The Badger and Habitat Survey of Ireland

The abundance and distribution of the badger *Meles meles* in Ireland, with especial reference to habitat surveys

Summary Report

An Roinn Ealaíon, Cultúir 7 Gaeltachta
Department of Arts, Culture and the Gaeltacht

Department of Agriculture, Food & Forestry

The Badger and Habitat Survey of Ireland

SUMMARY REPORT

Report prepared by

Chris Smal

This report is a summary of a research project jointly funded by the National Parks and Wildlife Service of The Office of Public Works and The Department of Agriculture, Food and Forestry. The survey was carried out principally by staff of the National Parks and Wildlife Service with additional research carried out by staff of The Department of Agriculture, Food and Forestry.

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An Roinn Ealaíon, Cultúir agus Gaeltachta

The Eurasian badger *Meles meles* is one of Ireland's most common large mammals and the largest of its terrestrial carnivores. A Mustelid, it is related to the otter, the stoat, the pine marten and to the American mink. It is distinguished by a strong muscular body, short legs and by the distinctive black and white stripes on its head and neck. Though nocturnal and generally shy of man, the badger is held in great affection by most people and readily recognisable to all.

Badgers usually live in social groups, each group consisting of a dominant male and female accompanied by a variable number of other adults and juveniles. The burrows that they construct for shelter and for breeding, known as setts, are used by succeeding generations and may evolve into large structures with many entrances and underground chambers. Each badger group defends a territory within which are located several setts of varying size. The territory occupied by the group provides the badgers with suitable locations for sett construction and with their food resource. In Ireland, the main constituent of the badger's diet is the earthworm.

The species is widespread across northern Europe and Asia but appears to be most abundant in Britain, Finland, Ireland, Norway and Sweden. In Ireland, badgers are protected under the 1976 Wildlife Act but the digging out of badgers for sport is still an occasional, if illegal, activity.

The badger has also been regarded as a minor pest species in Ireland, particularly with regard to protection of game and domestic fowl. Badgers may occasionally become a nuisance in gardens, damaging lawns in search of food. In some parts of Europe and Asia, they are still hunted for their meat, and use is also made of the pelt, hair and fat. The discovery, in the 1970s, that bovine tuberculosis (TB) was endemic within badger populations brought the species into a controversial and continuing debate over the species' role in the transmission of the disease to cattle.

Elimination of TB from cattle is a long standing objective for the state's agricultural industry, and, of the possible wildlife sources of infection in herds, the badger is probably the most significant.

Various reports and research studies, conducted in Ireland and in the United Kingdom, where the disease is also a problem, have suggested that diseased badgers have contributed to TB outbreaks in cattle. However, the chief mechanisms by which transmission may occur from badgers to cattle remain unclear. When other possible sources of infection have been eliminated in an inquiry into the cause of a TB outbreak in a locality, samples of badgers have been removed, under license, to evaluate their TB status.

To address this important aspect of the TB problem in Irish cattle, a substantial research project was initiated, in 1989, to provide information on the numbers and distribution of badgers. With almost no prior data available on the abundance of badgers in Ireland, an assessment of numbers was a primary goal. The relationships observed between badger density and habitat composition have also provided a detailed evaluation of the ecology of the species in Ireland, essential to further progress in understanding the inter-relationships between badgers, cattle and bovine tuberculosis. Assessed levels of human disturbance to badger setts have also indicated whether the species is threatened in this way.

The principal results of this wildlife survey, the largest and most comprehensive of its kind to have been undertaken in Ireland, are presented in an abbreviated form in this *Summary Report*. The findings have immediate application to other TB studies, with a framework also established for subsequent investigations of other species of fauna and flora, and for general ecological studies in Ireland.

Methodology

In a large-scale survey, badgers cannot be enumerated by direct observation as they are both secretive and nocturnal, but their setts are easily identified and counted. Once the relationship between a count of setts with badger numbers can be established, it is possible to estimate badger densities on a local or regional basis. A systematic survey of 1% of Ireland's land area was undertaken by the Wildlife staff of the National Parks & Wildlife Service, aided by some volunteer effort. In total, 729 1km squares were surveyed, within each of which a detailed record was kept of all badger setts present, with each sett's type and utilisation noted. Additional observations of signs of badger activity were recorded and the presence of other wild mammals was also noted. All survey areas were mapped in detail, according to their habitat composition and land use, with attention paid to the types of farm animals using pastures.

This* main *sett in Co. Wicklow has a total of 18 entrances. A badger latrine is visible, located to the right of the sett entrance in the foreground

Correct classification of the types of setts constructed and used by badgers was critical to an evaluation of badger numbers in Ireland. Within its territory, each badger social group uses only one sett for breeding and over-wintering, known as the *main* sett, and which usually has several entrances and underground chambers. Nearby may be an *annexe* sett, often of similar size; sometimes badgers will transfer their main activities to this sett.

Further away are *subsidiary* setts, almost always smaller in size and less active, and, towards the perimeters of their territory, are small *outlier* setts. The species' construction of setts, and the manner of their use, allows an estimate to be made of social groups present in any area surveyed from a count of the *main* setts.

The methods adopted for classification of sett types, based mainly on previous research in Britain, were assessed by separate studies here in which survey estimates were compared with actual badger presence as determined by trapping operations. Some minor adjustments were subsequently adopted for the sett classification procedures. Once the average number of badger social groups was known from a count of *main* setts in survey areas, the number of social groups present in Ireland could be derived by multiplication for the country's total land area.

Estimation of the actual *number* of badgers present in Ireland, as opposed to badger *groups*, was more problematical. The number of badgers in each social group varies, so estimates were obtained from additional studies, carried out in a collaborative programme with The Department of Agriculture, Food & Forestry, in which badgers were captured from samples of social groups from all parts of the country. The total number of badgers captured within each territory was corrected, by statistical methods, to take into account badgers that might not have been caught within the trapping period. As before, once the number of badgers per social group was known, or that of the number of badgers present at each sett type evaluated, it was feasible to estimate the number of badgers present in Ireland by extrapolation of sett survey results to the overall land area.

Each of the survey squares was assessed for habitat composition, with 42 principal habitat types identified and evaluated. Most habitats, such as grassland, woodland and bog, were assessed in terms of land area, but linear features, such as hedgerows, streams and roads, were also evaluated by their length. This field survey of Ireland's habitats was the first to be undertaken on this scale, and has enabled the relationship between badger density and habitat composition to be investigated.

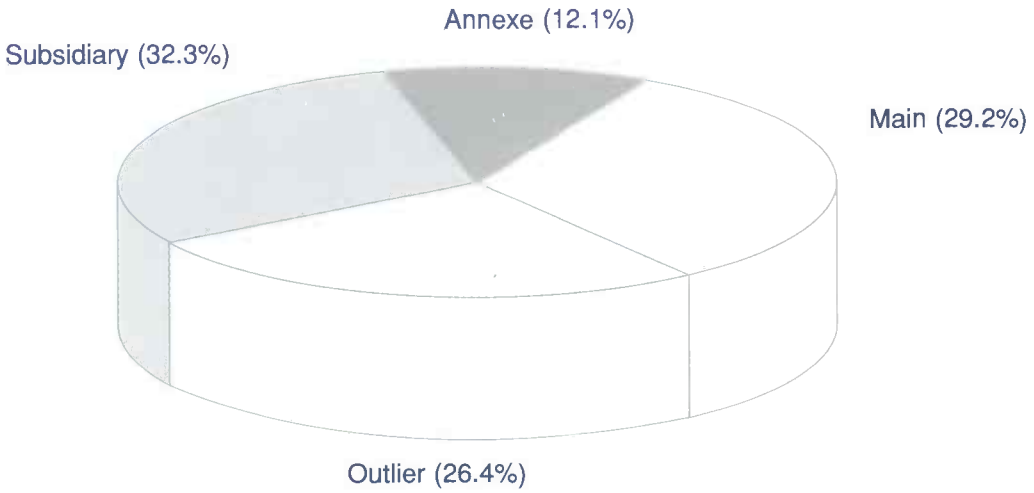
This study has been complemented by an affiliated survey of badgers and habitats in Northern Ireland, which has adopted the methodology employed here. Combination of the results, at a future date, will allow for a comprehensive analysis of results for all of Ireland.

The survey of badger setts

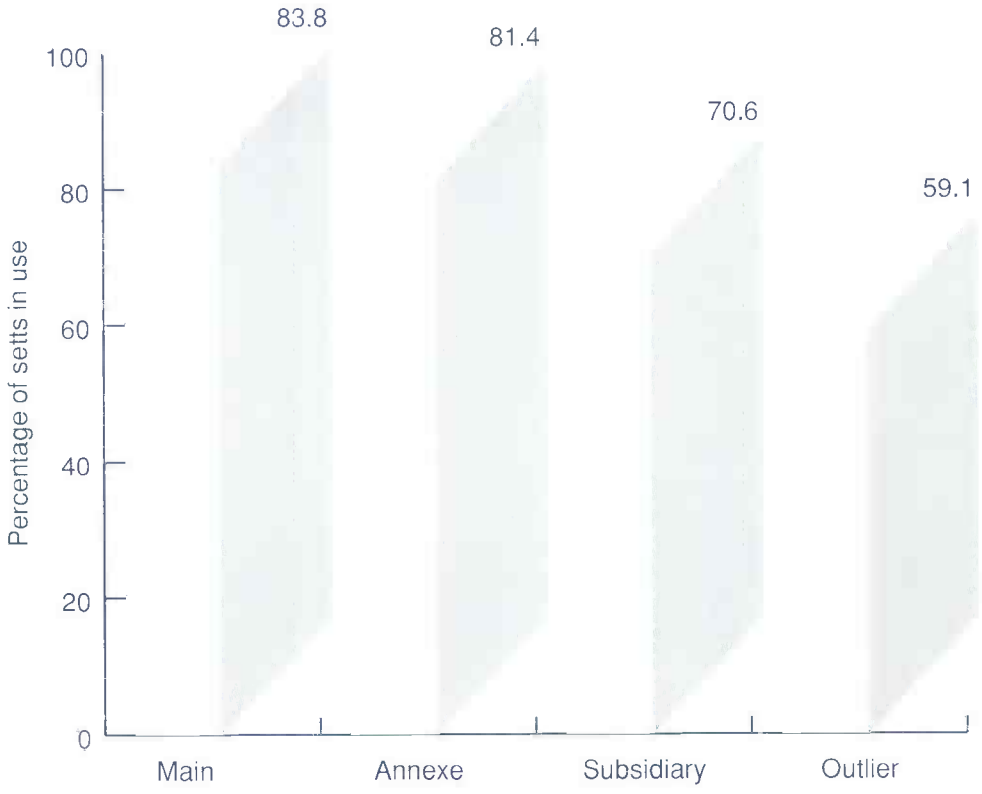
In total, 1,378 badger setts were identified in the 729 survey areas, with an estimate obtained of *c.* 139,000 setts present in Ireland. Setts were classified into four types, with each occupied *main* sett indicating one badger social group. Each social group territory, therefore, contained only one active *main* sett, plus, on average, 0.2 disused *main* setts, 0.5 *annexe* setts, 1.3 *subsidiary* setts and 1.1 *outlier* setts - a total of 4.1 setts per territory. Not all setts were in use by badgers, with 84% of *main* setts found to be active, but only 59% of *outlier* setts were in use by badgers. Signs of activity at setts included latrines, bedding, hairs and tracks.

The *main* setts, which are the focus of the social groups, were usually larger than other setts, averaging 7 entrances each, but the largest sett found in the course of the survey had 44 entrances. Only four small one-entrance setts were identified as *main* setts. The average size of badger setts in Ireland is smaller than that observed in studies in Britain, which may result from many setts in Ireland being located in hedgerow rather than in woodland: the narrow hedgerow habitat does not usually allow badgers to construct large setts.

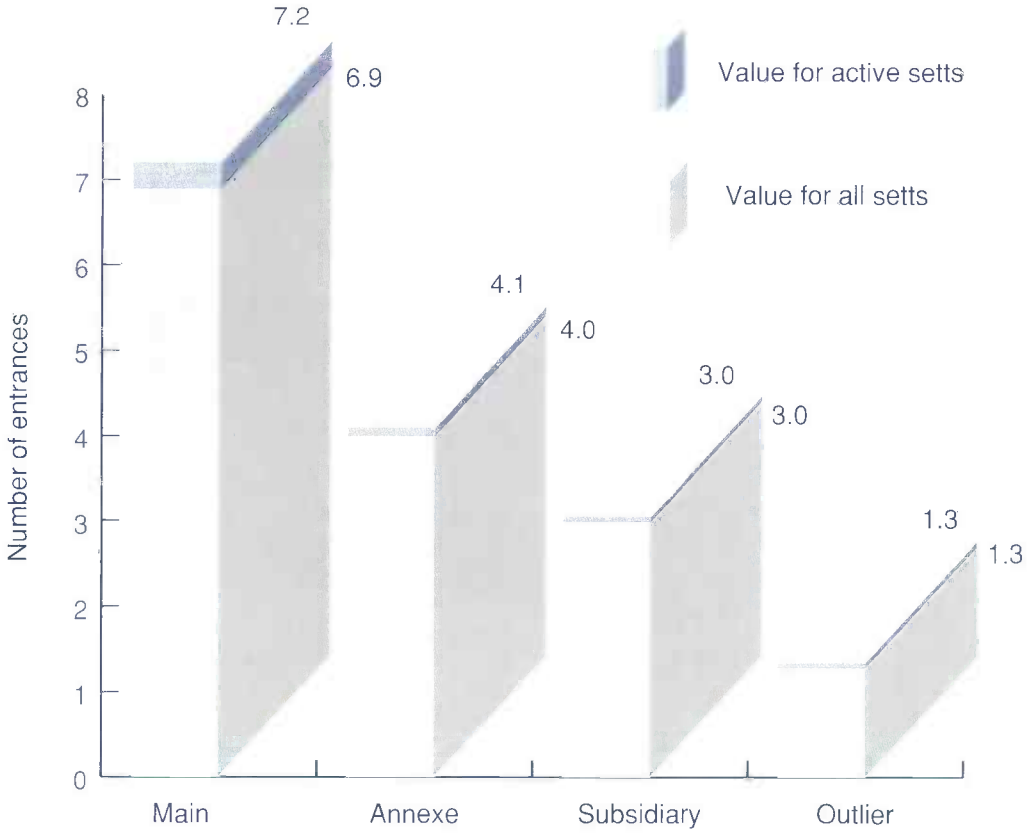
The size of setts did not show much regional variation, but the number of setts within each badger territory was, generally, found to be lower where badger group density was lower: 2.8 setts and 3.2 setts per social group in the west and north-west of the country, respectively, and in the range 4.2 to 4.8 setts per social group elsewhere.



Pie-chart showing the proportions of types of badger setts observed in the survey



Proportion of setts surveyed occupied by or in use by badgers



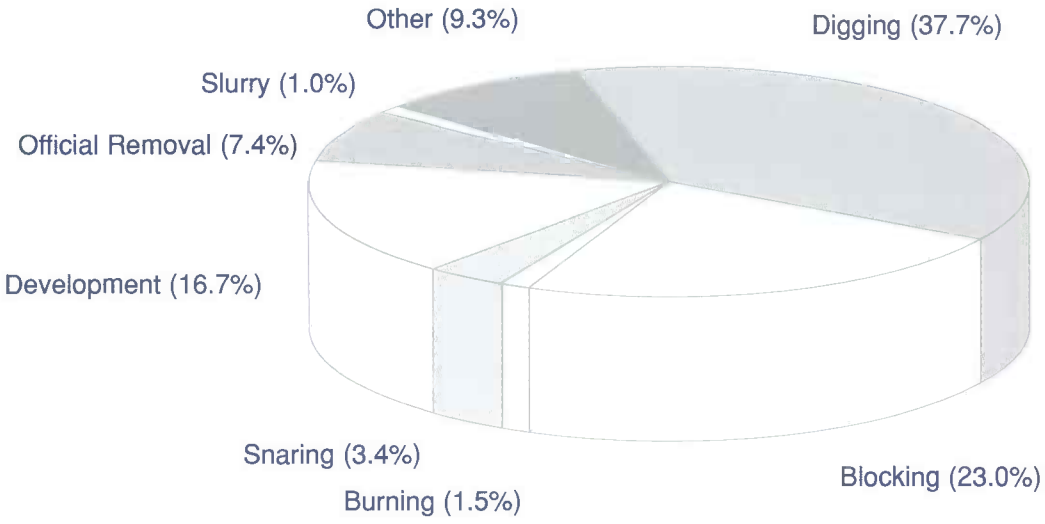
Mean size of the four types of badger setts, as given by the number of entrances

Badgers were not always the only mammal species present at badger setts, with setts sometimes being shared with rabbits or foxes, though the occupation of setts by other species was more common when the setts were no longer used by badgers.

Approximately 15% of all setts had suffered some form of disturbance, with *main* setts being most affected (21% had been disturbed). Digging was the most common form of disturbance, but setts were also frequently found blocked (with stones or branches) and many setts had been adversely affected by land improvement or development. A repeat sett survey would allow a precise estimate to be obtained for an annual rate of sett digging, but the present data did suggest an upper estimate of badger deaths that might have resulted from such disturbance (*c.* 4,000 annually). It was not possible to estimate how much of the digging of setts was carried out specifically for the purpose of badger-baiting. Similarly, a repeat survey would be required to estimate the overall impact of agricultural development, such as hedgerow clearance.

Overall, the observed level of disturbance to setts was not considered to threaten the survival of the species in Ireland, though there may be localised impacts. It was observed that the frequency of abandoned setts was higher in those areas with a greater road network, which suggests that road fatalities may also reduce the size of badger populations in some areas.

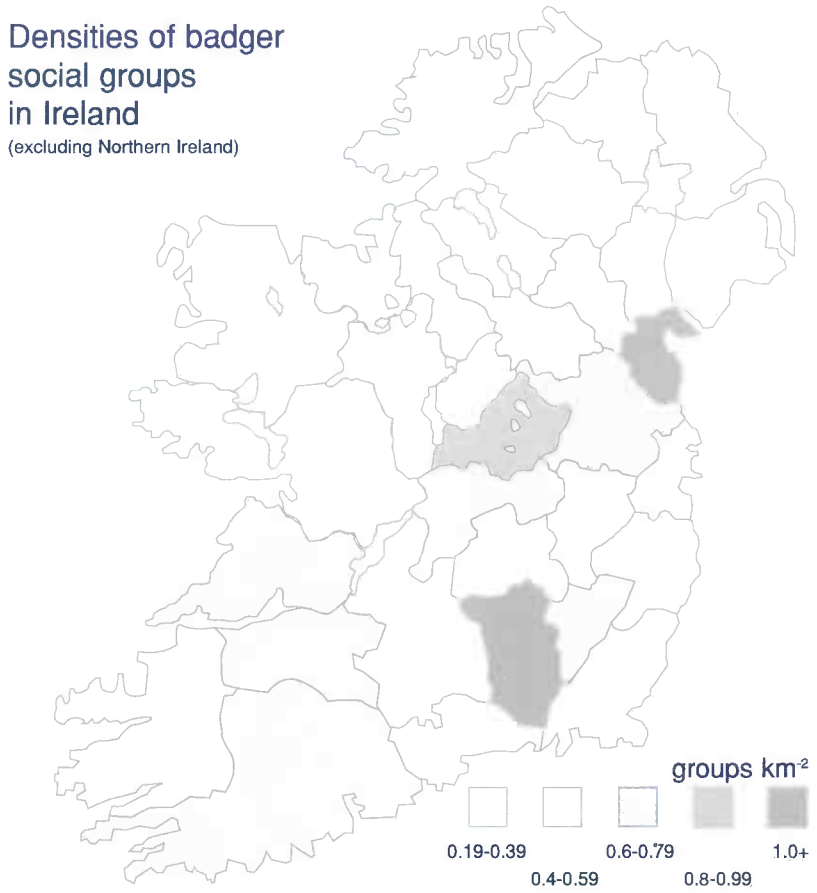
In the east of Ireland, there were 0.44 abandoned *main* setts to each *main* sett in use, compared to a value of *c*. 0.2 in most other regions, and 0.1 in the mid-west and north-west.



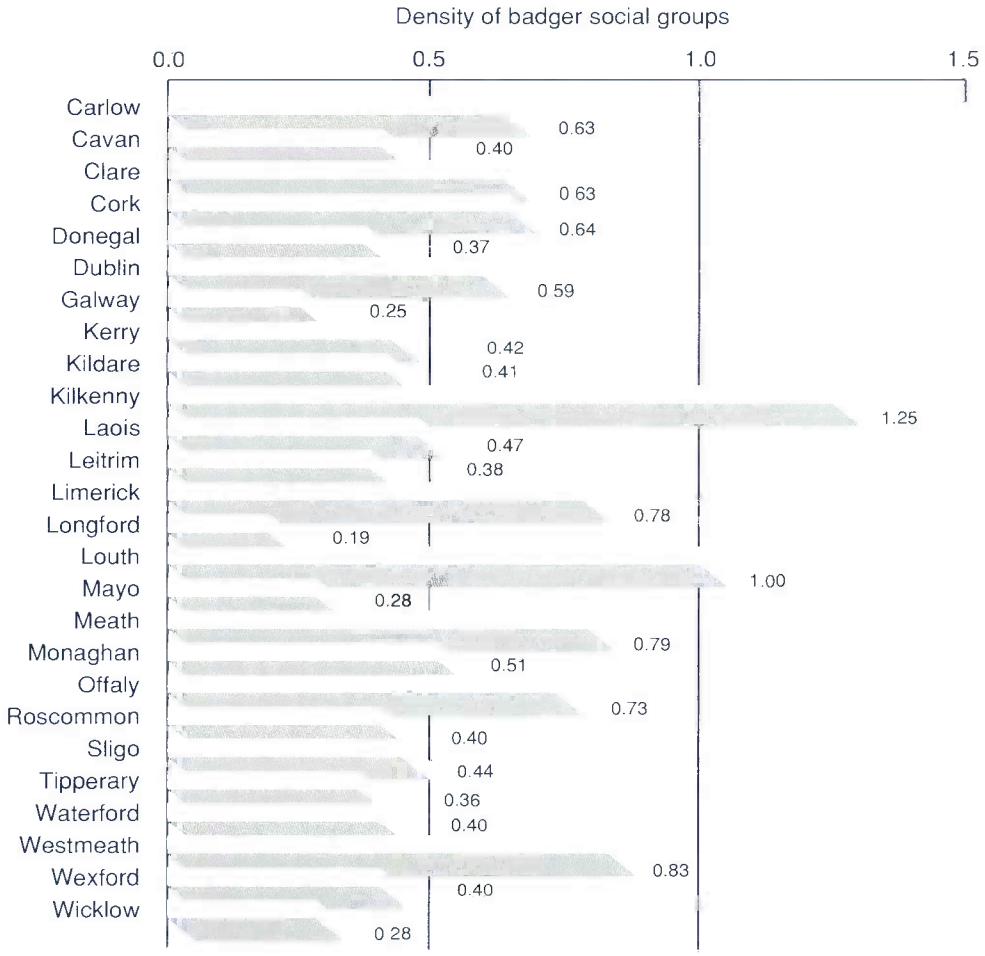
Pie-chart showing types of disturbance to badger setts, given by percentage of those setts observed to have been disturbed in the national survey

Badger population densities and numbers in Ireland

From the count of *main* setts, the mean density of badger social groups in Ireland was estimated at 1 group per 2 km^2 (0.495 per km^2). Badgers were found to be unevenly distributed in Ireland, having lower densities in several western and north-western counties and also in Wicklow, these counties being generally distinguished by their large areas of upland, bog or moor. The six counties of highest badger densities (> 0.7 social groups per km^2) are all located in a broad midland zone (Cos. Kilkenny, Louth, Limerick, Meath, Offaly and Westmeath). All these counties possess a relatively large proportion of quality grazing land. Three further counties (Cos. Carlow, Clare and Cork) had badger densities slightly lower (0.6 - 0.7 groups per km^2). The lowest badger density was recorded for Co. Longford (0.2 groups per km^2) and the highest for Co. Kilkenny (1.3 groups per km^2).



Regional variation in the density of badger social groups



Estimated badger social group density in each Irish county (groups per km²)

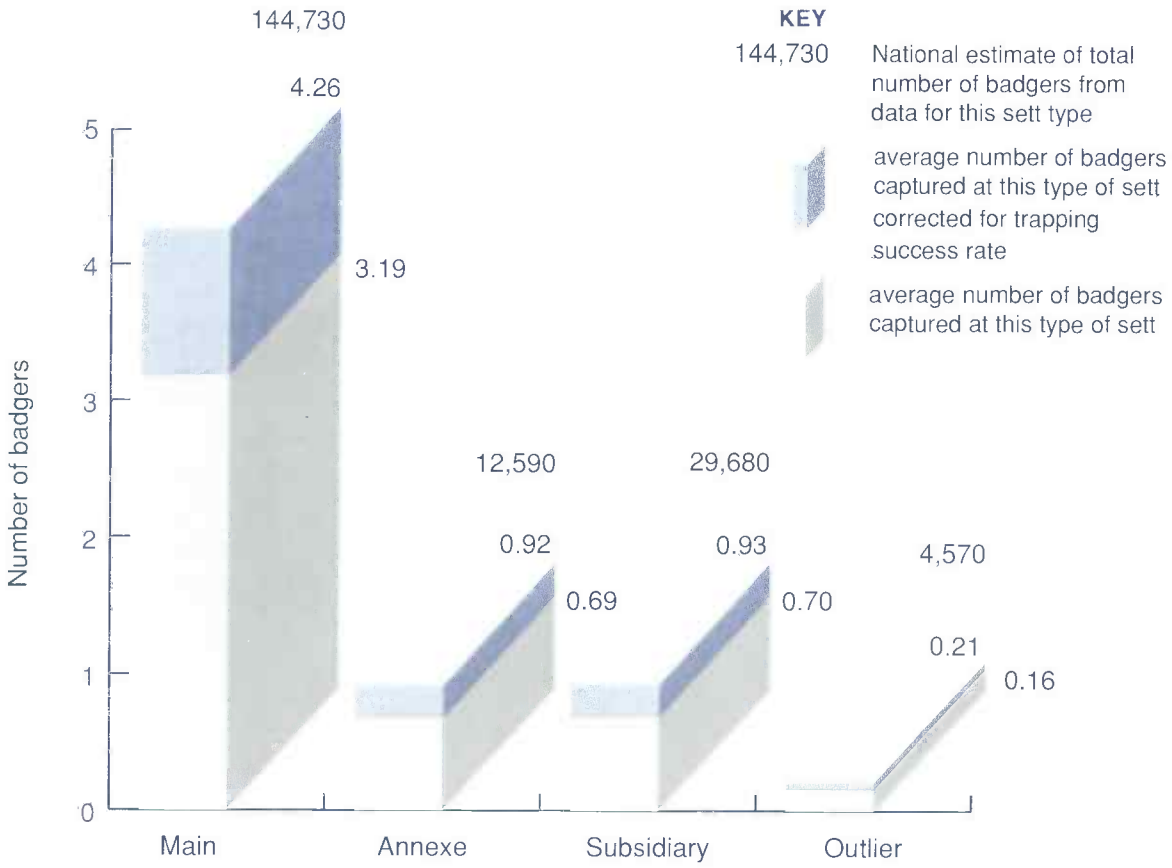
The survey of badger setts provided reliable data for the estimation of the number of social groups present in Ireland. The total number of social groups present in Ireland was estimated at *c.* 34,000 (±11%; 95% confidence limits: 30,250 to 37,800 social groups).

In order to estimate actual numbers of badgers present in Ireland, separate studies were conducted to determine the average number of badgers present within each social group. In total, 36 badger groups were assessed in detail, from sites distributed throughout the country. The group territories were identified initially by a survey of setts and the number of badgers present within each of the territories was then evaluated in trapping studies carried out over a period of 10 days at each site. These investigations also provided useful information on how trapping methodology, itself, can influence the estimation of certain population parameters.

The average size of badger social groups was estimated at 5.9 adults per group (95% confidence limits: 5.4 to 6.4 badgers per social group). This estimate was determined following a statistical evaluation of trapping success and includes, therefore, a correction factor for badgers not trapped. For the 36 groups evaluated, the trapping success rate was estimated at 75 - 80%.

The studies revealed that the *true* sex ratio of adult badgers in Ireland is 1 male : 1 female, but, as females were shown to be more prone to capture than males, sex ratios determined in other studies may have been substantially affected by their methodology. Similar reservations may pertain to estimates of other population parameters obtained in previous studies in Ireland and elsewhere.

Badger numbers in Ireland were estimated in two ways: from the data obtained from the badger sett survey and from the results of the trapping studies. The value of 5.9 adults per social group was applied directly, giving an estimate of 200,450 badgers present in Ireland (excluding Northern Ireland). An alternative estimate was obtained from the mean number of badgers captured at each sett type (again, following corrections for trapping success rates), which gave an estimate of 191,570 badgers.



Estimates of badgers present at each type of badger sett (data for occupied setts only)

Whilst a more detailed knowledge of how badger group size varies with habitat would allow more precise estimates of badger numbers in Ireland, the present estimates have been derived from the largest sample of badger social groups to have been investigated to date in Ireland or in the United Kingdom. In consideration of the sampling methodologies employed, the most reliable estimate for the number of badgers present in Ireland is the average of the two estimates given above, *i.e.* 196,000 adult badgers.

The estimates of badger density by county have shown that badgers are not evenly distributed throughout the country, but they are present in most areas, their presence having been noted in 75% of 10km squares surveyed. Foxes, hares and rabbits were observed to have been equally widespread, but their numbers and densities were not evaluated in this study.

The total badger population of Ireland is on a par with that of Britain and Sweden and is, therefore, one of the highest in Europe. The high population level arises from the abundance of favourable habitats found throughout most of the country.

The actual densities of badgers in Ireland - *numbers per unit area* - are not, however, higher than those reported for those areas of Britain, and other European regions, that have similar landscapes and land use. In Ireland, no areas were found to have the exceptionally high densities of badgers observed in some localities in Britain, such as the Cotswolds of Gloucestershire.

The habitat survey of Ireland

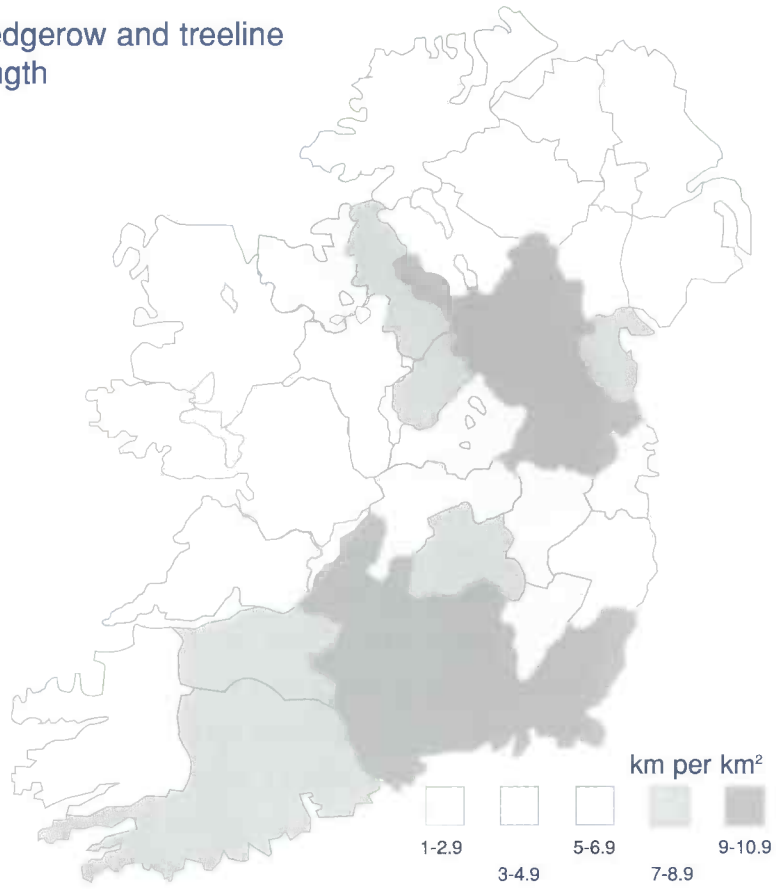
To identify the principal factors that might determine the density of badgers in any area, the habitat composition of each of the survey squares was assessed in detail. 42 principal habitat types were evaluated, including habitats such as hedgerow, plantation, natural woodland, scrub, coastal margins, moorland, bog, marsh, rivers, streams, canals, lakes and reservoirs, improved and unimproved grassland, arable land, cliffs, roads and built land. The type of domestic stock grazing on pastures was also recorded. Although the habitat survey was conducted primarily to complement the badger sett survey, this study of Ireland's habitat composition has also provided a valuable database for future investigations, which may include assessments of land use change (such as hedgerow clearance), of climate change impacts, and, also, for a variety of ecological monitoring studies. A current research programme is also examining the *landscape* attributes of the surveyed areas, which will add substantially to the descriptions of the overall ecological and environmental character of the survey areas. With a large information base, inter-relationships between land use, habitat composition, wildlife species, domesticated live-stocks and disease can be examined further.

The main components of the Irish landscape were estimated to be as follows: grasslands constitute 60% of the land area, arable land about 7.5%, bog and moorland 16%, woodland 6%, hedgerow 1.5%, total area of roads and built land *c.* 3.5%. In line with expectation, there was considerable geographical variation, which is illustrated, on a county by county basis, for peat and moorland, improved grassland, arable land and hedgerow length. The overall length of hedgerow and treeline in Ireland, an important habitat for wildlife in agricultural areas, was estimated at 416,000 km.

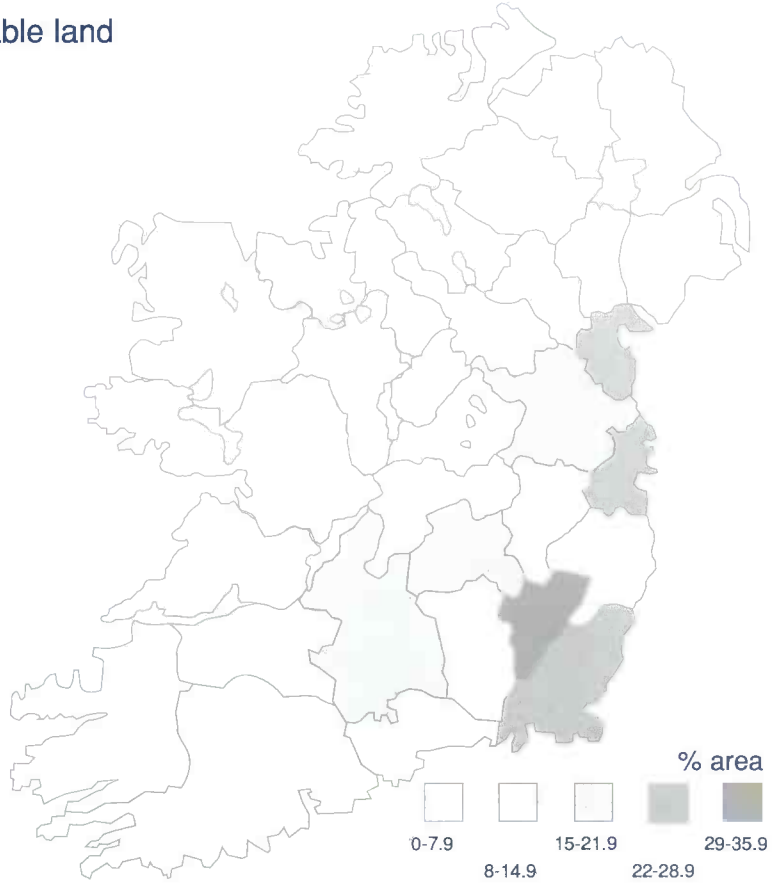
Over 72% of all grazing lands and over 81% of grassland pastures were utilised for cattle, though some of this land was used for sheep grazing also. The overall proportion of Ireland's land area utilised by cattle was over 44%, suggesting that separation of cattle from badgers would be difficult to achieve.

Maps illustrating geographical variation in the habitat composition of Irish counties. Note that the percentages shown in the figures are equivalent to ha per km²

Hedgerow and treeline length

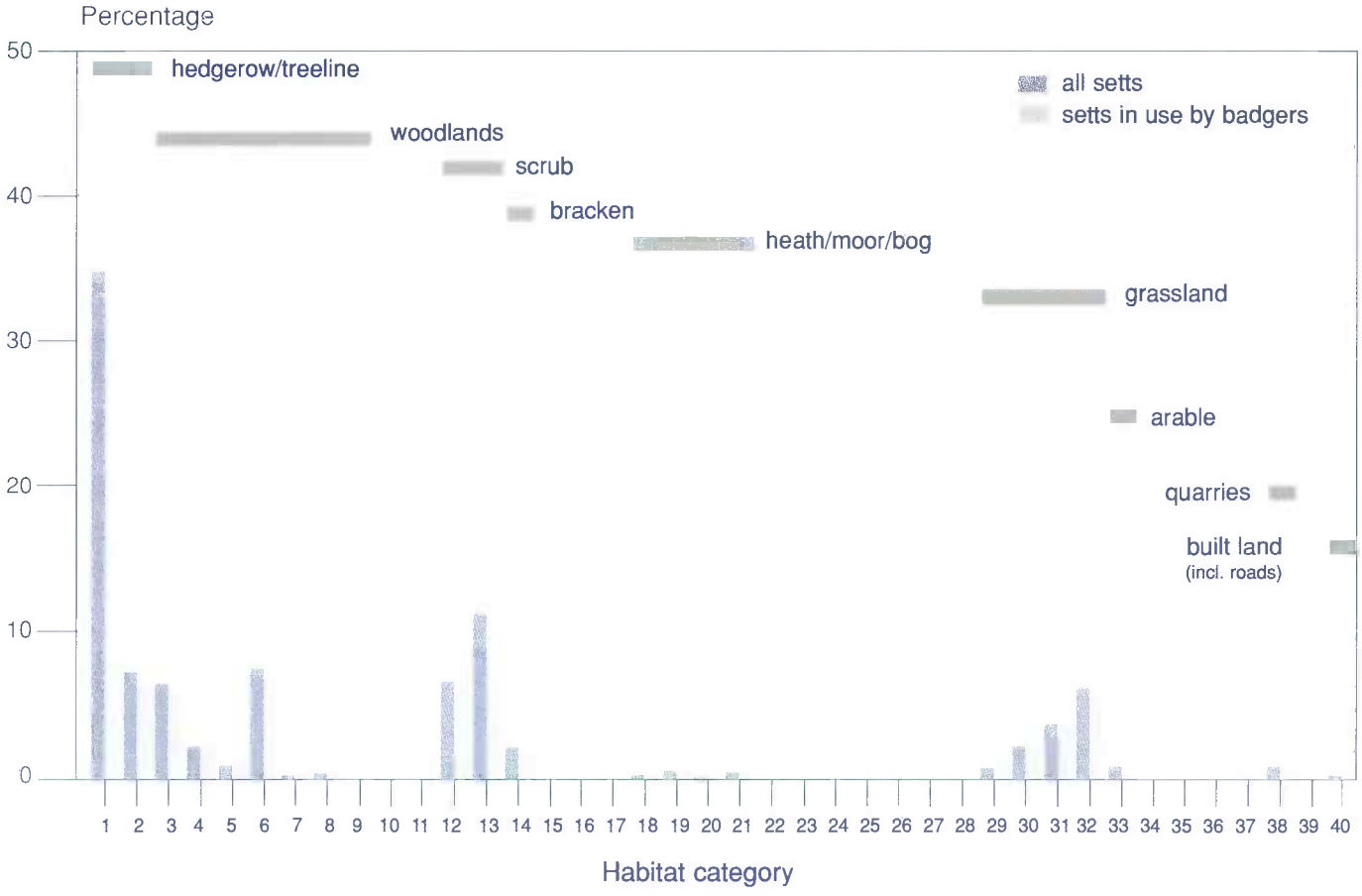


Arable land



Badger distribution in relation to habitat composition

The habitats most frequently selected by badgers for sett construction were hedgerows and treelines, largely because these are widely available, providing badgers with cover and, often, a dry and stable raised bank in which to construct the sett. Where woodland and scrub occur, these habitats were also found to have been favoured by badgers for location of their setts. Grassland, moorland, bogs and young coniferous plantation were generally avoided. A higher proportion (*c.* 50%) of the smaller types of setts (the *subsidiary* and *outlier* setts) were located in the narrow hedgerow and treeline habitat than were the larger types of setts (*main* and *annexe* setts - *c.* 36%). Badger preferences were evaluated in detail and statistically significant preference or avoidance was observed for many of the major habitats. The behaviour of badgers in their choice of sett location was generally in line with that observed in Britain, with sites that provide cover found to be favoured. The overall habitat composition of Ireland differs from that of Britain, resulting in a far greater proportion of setts being located in hedgerow in Ireland and a substantially lower proportion located in woodland.



Distribution of badger setts according to the habitat in which they were located

It is unlikely that a lack of suitable habitat for the establishment of setts limited badger numbers in any area of Ireland, with the exception of steep upland or mountainous areas and large expanses of raised or blanket bog. In such areas, badgers tend to be either scarce or absent anyway, as food resources are poor. Where soils are thin and the terrain rocky, setts were found in passages under large rocks. In peat areas, setts were usually located on their margins, where natural or artificial drainage has allowed the peat to dry, providing a good substrate for sett construction. Generally, soil type, in itself, did not appear to have any appreciable effect on badger numbers. Setts were observed to have been dug in most types of soil including peat and clay, with most soil types acceptable as long as a stable structure could be made.

In some arable areas, opportune sites for construction of setts were limited, but no areas were identified in which some suitable habitat was not available, with setts occasionally having been built in the centre of pastures or even in arable land. Nevertheless, the decrease in habitat diversity and the clearance of hedgerow, scrub and semi-natural woodland, resulting from agricultural intensification, would bring about a decrease in badger numbers, as has already occurred in many parts of Britain.

The *Survey's* results suggest that the major factors governing the density of badgers in any area in Ireland were food availability and suitable vegetational cover. Other factors that have been revealed to have probably had some impact on badger populations, locally, are human disturbance and, also, fatalities on roads. Highly urbanised areas do not provide much suitable habitat for badgers, with the setts then also prone to human interference.

As very high badger densities were not observed in this study, the territorial behaviour of badgers is unlikely to play any direct role in limiting badger numbers in most Irish landscapes. Indirectly, the conflicts that occur between members of adjoining badger groups would tend to reflect the availability of resources in any area.

The density of badger social groups in any area was found to have been largely determined by the proportion of improved agricultural grassland, and, in particular, by the proportion of pasture grazed by cattle. This relationship was not simplistic, however, and those areas of high badger density were also found to possess other, specific, landscape or habitat qualities. For example, the area of natural woodland influenced badger density positively.

Additionally, there was found to be a positive correlation between badger density and hedgerow length, but, because there is a greater length of hedgerows and treelines in areas that have more cattle pasture, it was demonstrated that the area of improved pasture was the more significant of the variables explaining badger density. Overall, 75% of badger setts identified in the survey were located near cattle pastures. There was a negative association with sheep grazing (and unimproved grassland): this is probably because most sheep grazing is in poorer terrain and often at higher elevations, and there was no evidence to suggest that stock-type by itself influenced badger densities. There was a negative relationship between badger density and the proportion of bog and moorland, these habitats providing few resources for badgers.

Whilst most Irish counties possess a wide variety of landscape types, it was found that the overall habitat composition of any county determined the overall badger density within that county. Thus, the six counties with the highest badger densities (Cos. Kilkenny, Limerick, Louth, Meath, Offaly and Westmeath) were characterised as generally having low habitat diversity, high farming productivity (but with agricultural land being used mainly for cattle pasture rather than for sheep or for arable crops), more hedgerow and treelines, less scrub, less raised and blanket bog, less heather moorland, more canalised waterways and drains (indicative of land improvement) and more woodland, particularly broad-leaved woodland. These counties may be considered as 'rural', in that they generally possess smaller road networks.

This landscape in Co. Kilkenny is typical of areas with a high badger density

Uplands, moorlands and areas of rough grazing, such as this landscape in Co. Kerry, have a low badger density

It is a favourable *combination* of certain habitat characteristics, rather than any single habitat variable, that is conducive to higher badger densities being found in any area. The combined predictive capacity of habitat variables in determining badger densities expected was, therefore, found to be good. Thus, the *overall* habitat composition of Irish counties corresponded with the badger densities observed within them. Furthermore, badger densities could be predicted, with a reasonable degree of accuracy, at a much smaller scale, from the habitat characteristics of the 1km survey squares. The success rate of statistical models employing habitat data alone was 90% for those squares that had been predicted to have no active *main* sett present, and 50% for areas predicted to have an active *main* sett present.

The latter result is satisfactory, given that, with an overall density of badger social groups of around 1 per 2 km^2, the prediction corresponds with the overall badger densities in these areas. Current research is elaborating upon this potential, with the incorporation of environmental variables (such as elevation, topography, climate, soils and geology) into the database for these 1km squares.

These additions and the statistical derivation of landscape descriptions will improve the predictive capacity for these smaller survey areas. Future research aims to create predictive models that can utilise data gathered remotely (from maps and satellite images), reducing the expense of intensive and large-scale field surveys - of either badgers or habitats.

The predictive potential revealed from the results of the badger and habitat survey has considerable implications for future investigations into TB in Ireland as well as for general ecological monitoring programmes. In particular, the study will enable efficient choice and targeting of 'high-risk' areas in the implementation of any future badger vaccination programme for the country.

From the study of the inter-relationships between badger densities and habitat characteristics of landscapes, it may be concluded that badger numbers have, almost certainly, increased in Ireland in this century, as a direct consequence of the improvement of grasslands and an increasing use of pastures for cattle. The protection of the badger under the 1976 Wildlife Act has, certainly, had some positive effect on overall badger numbers in the country.

To generalise, the badger is a highly adaptable species, with resource requirements that many Irish landscapes provide. Much agricultural development, especially pasture improvement, mainly carried out to increase cattle stocking density, has resulted in providing badgers with a substantial and readily available food supply - principally earthworms, and other invertebrates taken by badgers. The pattern of agricultural development in Ireland has, nevertheless, retained those habitats that provide suitable sites within which badgers may construct their dwellings. One factor constraining badger numbers in Ireland might be the lack of natural or semi-natural woodland, a habitat favoured for substantial permanent setts, so that the high badger densities recorded in some British localities have not been observed in Ireland.

Conclusions

The *Badger & Habitat Survey of Ireland* was designed to provide information on the ecology, distribution and abundance of the badger in the country. Of necessity, the survey required a substantial investment in time and manpower. The ecology of one of Ireland's most common and widespread large mammals has been evaluated, from a sample of Irish landscapes, in the largest study of its kind undertaken in Ireland.

The information provided is of direct relevance to studies assessing the role of the badger in the transmission of bovine tuberculosis to cattle and to TB eradication programmes. The results of the *Survey* have suggested several promising lines of enquiry, as well as establishing a framework, not only for continuing investigations of badgers and TB, but, also, for future ecological monitoring and analytical studies. Current research, based upon the *Survey's* findings, aims to enhance the predictive models developed in this study and, additionally, to reduce the scale of intensive field studies that have, to date, been required for wildlife and disease investigations in Ireland.

The *Survey* has revealed that badger densities are, to a substantial extent, determined by the proportion of land improved and used for cattle pasture. Badgers may play a role in the transmission of bovine tuberculosis to cattle, but any relationship between badgers and the disease will remain difficult to interpret because of this underlying relationship between badger numbers and the use of agricultural land for cattle farming in Ireland. Ireland has one of the highest populations of badgers in Europe, which results from the favourable habitat composition of most parts of the country. Overall badger densities are much the same as those recorded for similar habitats and landscapes in Britain and Europe.

Acknowledgements

The *Badger & Habitat Survey of Ireland* was funded by the National Parks & Wildlife Service of The Office of Public Works and the Department of Agriculture, Food & Forestry. Most of the survey work was carried out by the Wildlife Rangers of the National Parks & Wildlife Service. The considerable effort of staff, of both departments, in the survey work and in ancillary studies, as well as that of those volunteers who also contributed to the surveys is acknowledged, as is that of all others, who, at one stage or another, contributed to this research project.

Photographs provided by: W. Clarke (cover illustration), R. Mills (badger silhouettes), J. Considine (badgers, page 2), C. Smal (*main* sett, page 4, and landscapes, pages 18 and 19).

The views expressed in this report are not necessarily those of The Office of Public Works, The Department of Arts, Culture and the Gaeltacht or of The Department of Agriculture, Food & Forestry. This *Summary Report* provides a brief account of a major research study undertaken from 1989 to 1995, which is detailed in a full report that is available from the Government Publications Sale Office.

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