this project 1-km squares were plotted from Ordnance Survey maps each being spaced 10 km from the neighbouring sample square. By so doing such samples were obtained from all parts of the county and a total of 39 1-km squares were surveyed.

The data recorded from each square was also consistent with the requirements of the national badger survey. Firstly the presence or absence of badgers was noted together with local geology and topography. Different types of habitat were also recorded eg. deciduous woodland, grassland; again these were based on the criteria established for the national survey. The collection and interpretation of the resulting data was to be used in assisting to identify factors influencing badger density and distribution in Hampshire.

RESULTS

Analysis of Badger Setts

At the conclusion of the study over 600 badger setts were recorded in Hampshire, 490 of which were classified as main setts. These were considered to be of greatest importance as in most circumstances each badger social group maintains only one main sett. Figure 2 illustrates the distribution and density of badgers in the county and it can clearly be seen that the pattern is far from uniform.

When considering the many factors which combine to make suitable badger habitat it is not surprising to find equal variability in the species distribution and density, especially in an area as large as Hampshire. Figure 2 readily identifies favourable and less favourable badger areas. The scarcity of badgers in some parts is equally as interesting as their presence in others and the low number of setts found in central and north-western districts is easily recognised. This is a vast area of upper chalkland, intensively farmed with majority of the human population being concentrated at Basingstoke, Winchester and Andover. There was an awareness of the fact that so few recorded setts may be the result of inadequate surveying and measures were taken to eliminate any such bias. Greater effort was given to searching for setts in this part of the county but

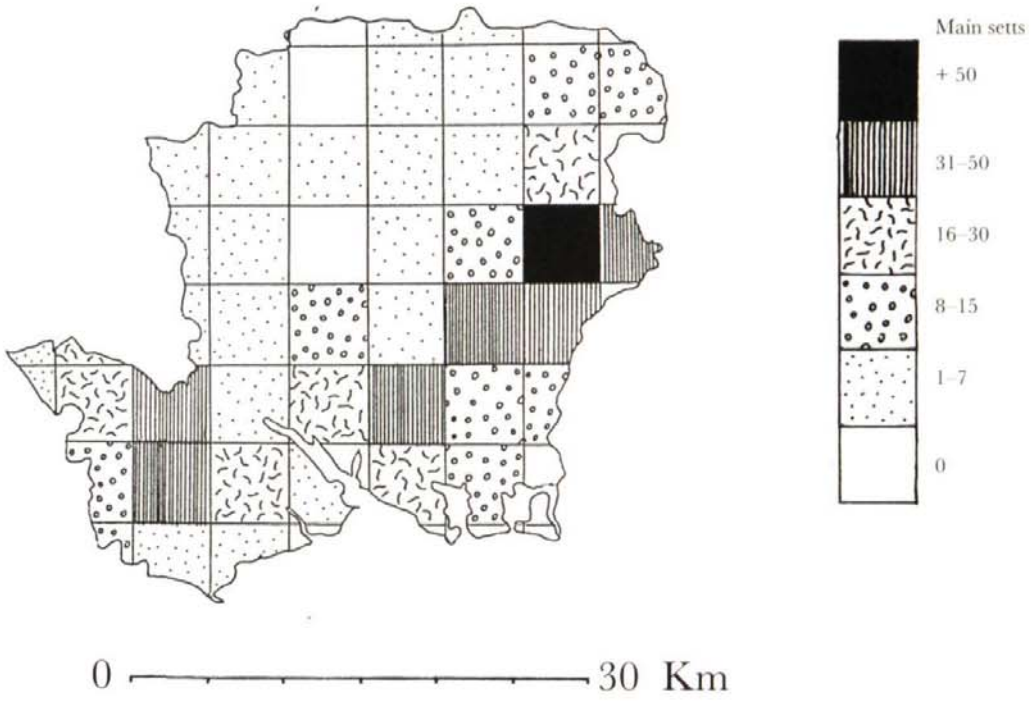

Fig 2. The distribution and density of badgers in Hampshire.

with little success. These findings were also confirmed by the earlier work of Clements.

In the south-west of the county badger numbers attain reasonable levels although the distribution of setts is patchy. Despite poor habitat most of the setts in this area were found within the New Forest with numbers reducing towards the Dorset border and southwards along the more urban coastline. Another area of reasonable density is in the south of the county below the chalk between Southampton and Portsdown. Again distribution is sporadic but in suitable parts main setts occur about one per square kilometre. As previously stated the whole corridor between Southampton and Portsmouth has been heavily urbanised but badgers still persist and reports of badgers feeding in gardens are not uncommon, particularly in Fareham and Southampton.

The greatest density of badgers is to be found in the area of east Hampshire where over a quarter of all the county's setts have been recorded. Many of these occur in chalk and much of this is due to the extensive escarpments which transect the area from north to south. Below these, easily worked sandy soils extend eastward and are much favoured by badgers. This whole area has remained chiefly agricultural but the local topography has restricted the intensive practices witnessed elsewhere on the Hampshire chalklands. One of the 10-km squares illustrated in Fig 2 contains over fifty main setts and the one below only a few less, such statistics are exceptional for Hampshire but easily surpassed in parts of Sussex and south-west England. In the remaining area of north-east Hampshire a low to moderate number of setts were recorded. Here again there has been tremendous urban growth although some large areas have been preserved as the property of the Ministry of Defence. Nevertheless the quality of the soils is poor and this is reflected by the local habitats.

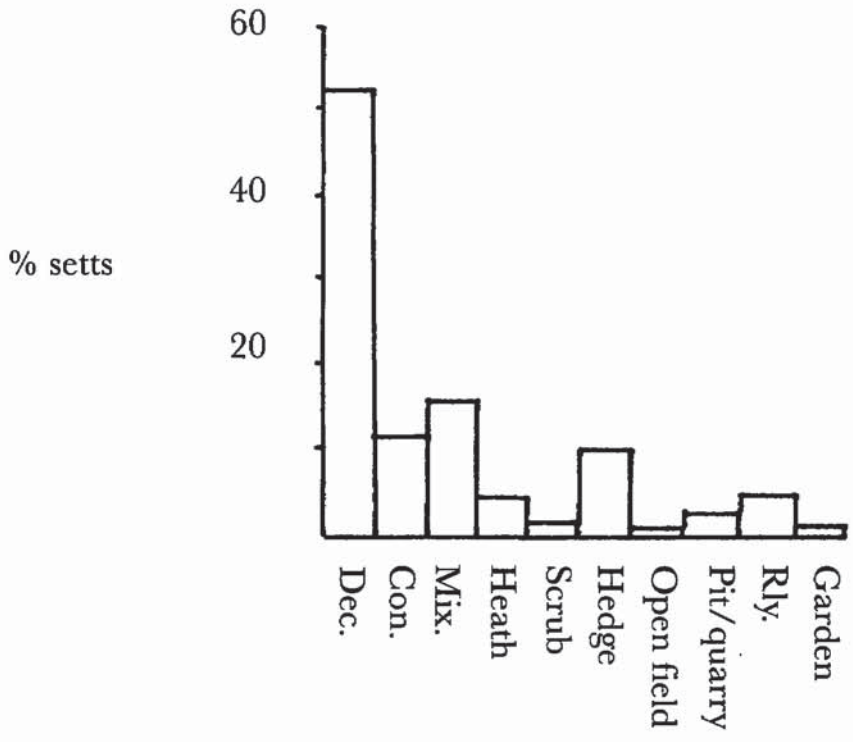

Fig 3. Habitat selection of badger setts in Hampshire.

Choice of Habitat

All the main setts that were recorded were classified according to the type of habitat in which they were found. Ten such habitat classes were utilised by Hampshire's badgers for the siting of setts, deciduous woodland, coniferous woodland, mixed woodland, heathland, scrub, hedgerow, open field, pit/quarry, railway embankment/cutting and garden etc. The relative usage of each class is shown in Fig 3.

It is clear that there is an overwhelming preference for deciduous woodland sites. Such preference is compounded by the inclusion of the two other woodland categories which collectively house 75% of Hampshire's main setts. The county is of national importance for the presence of its heathlands although their demise has been rapid, particularly in the north-east. Setts can be found in these heathland sites but they are nearly all exclusive to the New Forest. In parts of south-west England hedgerows are a favourite site for setts, but only 10% of those recorded in Hampshire were included in this category. Disused chalk pits are sometimes utilised as are railway cuttings and embankments which by their design make ideal sites.

Woodland Setts

Given that three-quarters of all main setts were located in woodland these habitat classifications warranted closer examination. Firstly a note was made of a setts position within the woodland block and 77% of all setts were found to be less than 25 m from the woodland edge. This figure would have been higher had it not been for the data recorded from the New Forest setts. Here setts are often located deep within large plantations or enclosures where food availability is greater than that of the surrounding heathlands. A record was made of dominant tree, shrub and herb species present at the site of badger setts (Table 1). However the results are undoubtedly a reflection of occurrence rather than specific species preference.

Table 1.1 Dominant tree species at the sites of badger setts in deciduous woodland.

Species	*% occurrence*
Beech (*Fagus sylvatica*)	33
Ash (*Fraxinus excelsior*)	32
Pedunculate Oak (*Quercus robur*)	55
Sweet Chestnut (*Castanea sativa*)	6
Birch (*Betula pendula*)	17
Alder (*Alnus glutinosa*)	3
Field Maple (*Acer campestre*)	3

Table 1.2 Dominant shrub species at the sites of badger setts in deciduous woodland.

Species	*% occurrence*
Elder (*Sambucus nigra*)	24
Hazel (*Corylus avellana*)	31
Hawthorn (*Crataegus monogyna*)	7
Holly (*Ilex aquifolium*)	10

Table 1.3 Dominant herb species at the sites of badger setts in deciduous woodland.

Species	*% occurrence*
Bramble (*Rubus fruticosus*)	28
Dogs Mercury (*Mercurialis perennis*)	19
Wild Garlic (*Allium ursinum*)	3
Nettle (*Urtica dioica*)	29
Bluebell (*Endymion non-scriptus*)	21
Bracken (*Pteridium aquilinum*)	57
Ground Ivy (*Nepeta hederacea*)	6
Old Mans Beard (*Clematis vitalba*)	8

Altitude and Aspect

For burrowing animals such as badgers the advantage of sloping ground in which to dig is self apparent. This is reflected in the fact that 86% of main setts in Hampshire are situated on sloping ground. The aspect of the slope was recorded in each case and as illustrated in Fig 4 there is no apparent significance as to the direction of the slope.

Due to the county's lowland situation there was no expectation that altitude would be of great

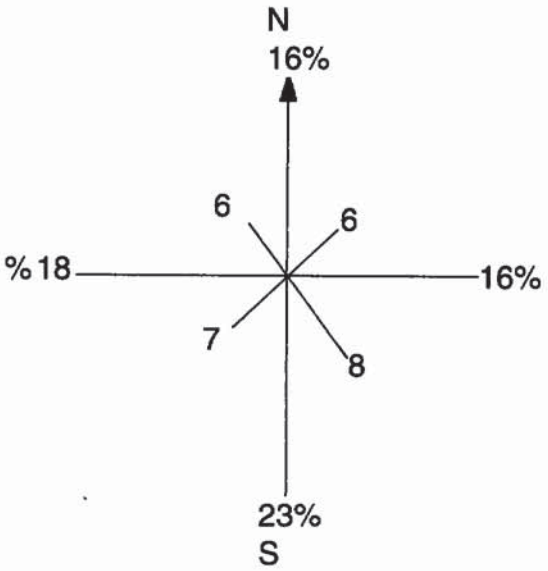

Fig 4. Aspect of slope at sites of main setts in Hampshire.

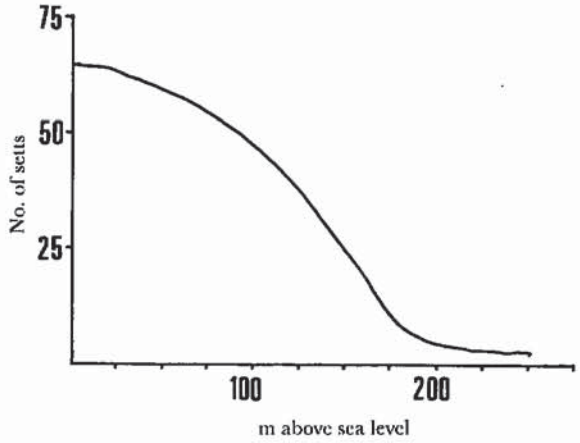

Fig 5. Altitude of main setts in Hampshire.

significance to badger distribution. In only a few cases do heights exceed 250 m but as Fig 5 illustrates 82% of setts are found below 150 m.

Geology

For the purposes of this study five distinct geological formations were recognised. These categories were the sandy soils, chalk, Upper Greensand, clays and a remaining group comprising chiefly of alluvium, valley and plateau gravels. With the aid of geological survey maps the strata in which each main sett was located became readily identified and their frequency of use is illustrated in Fig 6.

Sandy soils: This category comprises of the below listed groups which occur with varying frequency within the county. 51% of main setts are constructed in sandy soils, this figure is sub-divided as follows:

Soil Type	*% main setts*
Headon Beds	5
Barton Sand	16
Bracklesham Beds	30
Bagshot Sands	25
Reading Beds	2
Folkestone Beds	10
Hythe Beds	8
Bargate Beds	4

Chalk: 27% of Hampshire's main setts were located in chalk, sub-divided as follows:

Chalk Type	*% setts*
Upper Chalk	44
Middle Chalk	31
Lower Chalk	25

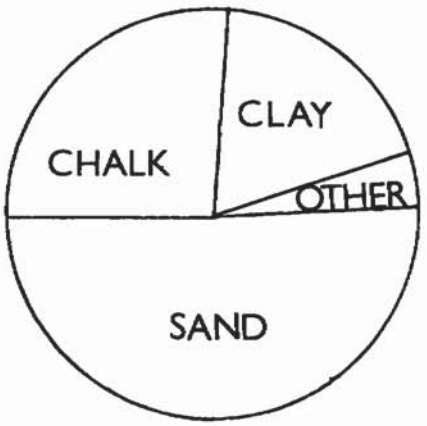

Fig 6. Density of badger setts in relation to geology.

Upper Greensand: 10% of main setts were located in Upper Greensand.

Clays: 8% of main setts located in clay soils, subdivided as follows:

Clay Type	*% setts*
Clay with flints	3
Barton Clay	33
London Clay	55
Gault Clay	9

Other: Only 4% of setts fell within this remaining category. Of these most were located in either alluvium or the plateau gravels of the New Forest.

Stratified Sampling

Of 39 1-km squares surveyed, badger presence was recorded in 8 of them (20.5% of sample). These positive squares were located in southern, eastern and north-eastern parts of the county, the remaining squares from central and north-western parts having no badgers recorded.

On completion of the survey twelve categories of habitat were identified and recorded. Each category is listed below together with the frequency that these habitat types occurred (A) and in what proportions (B).

Of the eight 1-km squares where badger presence was recorded six contained active main setts and one an active outlying sett. The final square contained a disused sett although current badger signs were evident in the form of paths and dung pits.

Deciduous woodland was recorded in all but one of the positive badger squares, the same proportion also applied to improved grassland. Arable land occurred in 5 of the 8 squares. This is considered significant as these figures are not consistent with the overall presence of such habitats within the total sample area. For example only 19% of all squares surveyed contained deciduous woodland. Likewise improved grassland and arable only represented 31 and 30% respectively. Although wholly expected such findings indicate a basic habitat preference which was nevertheless useful to the purpose of this study.

Of the eight sample squares where badgers were recorded six comprised of sandy soils and two of chalk. As with the choice of habitat these findings provide useful secondary data on geological factors influencing badger distribution in Hampshire.

Table 2. Frequency and proportion of habitat types

	(A)	(B)
Deciduous woodland	61	13
Mixed woodland	18	2
Coniferous woodland	15	4
Improved grassland	49	16
Unimproved grass	33	6
Arable	64	38
Amenity grassland	10	3
Heathland	15	7
Scrub	3	1
Built up areas	26	7
Marshland	5	2
Water	8	1

ie Deciduous woodland was recorded in 61% of all sample squares surveyed.

Deciduous woodland covers 13% of total area surveyed.

DISCUSSION

Distribution

The results of the study revealed that the distribution of badgers within Hampshire is very uneven. This point is illustrated by the density map at Fig 2, in which there is often considerable variation between neighbouring 10-km squares. Even within these units it was found that the presence of badgers could be profoundly localized and vary greatly from one small area to the next. In broader terms badgers occur more frequently along the southern districts of the county and in the area of eastern Hampshire where in parts they are most common. By contrast numbers in the large expanse of central and north Hampshire are extremely low, at best setts are scarce and more often absent altogether. It is probably no coincidence that this part of the county is more intensively farmed than any other; there are however further important factors which

collectively influence the pattern of badger distribution and density throughout Hampshire.

Habitat

The availability of suitable habitat is of obvious consideration when attempting to understand the complexities of badger distribution. Given that 75% of main setts in Hampshire are in woodland the importance of this habitat type is clear, not only for its suitability for sett sites but also for the provision of feeding areas. This being the case an attempt was made to identify any basic correlation between the patterns of badger and woodland distribution. With the use of Ordnance Survey 1:25000 maps analysis was made of each 1-km square in the county (total 3782 km^2). With the use of a simple scoring system a clear illustration of woodland distribution in Hampshire was provided. The system then progressed a stage further and incorporated information on the size of woodland blocks. The purpose of this is discussed by Thornton (1988) by which it was recognised that smaller fragmented blocks of woodland are likely to support more setts and more badgers than one solid unit of equal area. The reason for this is that smaller woods would be interspersed with other habitat types which collectively provide badgers with greater food diversity. Also 77% of woodland setts were found within 25 m from the woodland edge, a series of small woodland blocks provide a greater number of potential sett sites than the perimeter of one large block. Fig 7 illustrates the

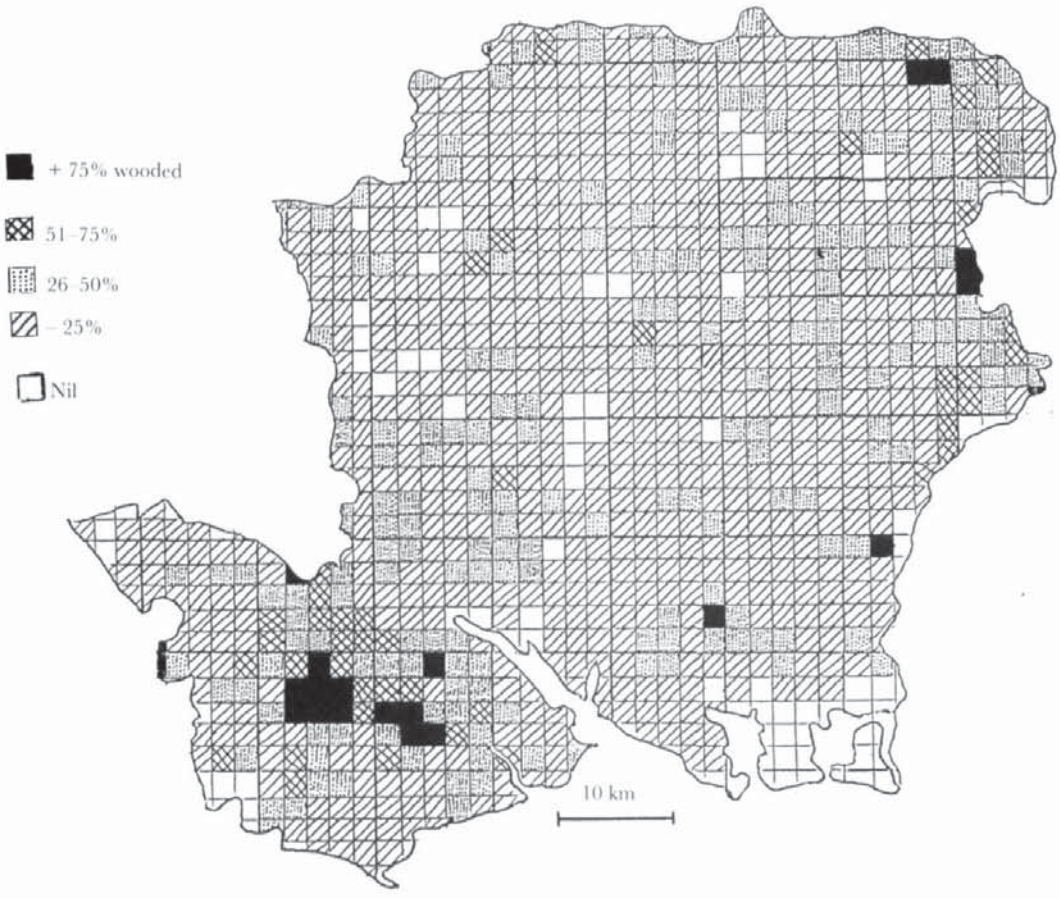

Fig 7. The dispersal of woodland in Hampshire.

dispersal of woodland in Hampshire, which shows, when compared with Fig 2, in areas of very low badger density woodlands are still present. Unfortunately the constraints of this study did not allow a similar map to be produced depicting habitat diversity. Such information would be invaluable to the furtherance of this project and provides ample scope for future work. Habitat diversity is of great importance to badgers because different habitats provide different sources of food; it doesn't pay to have all your eggs (or earthworms) in one basket. During the summers of 1989 and 1990 drought conditions kept the badgers away from grassland as earthworms became unavailable, food was also scarce in the woods and in many parts of east Hampshire – and probably elsewhere – badgers fed almost entirely on cereals.

Results showed that badger distribution was not consistent with the distribution of woodland. Nevertheless the importance of woodland – particularly deciduous woodland – to the ecology of badgers in Hampshire is clear. However in some areas the presence of woodland and an accompanying absence of badgers illustrates that suitable habitat is only one of a number of factors affecting the distribution and density of the species in the county.

Geology

It is recognised that geology is one of the single most important factors affecting badger distribution. Badgers are prolific diggers which live in underground systems of tunnels and chambers the sizes of which can become immense. However some soils are far more suited for use by badgers than others, particularly those which are well drained and easily dug. Few badger setts were found to exist in areas where these essential qualities were absent. Geological factors will also affect an area's suitability for badgers in respect of feeding. The frequency at which setts occur in various geological formations is previously illustrated (Fig 6). Having these results it was then necessary to investigate the role they play in the distribution of badgers in Hampshire and what qualities make some soils preferable to others.

It can be seen that over half of the county's badgers are found in the mainly sandy soils of the Hampshire and Thames Basins and the Western Weald. By rough approximation these groupings account for about half of the county area, the remainder being covered by chalkland. The fact that only 27% of setts are located in chalk shows that these proportions are not relative to chalk/sand frequency.

Of the sandy soils Bracklesham Beds are widespread in both the Hampshire and Thames Basins but absent from the Western Weald. Bracklesham Beds are well favoured by badgers and host large numbers of setts. Generally speaking there are few areas of Bracklesham Beds where without good reason badgers cannot be found.

Bagshot Sand is also well drained and easily worked and occurs most extensively in the north-east of the county. Where other conditions are favourable setts can occur frequently although the quality of the soil is extremely poor. Barton Sands occur regularly in south-west and north-east Hampshire, they vary greatly in quality and become quite clayey in parts but in many localities it is well favoured by badgers. The lower Greensand of the Western Weald comprises chiefly of Hythe, Bargate and Folkestone Beds. These again are poor quality soils but are particularly well suited for badgers due to the ease with which they are dug. An example of this is at one parish close to the Surrey border which comprises of a mixture of Hythe and Bargate Beds. Although the ground is heavily leached it does become more fertile along the Wey Valley and one area of 10 km^2 contains sixteen separate main setts. Clements has observed that in the same area setts are often constructed at the junction of the two strata with badgers digging out the soft Hythe Beds beneath the tougher sandstone of the Bargate Beds which provide a secure roofing. To both the south and north of the central chalklands there are long narrow deposits of Reading Beds which run the width of the county. These are very thin mixtures of mottled clay and sand and contain few setts.

It is clear that wherever formations of sandy soils occur in Hampshire they are utilized by badgers although the extent of such use will also

be dependent upon a number of non-geological factors. Such a preference for sand was fully expected and by the same token an aversion to certain other strata was not surprising. Large areas of plateau gravel are found in the New Forest and north-east Hampshire. This poor quality gravel and sand mixture is not good for sett construction and worse still for feeding, although some New Forest setts do survive. One might expect that the rich fertile river valleys of the Avon, Test and Itchen would provide good badger country but in general this is not the case. The river alluviums found here are tremendously variable and more often than not they are unsuitable for badgers; this is particularly true of the Avon with its very wide flood plain. Varying deposits of Brickearth and valley gravel are also found along each river, both lack the qualities consistent to favoured badger soils.

The main types of clay found in Hampshire are London Clay, Barton Clay and Gault, many of the upper chalk areas are also capped with a clay with flint mixture. Although variable, London Clay is generally heavy and does not drain well and consequently it is rarely utilized by badgers. Gault clay is only found in the Western Weald where it covers a sizeable area of level ground below the Upper Greensand scarp. A number of setts can be found in Barton Clay, most of these occur in localized areas of the New Forest where a higher sand content makes the soils less heavy.

As previously described central and northern Hampshire is covered by a vast expanse of chalklands. These chalklands comprise almost exclusively of upper chalk which in many parts is capped by clay with flints. These clay caps can sometimes be extensive, particularly in eastern parts. Generally it is only on the borders of the upper chalk that the middle and lower chalks occur, here the middle chalk forms escarpments and the lower chalk the lesser slopes. Hampshire's chalklands do not drain exceptionally well, the upper chalk is the most heavily cultivated chiefly because it forms the largest areas and is also the flattest. The upper chalk is also the purest but does contain a high content of flints. The lower chalk is the poorest of the three and is grey and marly in appearance, it is easier to dig but has the poorest drainage. Having considered these qualities an attempt was made to discover why relatively few setts (27%) are found in the chalk.

Elsewhere in the south of England chalkland setts are common, this is certainly the case in neighbouring Wiltshire which has areas of high badger density close to the Hampshire border. In fact the overall scarcity of chalkland badgers is greater than it appears on realizing that 80% of the recorded setts occur east of the Meon Valley. This leaves little doubt that badgers in the remaining area of Hampshire chalkland are rare, these findings are consistent with observations from other reliable sources. I do not believe that the cause of badger scarcity over such a vast area of upper chalk is solely geological. The high flint content of the upper chalk is not ideal for badgers in that it makes difficult digging, however east of the Meon upper chalk setts are not infrequent. Moving further east sett numbers increase on reaching the middle and lower chalk. These strata provide softer digging and the steep slopes of the dramatic landscape have resulted in much of the area remaining wooded. This is equally true of the substantial belt of Upper Greensand which occurs beneath the lower chalk. It is well drained and fertile and runs from Bentley to south of Petersfield. The only other example of Upper Greensand in Hampshire is a small area at Kingsclere although it is common on the Isle of Wight. The fact that 10% of all recorded main setts are found in this stratum, which covers only a fraction of the county's land area, reflects its suitability for badgers.

The badgers' preference for siting setts on sloping ground has long been acknowledged. The situation in Hampshire is no different with 86% of main setts being so situated. There are few parts of the county where sloping ground is absent and therefore topography is not a major restrictive factor on badger distribution. The flattest parts of the county are found in the south-western coastal areas and Portsea Island. In the former the species are scarce and in the latter totally absent (due equally to long term urbanisation). In the hanger country of east Hampshire badger densities are very healthy but in other hilly districts numbers can be low. To investigate this a tabletop survey was conducted of the whole county utilizing 25 m contour lines

depicted on 1:25,000 maps. As with the similar woodland survey a simple scoring strategy was devised to identify the extent of undulation. The results were not remarkable but did serve to prove that there was no direct correlation between badger distribution and topography alone.

The Influence of Man

Thus far a number of factors have been discussed in relation to their effect on the current status of Hampshire's badgers, singularly none of these are as important as the role played by man. Initially the availability of suitable habitat was examined, however in common with the rest of lowland Britain, Hampshire's habitats are mostly man made. It is the management of these habitats which is important. In the chalklands of Hampshire areas of former downland are now represented by huge featureless fields which have been intensively farmed over long periods of time. Such areas do not provide the required diversity to sustain the badger diet, consequently numbers are low. It is not without good reason that badger density improves in the border regions of Hampshire and Wiltshire, here areas of natural downland survive alongside modern farming systems and the habitat diversity is greatly enhanced. In contrast to other parts of the county the steep landscape features of east Hampshire have somewhat restricted agriculture to smaller scale mixed practices. To complement this there is an abundance of mature broadleaf woodland which probably accounts for the fact that east Hampshire supports nearly half the county's badger population. Further south between Portsmouth and Southampton there is also a pattern of diverse habitats resulting in reasonable badger density, albeit sometimes rather localized. This is however an area which has suffered from tremendous development during the last twenty years but most setts have done well to adapt. It is in the New Forest that badgers have suffered least from the intervention of man although the poor quality of feeding is handicap enough, indeed it is remarkable that some setts continue to survive here at all.

The scarcity of badgers over large parts of the chalkland area cannot be attributed to poor habitat and unsuitable geology (although intensive farming has probably played a part). It is believed that the chief reason for the absence of the species is sustained persecution by man. Central and northern parts of Hampshire have long been the home of many large shooting estates and even today there are few woodlands in these districts which are not used for the rearing of some game. Historically all predators were ruthlessly exterminated and this included badgers which, I believe, were persecuted to such an extent that numbers were ultimately reduced to today's low levels. Fortunately most contemporary game-keepers appreciate that such drastic measures are unnecessary, however so thorough was the eradication that there was little chance of rapid recovery. Badgers are not a very dynamic species and recolonisation is a slow process. In Gloucestershire, Cheeseman maintained a study area in which badger density averaged twenty adults per square kilometre. Even with such exceptional populations complete recolonisation of badger free areas has been seen to take about ten years. In districts of moderate to low density expected recovery times will be much longer and in many cases recolonisation will not take place at all. I consider that this has been the case with regard to much of central and north-west Hampshire.

The present persecution of badgers is outlawed by comprehensive legislation. In comparison with other parts of the country problems in Hampshire are minimal and incidents of badger digging are thankfully rare (only five badger prosecutions have been brought in the county since the adoption of the original Badgers Act in 1973). Conflict of interest between man and badgers is not uncommon with most problems being experienced by farmers. One of the most frequent complaints arise from setts undermining fields causing hazards to both machinery and cattle. Crop damage may also be a problem, particularly in the summer months when wheat can form an important part of the badger diet.

Numbers

Estimating badger populations is a difficult task, not least because of the tremendous variation in

the number of animals found within individual setts. Numbers will fluctuate according to local food availability. In some parts of Hampshire I have counted as many as fourteen badgers emerge from a sett whereas others can support less than half this figure. The most practical method for estimating large populations is to multiply the number of setts by an average number of badgers. In Hampshire 490 main setts were recorded, if it is assumed that there are six badgers per sett there will be a total population of 2940. This is in fact a rather conservative estimate as many setts will contain more than six animals. A more realistic figure would be in the region of 3000–3500 badgers and although this seems a high figure it is probably the lowest population of all the south-coast counties. Cresswell, Harris and Jeffries (1990) estimate the total badger population of Britain to be about 250,000.

Productivity and Mortality

Personal records dating from 1977 produce a mean litter size of 2.8 (Brown 1989). Such records result from direct observation and therefore cannot account for cubs which die below ground before they are old enough to emerge. If calculations are based on the number of recorded main setts there will be an annual production of 1372 cubs within the county. This is likely however to be an over estimate as not all main setts produce cubs each year.

There is little doubt that the biggest unnatural cause of badger mortality in Hampshire is road and rail traffic. In 1991 the East Hampshire Badger Group recorded 86 badgers having been killed on the county's roads (90% of these in east Hampshire). When considering the county as a whole it is estimated that between 150–200 badgers are killed this way each year. Fatalities also occur on the railways, usually the result of electrocution. The Fareham to Eastleigh line was electrified in March 1989 but despite genuine conservation measures 39 badger casualties were recorded within the first four weeks.

Starvation and disease are obvious causes of death but no data is available. In certain parts of the country Bovine Tuberculosis is endemic in badger populations and this has resulted in the much publicised control programmes. Fortunately there have been no outbreaks of the disease in Hampshire cattle. Nevertheless infected badgers have been recorded in each of the counties which border Hampshire and so it remains a possibility that the disease is present. The fact that it has been previously unrecorded may be lack of data rather than anything else. Between 1972 and 1990 260 badger carcases from Hampshire were examined by the Ministry of Agriculture and no Bovine Tuberculosis was discovered (MAFF 1991).

CONCLUSIONS

The results of this study reveal that the status of badgers in Hampshire is subject to great local variation, in some districts the species is common and in others rare. Such patterns of distribution and density are affected by three primary factors, habitat, geology and man. Seventy-five per cent of Hampshire badger setts are located in woodland, this statistic speaks for itself but the presence of woodland alone is not all important. The ideal badger environment comprises of a variety of habitats, as such an area will more readily satisfy the feeding requirements of the badger. As with habitat, the availability of suitable geology had a direct bearing on badger distribution in the county. Not surprisingly, easily worked well drained soils are favoured whereas the heavier and wetter clays are positively avoided. As a general rule it is true to say that wherever sandy soils occur badgers can if other factors permit. The lower and middle chalks are also utilised by badgers but the upper chalk less so, indeed the species is scarce over the extensive areas of upper chalkland in central and north-western Hampshire. It is thought however that this may result from the combination of intensive farming and a history of vigorous persecution.

It is estimated that Hampshire currently supports a badger population of between 3000 and 3500 animals. It is thought that such figures would rarely have been equalled at any time in the last century. Given the unprecedented increase of road traffic and considering a

corresponding rise in badger road deaths (currently 150–200 a year) it is evident that the badger population of Hampshire has been increasing. I suggest that this expansion is the result of reduced persecution brought about by protective legislation and a general change in attitudes.

Overall the current state of the badger in Hampshire is reasonably good but there is no measure of certainty as to how long this situation will persist. A major threat is the loss of habitat. Thankfully most authorities now adopt responsible policies in respect of badgers and where cases of potential conflict do arise setts are generally preserved. Unfortunately the loss of important feeding areas is less avoidable and this can be equally as damaging as the loss of a sett itself. Circumstances such as this are undoubtedly the cause of diminishing badger populations in numerous areas of new development. The same applies to radical changes in land use whereby badgers can be slow to adapt. At a time when British agriculture is entering a period of great uncertainty this is a problem of particular relevance. In Scotland, Kruuk observed that changes in farming practice lead to substantial decreases in earthworm numbers. Although some aspects of the relationship remained unclear a corresponding drop in badger numbers was consequently observed. An increasing number of Hampshire farms are being forced to diversify and it remains to be seen how resident badgers will be affected by alternative land use patterns. Unlawful persecution by badger diggers remains a worrying threat and it is important that the relevant authorities are fully aware of the potential risk. As stated at the beginning of this paper, if effective programmes of badger conservation are to be undertaken there must be an appreciation not only of the species current status but also of the factors which affect their distribution and density. It is hoped that the results of this project will assist in achieving this aim and will prove of use to all those concerned with the conservation of badgers in Hampshire.

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