Earth Syst. Sci. Data Discuss., https://doi.org/10.5194/essd-2017-131
Manuscript under review for journal Earth Syst. Sci. Data
Discussion started: 8 December 2017

Open Access Earth System Science Data Discussions

Land cover and vegetation data from an ecological survey of 'key habitat' landscapes in England, 1992-93

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Abstract.

Since 1978, a series of national surveys (Countryside Surveys) have been carried out by the Centre for Ecology and Hydrology (formerly the Institute of Terrestrial Ecology) to gather data on the natural environment in Great Britain. As the sampling framework for these surveys is not optimised to yield data on rarer or more specialised habitats, a survey was commissioned by the then Department of the Environment (DOE, now the Department for Environment Food & Rural Affairs, DEFRA), in the 1990s to carry out additional survey work in English landscapes which contained semi-natural habitats that were perceived to be under threat, or which represented areas of concern to the Ministry. The landscapes were: lowland heath, chalk and limestone grasslands, coasts and uplands. These landscapes were chosen from a list identified as 'key habitats' in the Countryside Stewardship Scheme, an agri-environment scheme initiated in 1991. The survey design was a series of gridded, stratified, randomly selected 1 km squares taken as representative of classes derived from environmental classifications (or spatial masks) for each of the four landscape types in England determined from a statistical land classification. This resulted in a total of 213 of these squares being surveyed in the summers of 1992 and 1993, with information being collected regarding vegetation species, land cover, landscape features and land use. Data from the survey were collected using standardised, repeatable methods, with the database now providing a valuable baseline against which future ecological changes, resulting from a range of different drivers, may be compared. Following the surveys, the data were analysed and described in a series of contract reports showing that valuable habitats were restricted in all landscapes and that the majority were within designated land. The data set provides major potential for analyses, beyond those published in the reports published in 1996, for example in relation to climate change, agri-environment policies and land management. Precise locations of the plots are restricted, largely for reasons of landowner confidentiality. However, the representative nature of the data set makes it highly valuable for evaluating the status of the associated landscapes and vegetation covered. Both land cover data and vegetation plot data were collected during the surveys in 1992 and 1993, and are available via the following DOI: https://doi.org/10.5285/7aefe6aa-0760-4b6d-9473-fad8b960abd4. The spatial masks are also available from: https://doi.org/10.5285/dc583be3-3649-4df6-b67e-b0f40b4ec895.

1 Introduction

Widespread concern has been expressed over recent decades regarding the loss of semi-natural habitats, many of which are of high nature conservation value. There has also been considerable debate, particularly across Europe, about the relative importance of various drivers causing these losses, including changes in land use or farming practices, atmospheric pollution, or industrial and urban development.

In England, the former Department of the Environment (DOE) commissioned the Centre for Ecology & Hydrology (formerly the Institute of Terrestrial Ecology) to undertake a research project (Hornung et al., 1997) to investigate the 'key habitats' occurring within the landscape types included as targets for conservation action in the original 'Countryside Stewardship Scheme' (CSS) (Countryside Stewardship, 2017). These 'key habitats' were: lowland heath landscapes, chalk and limestone grassland landscapes, coastal landscapes and upland landscapes. The project also took into account information collected during Countryside Survey 1990 (Barr et al., 1993), particularly regarding river valleys and waterside landscapes (not included in the data sets described here, but also publicly available (Barr et al., 2016b, c, a;Barr et al., 2014). All of these landscape types, together with their constituent habitats, were seen as areas which had suffered serious losses and habitat degradation in the past and appeared to be still under threat. They were also perceived as having major significance for wildlife, landscape, archaeology and amenity criteria.

Since 1978, a series of national surveys (Countryside Surveys) had been carried out by the Centre for Ecology and Hydrology to gather data on semi-natural habitats and landscape features across Great Britain (www.countrysidesurvey.org.uk). The sampling framework for these surveys had not been optimised to yield data on rarer or more specialised habitats, therefore the 'key habitat' survey was tailored to fill this requirement, whilst still utilising compatible methods.

Information regarding habitats has become increasingly available through thematic and local surveys and inventories, such as Natural England surveys (Wilson et al., 2013;exegesis SDM Ltd. and Doody, 2009;Doody and Rooney, 2015;Jerram et al., 1998) and collation of information on lowland heath and calcareous grasslands (Marrs et al., 1986;Rose et al., 2000;Gibson and Brown, 1991;Moore, 1962). However, as a national scale data set, the 'key habitat' data provide a unique contribution to this topic. The data have hitherto remained unpublished, aside from the information in contract reports written following the field survey (Barr, 1996c, b, d, a). It is therefore timely that these data are now being made available for wider use.

2. The survey in context

There are a number of long term national monitoring projects for widespread habitats, particularly across Europe (for example Hintermann et al. (2002) (Switzerland), Dramstad et al. (2002) (Norway), Ståhl et al. (2011) (Sweden), and also globally (United States Forest Service, 2015;Wiser et al., 2001;Gillis et al., 2005). Local studies of specific habitats or specific species are also frequent in many countries, for example in Europe: peatlands in Slovakia (Špulerová, 2009), dunes in Belgium (Provoost et al., 2004), hay meadows in France (Broyer and Curtet, 2005), coastal monitoring in Ireland (Ryle et al., 2007) and other examples, which can be viewed in the EuMon database (EuMon, 2017). Beyond Europe, many other vegetation studies have also been undertaken, for example in Belize (Bridgewater et al., 2002) and Borneo (Aiba and Kitayama, 1999). In Britain, there are a range of examples of detailed local studies carried out in the last Century regarding the ecologically valuable landscapes covered by this survey (Dargie, 1993, 1995;Radley and Dargie, 1994;Sneddon et al., 1994;Stevens et al., 2007).

Other examples of structured national monitoring of rarer habitats are not known, making this survey unique in its national scale coverage which includes the status of the semi-natural habitats, their distribution and quality. The survey employs repeatable methods, and also is designed in such a way as to integrate with the national habitat monitoring programme, the Countryside Survey (CS), which covers more common habitats.

2.1 Landscape Types

The landscapes selected for survey were identified in the original 'Countryside Stewardship Scheme' launched in 1991 in England. CSS was a grant scheme that offered payments to farmers and other land managers in order to make conservation part of normal farming and land management practice. The stated objectives of the scheme were to: sustain the beauty and diversity of the landscape, improve and extend wildlife habitats, conserve archaeological sites and historic features, improve opportunities for countryside enjoyment, restore neglected land or features and create new wildlife habitats and landscape features (Ovenden et al., 1998).

The field survey focused on the following landscapes: lowland heath landscapes, chalk and limestone grassland landscapes, coastal landscapes and upland landscapes, with a comparative analysis being carried out for riversides. The lowland heath, calcareous and coastal landscapes are characterised to a greater or lesser extent by a mosaic of land cover types and each landscape includes a variety of habitats. Thus, for example, lowland heath and calcareous grassland are the core habitats in the respective landscapes, but the landscapes also include many non-heath and non-calcareous grassland habitats (for example Fen, Marsh & Swamp, Neutral Grassland and Broadleaved Woodland). Similarly, the upland and coastal landscapes include a range of habitats which are characteristically upland and coastal, in addition to other associated habitats.

Each landscape contains habitats of high conservation value in a national, and in some cases international context. However, the characteristics of the habitats giving rise to the high conservation values differ, with some landscapes being valued for botanical diversity and the associated invertebrates, and others being notable for supporting a number of rare amphibian and bird species.

The landscapes are all highly valued scenically, and are widely used for recreation. Some activities are common to all the landscapes, such as walking and picnicking, while others are limited to one or two of the landscapes, for example climbing in the uplands and on coastal cliffs, and water sports in the sea by the coastal landscapes. The intrinsic recreational value of the heaths and calcareous grassland in southern England is heightened by their proximity to large urban populations. The National Park, Green Belt and Heritage Coast designations of many of the areas of heaths and calcareous grassland underline their recreational importance. Although the uplands tend to be more remote from large urban areas than the lowland heaths, they are often readily accessible by road, attract many people and are therefore now under intense pressure.

2.1.1 Lowland heath landscapes

European heaths are widely recognised to be of high conservation value as shown by their inclusion in Annex I of the EU Habitats Directive. The list includes 4010: Northern Atlantic wet heaths with *Erica tetralix*, 4020: Temperate Atlantic wet heaths with *Erica ciliaris* and *Erica tetralix*, 4030: European dry heaths and 4040: Dry Atlantic coastal heaths with *Erica vagans* (Romão, 2013). Lowland heath occurs across continental Europe, but the British heaths are especially important in conservation terms, in part because they form such a large proportion of the European resource. For example, Farrell (1989) estimated that Britain contains 18% of the total area, including wet heath and maritime heath vegetation types which are relatively rare. In the UK, lowland heath was designated as a Priority Habitat under the national Biodiversity Action Plan, reflecting its rare and threatened status (Maddock, 2008), and its importance for a number of characteristic species of birds, reptiles, amphibians, invertebrates, vascular plants, bryophytes and lichens (Department of the Environment, 1995).

The distribution of the lowland heath landscapes is largely controlled by particular combinations of geology and soils. The lowland heath occurring on acidic, often podzolic soils that are low in nutrients, mainly as a result of soil deterioration in prehistoric times. However, important bog and wet heath habitats in the lowland heath landscape are associated with wetter acid soils.

Lowland heaths have become the focus of increasing conservation concern as a result of high rates of loss and degradation. For example in Sweden and Denmark, the area of this habitat declined by 60-70% in the century prior to the 1960s, with the corresponding decline for the Netherlands being 95% (Farrell, 1989). The survival of the distinctive lowland heath vegetation and habitats, dominated by heather (*Calluna vulgaris*) and gorse (*Ulex europaeus*), is dependent on traditional use, including livestock grazing, cutting of the shrub for use as fuel and animal fodder or controlled burning (Dolman and Land, 1995). Much of the decline and fragmentation of heaths is attributable to changing patterns of land use, including agricultural intensification, afforestation, mineral extraction and urban development (Webb, 1986). As a result of these factors, many heaths have reverted to scrub or woodland through a process of natural succession, or have been converted into intensive grassland. In the UK, the extent of lowland heaths is now approximately one sixth of that present in 1800 (Department of the Environment, 1995). The decline of the Dorset heaths has been especially well studied (for example, Moore (1962);Pywell et al. (1997);Rose et al. (2000)), the area has dropped from around 40,000 ha in 1760 to 18,200 ha to 5,700 ha in 1983 (Webb and Haskins, 1980). Today most areas of lowland heath are used for low intensity grazing, military training and recreation, with some areas in the latter two categories areas being unmanaged.

In England, the largest remnants are concentrated in the New Forest, Breckland, the Suffolk Sandlings, East Hampshire, and Surrey, Dorset and the Lizard.

2.1.2 Calcareous landscapes

Calcareous grasslands are associated with shallow, calcareous soils overlying limestone and chalk bedrock. The type of grassland varies with the type of underlying calcium rich bedrock, with the principle division being between the chalk grasslands on soft substrates in the south and east of England and the limestone grasslands occurring on harder Carboniferous strata in the north and west of Britain.

Calcareous grasslands are botanically rich, being amongst the most species-rich and species-diverse plant communities in Britain and northern Europe. In Annex I of the EU Habitats Directive, the following are included: 6210/6211, Semi-natural dry grasslands and scrubland facies on calcareous substrates (*Festuco-Brometalia*) (including important orchid sites). Within Britain, the large number of plant species occurring in calcareous grassland constitutes a substantial percentage of the total native flora (estimated at 10-20%) and many of the plant species are scarce native species; a total of 77 protected or listed species occurs in calcareous grassland, of which 50 are restricted to calcareous grassland only (Keymer and Leach, 1990). In addition, calcareous grasslands (especially on the warm South Downs) provide habitats for many invertebrates including ants and butterflies which are confined to this region and are scarce or localised in Britain. In contrast to lowland heaths, England only contains a small part of the European stock of calcareous grassland; such grasslands occur over much of central and northern Europe. However, their rarity in Britain makes them a nationally important resource and they are listed as Priority Habitats 'Upland Calcareous Grassland' and 'Lowland Calcareous Grassland' (Maddock, 2008).

The extent of calcareous grassland is thought to have reached a maximum 300 years ago. Since then, large areas have been lost, with substantial losses occurring within the last seventy years (Poschlod and WallisDeVries, 2002;Fuller, 1987). The introduction of seeding agricultural grassland after 1700 led to a decline in the quality of some chalk grassland, and as farming became mechanised in the early Nineteenth Century, many grasslands were ploughed up. During the Twentieth Century many calcareous grasslands have been lost to arable or improved pasture, mineral extraction, afforestation and building development. Keymer and Leach (1990) suggested that between 1968 and 1980 the loss of grassland was about 60% due to ploughing or agricultural improvement, about 30% to scrub encroachment and 1% due to development. As most calcareous grassland remains in agricultural ownership, the impact of changes in agricultural management is significant and grazing is the dominant influence in the maintenance of calcareous grassland. In England, the largest areas are in the south, such as Salisbury Plain, and the North and South Downs. They also occur in Yorkshire, Derbyshire, Morecambe Bay and County Durham.

2.1.3 Coastal landscapes

Coastal habitats tend to be dynamic compared to the habitats in the other CSS landscapes. Geology is a major factor determining the type of coastal landscape and the constituent habitats, with the major division being between soft and hard rock coasts; the former associated with salt marshes and low earth cliffs and the latter with rocky foreshores and cliffs. Within these major divisions there is a mosaic of habitat types. Early successional plant communities are particularly important in the coastal zone, in comparison to the other landscapes. Many of the habitats in the coastal landscape are of restricted occurrence and contain rare species. Stewart et al. (1994) estimate that at least 20% of the Nationally Scarce Plants in Britain are coastal. Coastal habitats listed as Priority Habitats in the Biodiversity Action Plan (Maddock, 2008) include Coastal and Floodplain Grazing Marsh, Coastal Saltmarsh, Coastal Sand Dunes, Coastal Vegetated Shingle, Maritime Cliff and Slopes and Intertidal Mudflats. The UK has special responsibility for several coastal habitats listed in the EU Habitats Directive, including 1230: Vegetated sea cliffs of the Atlantic and Baltic coasts, 1160: Large shallow inlets and bays and 1130: Estuaries. A number of English estuaries are also of international importance as habitats for wading birds.

Coastal landscapes have often been heavily influenced by man, although some of the core maritime habitats are formed naturally. The coastal belt is particularly well used for a wide variety of recreational activities. The detailed mix of species and the mosaic of habitats (including cliffs, estuaries, mud-flats and beaches) are inevitably influenced by the management and use of the landscapes.

2.1.4 Upland landscapes

In the uplands, the interaction between the underlying soils, geology and climate determine the mosaic of habitats which make up the landscape. This landscape occurs largely in the north of the country extending from Northumberland to the Pennines, Yorkshire Dales, Derbyshire and Lake District, but with important outliers in the south west, notably Dartmoor and Exmoor. The combination of montane and oceanic climatic conditions gives rise to plant communities which are of restricted distribution in Europe. The British upland flora contains species that have diverse geographical distribution patterns in mainland Europe such as Atlantic species and Alpine species. The mixture of species in the British upland vegetation is therefore distinctive in European context. The habitats are relatively species poor but are often present as large continuous units extending over extensive expanses of land, which are rare elsewhere in Britain. They therefore support species of birds that might not persist in smaller, more fragmented habitats, such as hen harriers (*Circus cyaneus*), merlin (*Falco columbarius*) and raven (*Corvus corax*), as well as breeding waders (Thompson et al., 1995;Usher and Thompson, 1993). Upland Priority Habitats include Upland Heaths, Upland Flushes and Blanket Bog. Upland habitats listed in the EU Annex I directive include 7130: Blanket bogs, 4060: Alpine and Boreal heaths and 4030: European dry heaths.

Much of the upland landscape, has been dominated by upland heaths and bogs since the Iron Age (Tallis, 1991), but would also have been forested at some point since the last glacial period. Management, grazing and burning are important in maintaining the mix of habitats in the uplands but reversion to scrub or woodland would not take place over all the formerly wooded areas, as a result of peat formation and/or the current extreme climate.

3. Survey design: site selection and stratification

Figure 1: Distribution of spatial landscape masks and survey sites

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The overall design of the survey, in principle, followed the standardised procedures described by Bunce and Shaw in 1973 (Bunce and Shaw, 1973), and later utilised in a range of regional surveys (Wood and Bunce, 2016;Bunce and Smith, 1978;Wood et al., 2015), and later national surveys (Carey et al., 2008;Emmett and GMEP team, 2017). The survey design uses a sampling approach, with random samples of 1km squares being selected for survey from a statistical environmental classification to enable robust estimates of areas to be produced. This stratified, random strategy ensures adequate representation of the range of ecological variation within the landscapes. At the start of the project, only fragmentary information existed from which to define and map the national distribution of the landscapes. Procedures were therefore developed to create a mask for each landscape which defined those 1 km squares in England which contained the landscape or had the potential for the characteristic habitats, thus providing the environmental classification required for the stratification framework (Figure 1 and Table 1). Additional information regarding designation (designated or non-designated) (Natural England, 2017b) was also utilised to facilitate the choice of survey sites. In this context 'designated' refers to: Site of Special Scientific Interest (SSSI), National Nature Reserve (NNR), National Park (NP), Area of Outstanding Natural Beauty (AONB), Heritage Coast (HC), Green belt, and Environmentally Sensitive Areas (ESA). Sample squares were drawn at random from each of the resultant strata and randomly sampled (Figure 1) with land cover, vegetation in quadrats, landscape features and also historic features being recorded in field surveys. The location of the vegetation quadrats was permanently marked to facilitate resurvey. A target of at least 10 x 1 km squares per stratum were selected for field survey. In total, 213 squares were surveyed, as detailed in Table 2.

3.1 Defining the lowland heath mask

The lowland heath mask contains existing and potential areas of lowland heath landscape and was constructed by combining data on soils and altitude. Soil types characteristic of lowland heath vegetation and landscapes were used to define a population of 1 km squares having potential for heath. A 1 km dataset of the Soil Survey and Land Research Centre (Cranfield University, 2017) provided data in digital form on dominant and sub-dominant soils within 1 km grid squares. Soil types most likely to support heath vegetation were identified, along with the soil types appearing in areas of known heaths. Peat soils were also included as these have a potential for heaths, especially in the vicinity of existing sites. A full list of soil types used is given in the supporting documentation accompanying the data set.

Soils data alone cannot be used to differentiate between upland and lowland heaths. Neither can lowland heath simply be defined in terms of altitude. As climate varies in different parts of England, that which might be considered ‘upland’ vegetation in some places, may occur at relatively low altitudes in harsher environments. Thus, whereas the lowland/upland vegetation interface may be considered to occur somewhere in the region of 200-300 metres in the south of England, in the north characteristically ‘upland’ vegetation may occur in areas around sea level. In order to overcome these regional differences, use was made of the ITE Land Classification 1990 which provides an integrated environmental measure of lowland character (Bunce et al., 1990). This classification uses a range of environmental and physical parameters to assign all the 1 km squares in Great Britain into one of 32 land classes; land classes 17-24 and 27-28 which are characteristically ‘upland’ in nature were used to exclude areas of England unlikely to contain lowland heath landscape areas. Coastal heathlands are poorly covered by this mask because they tend to be small and difficult to associate with soil types marked on the 1:250 000 soil map. Attempts were made to identify soils in areas of known coastal heathlands so that they could be incorporated into the lowland heath mask, however, the soils identified were not specific to coastal heathland areas and no procedure could be devised to limit the soil types to those areas. However, coastal heathlands are part of the coastal mask. The lowland heath mask covers 8538 km^2 in lowland England.

3.2 Defining the calcareous grassland mask

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The calcareous grassland mask covers 26555km^2 in England, containing existing and potential areas of calcareous grassland habitat. Areas of potential calcareous grassland were identified by using a combination of data on solid geology and quaternary deposits. Simplified digitised versions of the 1:625 000 British Geological Survey (BGS) solid geology and quaternary maps (drift geology) of Britain were employed (British Geological Survey, 2017). Using these data, a 1 km resolution map was defined by identifying 1km squares dominated by marine limestones, Oolitic and friable limestones, and metamorphic limestones, excluding squares where the rocks are overlain with non-calcareous soils. Any adjacent 1km squares containing steep slopes were added to improve the coverage of sites found on escarpments. Squares with more than 75% urban land were excluded.

3.3. Defining the coastal mask

The coastal mask was defined as that area of land extending 500m inland from the mean high water mark (HWM) plus all contiguous areas of saltmarsh, dunes and coastal bare land. The 25m resolution Land Cover Map 1990, a satellite derived map of UK land cover types (Fuller et al., 1993), gave the location of the HWM and this was chosen for use. A coastal buffer was defined as a set of contiguous 1km grid cells in England where coastal attributes (i.e. coastal buffer, saltmarsh or coastal bare) were present. In total, 8870 km squares which were covered in some part by the coastal zone. Of these, 787 urban squares (>75 % built up) and 742 squares which were predominantly sea were also excluded, leaving a total of 7341 km squares in England. The coastal mask was further sub-divided into estuarine, soft and hard coasts. As the coastal areas are narrow zones around the coast, squares often contain a proportion of sea.

3.4. Defining the upland mask

Again, it was not adequate to simply define the uplands by altitude alone. To allow for the inherent variation in land above certain altitudes in different parts of England, the upland mask was derived from the ITE Land Classification 1990 (Bunce et al., 1990), as this stratification provides an overall integration between the critical environmental factors. As described above, the predominantly upland classes include 17-24 and 27-28 and thus were used as the basis of the mask. Squares which were predominantly urban (51) were excluded providing a mask area of 15616km^2.

Lowland heath - Distribution of soil types characteristic of lowland heath overlain with ITE Land Classes 17-24 and 27-28, to exclude upland heathland. Land Classes 17-24 and 27-28 are grouped as being predominantly upland in character, while classes 1-16, 25 and 26 are predominantly lowland (Barr et al 1994).
Calcareous grassland - Distribution of limestone and chalk bedrock overlain with the distribution of drift deposits and with the addition of adjacent 1km squares containing steep slopes, to ensure inclusion of limestone escarpments; areas with drift overlying the calcareous bedrock were excluded from the mask.
Coastal landscape - All land within 500m of the coastline as defined on the ITE Land Cover Map 1990, plus any contiguous areas of coastal vegetation (sand dunes, shingle and saltmarsh) extending seaward of this coastal zone.
Upland landscape - ITE Land Classes 17-24 plus 27-28, the Land Classes considered to be primarily upland in character (Barr et al 1994).

Table 1. Summary of the spatial landscape mask definitions.

4. Data collected

The lowland heath landscapes were surveyed in the summer of 1992, with the remaining three landscape types surveyed in 1993. In a variation to the Countryside Survey methodology (Maskell et al., 2008a;Maskell et al., 2008b), surveys were carried

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out on a grid based sampling framework within each 1km square survey site, as shown in Figure 2. Coastal and lowland heath landscapes used a 25 point grid, and calcareous and upland landscapes used a 16 point grid.
Grid points were marked on base maps, and located in the field using measurements and bearings from prominent features. Rules were in place for relocating points falling on linear features, or in urban land. The detailed rules for relocation are given in the field handbooks (Barr, 1992, 1993), although the general rule meant moving the point 10m away from the original grid point.

Figure 2: Gridded sampling structure for 1km survey squares

4.1 Land cover data

4.1.1 Land cover data: areas

Land cover at each grid point was described using a comprehensive list of land use and land cover codes, as used in Countryside Survey 1990 (Barr, 1990). All mappable units included a primary description of the feature in question (for example 'maritime grassland', 'fen', 'scrub'), along with dominant species (>25%) and percentage cover codes, and use or other descriptive codes where appropriate (for example 'cattle', 'hay'). A full list of these codes can be found in the field survey handbooks (Barr, 1992, 1993), supplied as supporting information with the datasets. The codes reflected the 'Mappable Unit' or patch, in which the point fell. The Minimum Mappable Unit was $400m^2$. Each patch defined was determined by the constancy of the descriptive codes within. If one characteristic (e.g. cover of a dominant plant species) was different from that in an adjacent area, a different code was required, and a new patch was distinguished.

4.1.2 Land cover data: boundaries

The nearest vertical boundary (measuring >20m) to each grid point (within 100m) was described using codes, as used in Countryside Survey 1990. Codes included a primary description of the feature (or combination of features) in question (for example 'fence', 'hedge' 'earth/stone bank'), along with heights, an assessment of quality (for example 'stock proof', 'derelict') and dominant species and percentage covers (in hedges or lines of trees). A full list of these codes can be found in the field survey handbooks (Barr, 1992, 1993). The point on the boundary which was nearest to the grid point was recorded as part of a length which could be coded constantly as part of a single unit of not less than 20m (the Minimum Mappable Length (MML)). If the nearest point on the boundary was part of a longer length, then the coding reflected the variability of the longer length. A summary of the grid type used in each landscape is included in Table 2.

4.3 Vegetation data

Sampling of vegetation from within quadrats (i.e. plots), largely used the methodology followed by Countryside Survey (Wood et al., 2017) with variations as detailed below. At each plot, slope, aspect, shade, general soil type and descriptions were recorded. A summary of the number and locations of plots recorded is given in Tables 2 and 3.
In each plot, a complete list of all vascular plants and a selected range of readily identifiable bryophytes and macro-lichens was made. The field training course held before the surveys covered identification of difficult species, regular visits were made to survey teams by managers, and difficult specimens could be collected and sent to experts for identification. Cover estimates were made to the nearest 5% for all species reaching at least an estimated 5% cover. Presence was recorded if cover was less than 5%. Predetermined combinations of species may have been recorded as aggregates reflecting known difficulties in their separation in the field (refer to Barr (1993)).

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Landscape type	No. of 1km squares	Map Grid	X Plots (200m²)	X plots (4m²)	Y Plots (4m²)	SW plots (10x1m)	RV plots (10x1m)	Year surveyed
Lowland Heath	89	25 points, A-Y	-	25 plots, on grid.	-	-	-	1992
Calcareous	43	16 points, A-P	-	5 plots recorded at AJGDP	5 at locations selected by surveyor	-	5 plots adjacent to roadsides.	1993
Coastal	49	25 points, A-Y	5 plots recorded at points ALITW	-	5 at locations selected by surveyor	-	-	1993
Upland	32	16 points, A-P	5 plots recorded at AJGDP	-	5 at locations selected by surveyor	5 plots adjacent to watercou rses	-	1993

Table 2. Summary of vegetation plot locations

Landscape type	No. of 1km squares	X Plots (200m²)	X plots (4m²)	Y Plots (4m²)	SW plots (10x1m)	RV plots (10x1m)
Lowland Heath	89	-	540	-	-	-
Calcareous	43	-	122	215	-	81 (R) 120 (V)
Coastal	49	93	-	245	-	-
Upland	32	148	-	160	60 (S) 90 (W)	-
Total	*213*	*241*	*662*	*620*	*150*	*201*

Table 3. Summary of vegetation plots recorded

4.3.1. X-plots 4m²

These small plots were only recorded in the lowland heath and calcareous landscape types. In lowland heath landscapes, a 4m² X-plot was located at each of 25 points on the grid (Figure 2). In calcareous landscapes, five of these plots were located at points 'A', 'J', 'G','D' and 'P' (see Figure 2). Points were pre-marked on base maps and were laid out with the map point forming the south east corner of the plot. Using canes and measuring tapes, a square with sides of 2m in length was measured out, and was oriented north/south.

4.3.2 X plots – 200m²

These large, 200m² (14.14 x 14.14m) plots were used in 1993 in the coastal and upland surveys. Five plots were placed at random on grid points within the squares. The rules for the placement of these plots were as follows: in coastal squares, X plots were recorded where possible at points 'A','L','I','T' and 'W' on the 25 point grid (see Figure 2). In upland and calcareous squares (16 point grid), the X plots were recorded at 'A','J','G','D' and 'P'. Where land at the intersection in question was built-up, a lake, road, railway line, river or sea (below low water mark (LWM)) then another point was selected, with the nearest northern point being chosen first, rotating clockwise. X plots in arable fields or highly improved grassland were not recorded.

The methodology for 200m^2 X-plots was originally produced for woodlands as described by Bunce and Shaw (1973) and was also used and found appropriate for strategic ecological survey (Bunce and Smith, 1978). The design of the plot not only aids a systematic search of the vegetation present but ensures a standard area of the plot is covered on every occasion. The plot is set up by using a centre post and four corner posts, with a set of four strings tagged with markers at specified distances. The tagged strings form the diagonals of the square (as shown in Figure 3). The diagonals are orientated carefully at right angles with the strings on the north/south, east/west axes. Within the plot shown in Figure 4, the initial nest (2x2m) is searched first. This procedure is then repeated for each nest of the quadrat, increasing the size each time and only recording additional species discovered in each larger nest. In the final nest (the whole 200m^2 plot), the percentage cover (to the nearest 5%) of each species is also estimated. Estimates of cover for litter, wood, rock and bare ground are also included where present. Vegetation height, aspect and slope are also recorded. This approach is to ensure that the whole plot is observed consistently and systematically, avoiding unstructured search routines which are more likely to lead to species being overlooked, as described as far back as 1940, by Hope-Simpson (1940). The method has been widely tested and shown to be robust, not only in resource assessment, but also in measuring change.

Figure 3. X plot construction

Figure 4. Layout of vegetation X plot.

4.3.3 Y Plots 4m^2

Five of these small targeted plots were placed in each square in semi-natural vegetation types that were not covered by the main (X) plots. These type of plots were used in 1993, in the coastal, upland and calcareous surveys. The five plots were placed randomly in five different land cover types where available, additional to those types already represented by the five large (X) plots. If there were more than five land cover types available, priority was given first to those most typical of the landscape type, and second to the size of the area in question. If there were fewer than five land cover types, plots were placed proportionally to the number of land cover types available. These Y plots are important in sampling fragments of semi-natural habitat particularly in lowland landscapes, where patches may be small and embedded in a matrix of intensive farmland. Of all the plots recorded, they are most similar to the approach taken when positioning relevés (quadrats) during National Vegetation Classification (NVC) (Rodwell, 2006) because their location is not pre-determined.

4.3.4 S/W Plots - Streamside Plots

Up to five of these linear (10 x 1m) plots were placed immediately adjacent to watercourses where present, in the upland landscapes only (in 1993). The term ‘Streamside plot’ denotes linear plots which lie alongside running water features (mainly rivers and streams, but also canals and ditches). Two Streamside (S) plots were established located as close as possible to the two large X plots in each square which were furthest apart. Up to three additional Waterside (W) plots, representing other waterside types were included where appropriate.

4.3.5 R/V Plots - Roadside and Verge Plots

Up to five of these linear (10 x 1m) plots were placed immediately adjacent to roads where present, in the calcareous landscapes only. The term ‘Roadside plot’ denotes those linear plots which lie alongside transport routes (mainly roads and tracks). The ‘R’ and ‘V’ prefixes refer to the different origins of the plots: two Roadside (R) plots were established located as close as possible to the two X plots in each square which were furthest apart. Up to three additional Verge (V) plots were placed in verges alongside other transport routes where present in the square.

5. Data quality and repeatability

5.1 Spatial landscape masks

Work was carried out to validate the (mainly the calcareous and lowland heath) masks through comparisons with other data sets, although none of these provided definitive or directly comparable data for validation purposes. As the coastal and upland masks were more straightforward to define geographically, and the best available relevant data (at the time) were used in defining the masks, comparisons with other data were therefore not appropriate. The calcareous mask was compared against soils data (Mackney et al., 1983), and also the former English Nature (EN) database on calcareous sites (Natural England, 2017a). The lowland heath was compared to the Land Cover Map 1990 (Fuller et al., 1993) and to English Nature lowland heath sites (Natural England, 2017a). Overall, the lack of resolution resulting from the use of the 1km square geological data caused some discrepancies in comparison with these other datasets. However at the time, this was the only geological dataset available for use in the project. In terms of the calcareous mask, the match with the English Nature data was good, covering 89% of the EN chalk sites, and 87% of the EN limestone sites. The lowland heath mask covered only (55%) of the lowland heathland sites registered by English Nature. Most of the sites not covered by the lowland heath mask are scattered throughout England, but there is a particularly poor coverage in areas of Hampshire and Cornwall. In these areas, the missing sites occur on 1 km squares with dominant or subdominant soil types which are not specific to lowland heathland, and it was not possible to improve the coverage of the lowland heath mask without greatly increasing its size to cover large areas of England with little or no heathland potential. The map of lowland heathland areas derived using only soils and land class data therefore missed many small pockets of heathlands. However, with the exception of coastal heathlands, and areas in the New Forest and Cornwall where there are several mismatches between the ITE Land Cover Map and English Nature's reference database and the lowland heathland map, most areas of existing heathlands were adequately covered.

The overall conclusion was that although there were some mis-matches between the masks and other data sets, the fit was judged to be acceptable for the purposes of the project in providing an adequate sampling framework. It is acknowledged that with the increased quality and availability of digital data now, the masks could be improved and in the event of any re-survey, additional work could be undertaken to achieve this.

5.2 Field survey data

Several approaches were used to maintain quality in field recording and to minimise variation between surveyors. The field surveys were carried out by teams of experienced botanical surveyors, and were preceded by intensive training courses, ensuring high standards and consistency of methodology, effort, identification and recording across sites according to criteria laid out in the field handbooks (Barr, 1992, 1993). During the surveys, survey teams were initially supervised and later monitored by experienced project staff in order to control data quality. Data were recorded on waterproof paper sheets and were consequently transferred from the original field sheets to spreadsheets, using a “double-punch” method to minimise errors in data entry. They were checked using range and format checks, and corrected to produce a final validated copy.

During the field survey, independent ecological consultants revisited a sample of the survey squares, and repeated quadrats and land cover descriptions. Information from these repeat visits was given to surveyors so that consistency of recording was maintained.

5.2.1 Plot relocations

During the surveys, plot locations were recorded on paper using a sketch map with measurements from distinguishing landscape features, and by taking at least two photographs, preferably also including key landscape features in proximity to the plot. In addition to these, permanent metal plates or wooden stakes were placed in the ground to mark the sites.

The methods used to mark plots are identical to the methods used in Countryside Survey which have been widely tested and shown to be robust. The CS plots are estimated to have a precise relocation accuracy of 85–86% (Prosser and Wallace, 2008), and in the event of a resurvey of these ‘key habitats’, it would be expected that the plot relocation accuracy would be similar.

6. Analysis to date: key findings

At the present time, the results of the survey have been restricted to a set of contract reports, published in 1996 (Barr, 1996c, b, d, a). The previous unavailability of the data has so far resulted in limited use of the datasets, although one example has been the incorporation of the plot data in the niche models included in 'Multimove' (Henrys et al., 2015), which enables users to make predictions of species occurrence from specified environmental data, and allows plotting of relationships between the occurrence of species and individual environmental covariates. A summary of the key findings reported in the 1996 reports are described in the following sections, however the potential for further analyses is high.

6.1 Summary of results in terms of Broad Habitat

Table 4 gives a summary of Broad Habitat (Jackson, 2000) areas (with additional coastal habitats defined in Hornung et al. (1997) provided by the surveys. The table also includes estimates for England, from the national Countryside Survey (Carey et al., 2008).

In the lowland heath, calcareous grassland and coastal landscapes, only a small proportion of the landscape masks were estimated to be characteristic of the landscape type (figures shown in bold in Table 4). For lowland heath: 5.2%; calcareous: 1.6% and coastal: 11.6%. The large proportion of the upland landscape which comprises characteristic habitats (56.5%) reflects the less intensive use of the uplands and the extensive nature of many of the upland habitats.

More than a half of the total areas of the calcareous grassland, lowland heath and coastal landscape masks were under arable crops or managed grassland, reflecting the predominantly lowland distribution of these landscapes and previous intensification of agriculture. In contrast to the other landscapes, only a small proportion of the upland landscape area was under crops (1.4%) with a large proportion of the land cover consisting of semi-natural vegetation; crops being only recorded in the marginal uplands. The largest area of buildings and roads was found in the coastal landscape (27.2%) showing the extent of urban development in the coastal zone. The largest area of woodland and scrub occurred in the lowland heath mask (20.1%) and the smallest in the coastal mask (5%).

Figures from Countryside Survey enable an assessment of the amount of each Broad Habitat covered by the 'key habitat' survey in England compared with national figures. In the case of Dwarf Shrub Heath, Countryside Survey estimates a stock of 331,000 ha in England. The survey of Dwarf Shrub Heath in the lowland heathland (44,000ha) and upland landscapes (279,000ha) in the 'key habitat' survey gives a lower overall estimate than CS, at 323,000ha, indicating that perhaps some small areas of heath were missed during the 'key habitat' survey. The upland habitats (incorporating Acid Grassland, Bracken, Dwarf Shrub Heath and Bog) are covered well by the 'key habitat' survey, covering 84.3-99.3% of the total England areas. 36.8% of the English Fen, Marsh and Swamp habitat was found in the upland areas (but is also present in lowland areas). In terms of the calcareous grassland, the 'key habitat' survey estimates a total of 43,000ha in comparison with a CS total of 30,000ha. This perhaps reflects the fact that CS is not designed to effectively monitor or survey less common habitats such as this (Morton et al., 2011).

In the survey reports, analysis indicated that, overall, the vegetation of the coastal landscape was the most sensitive to the changes considered (such as arable intensification, urban development, climate change, and recreation pressure). In all four landscapes, the majority of high quality habitats were located within protected areas, potentially demonstrating the effectiveness of designation in restricting habitat loss. In contrast, the comparative analysis of riversides using CS data showed that the majority were not designated or protected although they included significant and internationally important landscapes.

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Manuscript under review for journal Earth Syst. Sci. Data
Discussion started: 8 December 2017

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	England†		Lowland heath			Calcareous			Coastal			Upland		
Broad Habitat (BH)	*Area ('000ha)*	*%*	*Area ('000ha)*	*% of mask*	*% of BH in Eng*	*Area ('000ha)*	*% of mask*	*% of BH in Eng*	*Area ('000ha)*	*% of mask*	*% of BH in Eng*	*Area ('000ha)*	*% of mask*	*% of BH in Eng*
Broadleaved, Mixed and Yew Woodland/ Coniferous Woodland	1238	9.3	172	20.1	13.9	295	11.1	23.8	37	5	3.0	168	10.8	13.6
Arable and Horticulture	4002	30.4	234	27.4	5.8	882	33.2	22.0	190	25.9	4.7	22	1.4	0.5
Neutral/Improved Grassland	4309	32.7	257	30.1	6.0	812	30.6	18.8	196	26.7	4.5	439	28.1	10.2
Calcareous Grassland	30	0.2	0	0	0.0	**43**	**1.6**	**143.3**	14	1.9	46.7	0	0	0.0
Acid Grassland/Bracken	487	3.7	15	1.8	3.1	178	6.7	36.5	0	0	0.0	**421**	**27**	**86.4**
Dwarf Shrub Heath	331	2.5	**44**	**5.2**	**13.3**	50	1.9	15.1	0	0	0.0	**279**	**17.9**	**84.3**
Fen, Marsh and Swamp	117	0.9	0	0	0.0	16	0.6	13.6	9	1.2	7.7	**43**	**2.7**	**36.8**
Bog	140	1.1	5	0.6	3.6	32	1.2	22.8	0	0	0.0	**139**	**8.9**	**99.3**
Built-up Areas and Gardens	1038	7.9	108	12.7	10.4	274	10.3	26.4	200	27.2	19.3	28	1.8	2.7
Other land*	1488	11.3	18	2.1	1.3	74	2.8	5.0	4	0.5	0.3	23	1.5	1.6
Bare shore									***26***	***3.6***	***100***	0	0	0
Saltmarsh									***37***	***5***		0	0	0
Maritime vegetation									***22***	***3***		0	0	0
Total	*13180*	*100*	*854*	*100*	-	*2656*	*100*	-	*734*	*100*	-	*1562*	*100*	-
% of Eng. in mask				6.5			20.1			5.6			11.8	

† *Figures from Countryside Survey (Centre for Ecology and Hydrology, 2009)*
**includes unsurveyed urban land, rivers and streams, standing open waters & canals, boundary & linear features, coastal habitats.*

Table 4. Estimates of Broad Habitat extents in England from 'key habitat' survey and Countryside Survey

6.2 Summary of boundary results

The proportion of different boundary types recorded in each of the landscape masks is shown in Table 5, including the proportion of points for which there was (or was not) a boundary within 100m. In calcareous, coastal and lowland heath landscapes, fences are the most frequent boundary type, accounting for 42-43% of all boundaries. In the uplands, fences accounted for 33% of all boundaries, whereas walls formed 36%. Combinations of walls and fences accounted for a further 23%.

Field boundaries were most common in the calcareous and lowland heath areas, with 68% of points having a boundary within 100m, reflecting field size, cropping practices and the presence of urban features (including roads).

In coastal land, only 45% of all grid points had a boundary within 100m. Squares in designated land had a lower proportion of field boundaries, indicating the greater areas of unenclosed parcels on protected land.

In the uplands, 63% of all grid points had a boundary within 100m. There was a clear difference between strata in the number of boundaries. Additional analyses showed the squares in the true uplands had a lower proportion of field boundaries, showing the greater areas of unenclosed land (heath and woodland) (Barr, 1996d). In designated land, and the non-designated marginal land, walls (with or without fences) formed the most frequent boundary type, followed by fences, but, in the non-designated true upland land, walls were less common and fences formed the predominant boundary type. Only 7% of boundaries in the uplands included hedges.

Earth Syst. Sci. Data Discuss., https://doi.org/10.5194/essd-2017-131
Manuscript under review for journal Earth Syst. Sci. Data
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	Lowland heath	**Calcareous**	**Coastal**	**Upland**
% of points without boundaries	*32*	*32*	*55*	*38*
% of points with boundaries	*68*	*68*	*45*	*63*
Bank	4	1	10	+
Ditch	7	0	0	0
Fence	43	43	42	33
Fence/bank	2	1	3	1
Hedge	20	17	11	2
Hedge/bank	6	2	4	1
Hedge/fence	12	19	11	4
Hedge/fence/bank	5	2	3	1
Hedge/wall	0	+	1	+
Hedge/wall/fence	0	+	+	+
Wall	1	7	10	36
Wall/bank	0	+	+	+
Wall/fence	1	8	4	23
Wall/fence/bank	0	+	+	0

Table 5. Summary of boundaries by landscape type as a proportion of the total (+ denotes present at <1%)

6.3 Summary of vegetation plot results

The range of vegetation present can be described using the classification of plot species into 'habitat indicator groups'. The mean number of species in each of these habitat indicator groups per plot for each landscape type is shown in Table 6, along with the proportion of species in each indicator group in comparison with the total. Although the proportion of species from each indicator group falling into each landscape type in many cases reflects the overall extent of that type (figures in bold in Table 6), it also reflects the extent of fragmentation of some vegetation types. The characteristic vegetation types were well represented in the main plots in the uplands showing that they occur as relatively large areas. The uplands were dominated by moorland (23-29%), bog (8-10%), and upland grassland (14-17%) species, but also include a variety of more lowland indicator groups, such as neutral and improved grassland species (27%), and woodland species (8%).

In calcareous landscapes, the proportion of species from the calcareous grassland habitat indicator group was only 3% of the total. This indicates the scarcity and largely fragmented distribution of unimproved calcareous grassland even in areas with suitable geology. The proportion of species was far higher in the neutral grassland group (38-45%) and even the acid/moorland group (11-15%).

The habitat indicator groups with the highest proportion of species in the lowland heath landscapes were heath generalist species (42%) and acid or moorland species (27%). Woodland species were also well represented (16%).

In coastal landscapes, 35-43% of the species fell into the neutral grassland species group, followed by weeds/alien species (16-17%). Maritime species only accounted for 9-15% of the total.

Analysis in the contract reports showed that distribution of characteristic vegetation types demonstrated differences between designated and non-designated areas in the lowland heath, calcareous grassland, upland and coastal landscapes suggesting that larger areas of characteristic vegetation occurred in the designated sites. For example, in the heathland landscape there was almost twice as much heathland and acid bog vegetation in the designated sites compared to the non-designated areas.

Earth Syst. Sci. Data Discuss., https://doi.org/10.5194/essd-2017-131
Manuscript under review for journal Earth Syst. Sci. Data
Discussion started: 8 December 2017

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	Lowland heath		*Calcareous ($4m^2$ Main)*		*Calcareous ($4m^2$ Habitat)*		*Coastal ($4m^2$)*		*Coastal ($200m^2$)*		*Upland ($4m^2$)*		*Upland ($200m^2$)*	
Habitat indicator groups	*No.*	*%*	*No.*	*%*	*No.*	*%*	*No.*	*%*	*No.*	*%*	*No.*	*%*	*No.*	*%*
Acid grassland/moorland species	2.6	27	2.2	15	2	11	1	8	2	9	**3.9**	**23**	**6.6**	**29**
Aquatic margin species	-	-	-	-	-	-	0.4	3	0.2	1	-	-	-	-
Base-rich grassland/flush species	-	-	1	6	1.6	8	-	-	-	-	0.9	5	0.5	2
Bog/acid flush species	-	-	-	-	-	-	-	-	-	-	**1.8**	**10**	**1.9**	**8**
Calcareous grassland species	-	-	**0.4**	**3**	**0.6**	**3**	1.2	9	1.3	6	-	-	-	-
Damp grassland/tall herb species	-	-	0.5	3	0.8	4	0.5	4	0.8	3	-	-	-	-
Heath generalist species	**4**	**42**	-	-	-	-	-	-	-	-	-	-	-	-
Heath specialist species	**0.6**	**6**	-	-	-	-	-	-	-	-	-	-	-	-
Maritime species	-	-	0	0	0	0	**2**	**15**	2.1	9	-	-	-	-
Marsh and aquatic species	-	-	0.1	1	0.8	4	-	-	-	-	-	-	-	-
Neutral/improved grassland species	-	-	-	-	-	-	-	-	-	-	4.6	27	6.3	27
Neutral grassland species	0.6	6	6.6	45	7	38	4.7	35	9.9	43	-	-	-	-
Streamside/marsh species	-	-	-	-	-	-	-	-	-	-	1.7	10	1.1	5
Upland grass species	-	-	-	-	-	-	-	-	-	-	**2.4**	**14**	**3.9**	**17**
Weeds/alien species	0.2	2	1.7	11	2.6	14	2.1	16	4	17	0.4	2	1	4
Woodland/scrub species	1.5	16	1.4	9	1.7	9	0.6	5	1.5	6	1.4	8	1.9	8
Woodland edge/scrub species	-	-	0.9	6	1.5	8	0.6	5	1.4	6	-	-	-	-
Totals	*9.5*	*100*	*14.8*	*100*	*18.6*	*100*	*13.1*	*100*	*23.2*	*100*	*17.1*	*99*	*23.2*	*100*

Table 6. Mean number of species in each habitat indicator group per plot in each landscape type

7. Data availability

The datasets have been assigned digital object identifiers and users of the data must reference the data as follows:

- Barr, C.J.; Bunce, R.G.H.; Cummins, R.P.; Hallam, C.J.; Hornung, M.; Wood, C.M. (2017). Habitat and vegetation data from an ecological survey of terrestrial key habitats in England, 1992-1993. NERC Environmental Information Data Centre. https://doi.org/10.5285/7aefe6aa-0760-4b6d-9473-fad8b960abd4

- Bunce, R.G.H.; Parr, T.W.; Ullyett, J.; Hornung, M.; Gerard, F.; Bull, R.; Cox, R.; Brown, N.J. (2017). Spatial masks for calcareous, coastal, upland and lowland heath landscapes in England [Key Habitats 1992-93]. NERC Environmental Information Data Centre. https://doi.org/10.5285/dc583be3-3649-4df6-b67e-b0f40b4ec895

The datasets are available from the CEH Environmental Information Data Centre Catalogue (https://eip.ceh.ac.uk/data). Datasets are provided under the terms of the Open Government Licence (http://eidchub.ceh.ac.uk/administration-folder/tools/ceh-standard-licence-texts/ceh-open-government-licence/plain, http://www.nationalarchives.gov.uk/doc/ open-government-licence/version/3/). The metadata are stored in the ISO 19115 (2003) schema (International Organization for Standardization, 2015) in the UK Gemini 2.1 profile (UK GEMINI, 2015). Users of the datasets will find the following documents useful (supplied as supporting documentation with the datasets): Barr (1992) and Barr (1993).

8. Conclusion

During recent decades there has been increasing concern over the loss of a number of valued landscapes and their associated characteristic habitats. A number of policies have been introduced to protect and enhance the remaining areas of these characteristic habitats. The UK Biodiversity Action Plan (and the EU Habitats Directive) has also set targets for the protection of threatened species and habitats. However, overall, there is inadequate information with which to judge the status and quality of these and how they are changing. Together, the land cover and vegetation data described in the present paper, provide an important baseline which offers the potential to monitor and evaluate threats to the landscapes and characteristic habitats, assess the effectiveness of the policies designed to protect them, and interpret and predict the impact of land management on these habitats.

It seems likely that further declines may have occurred since the survey bearing in mind the current trends, but the extent of these could only be determined by a monitoring programme, for which this survey provides a useful framework. The Countryside Survey has demonstrated the robustness of a similar database for such a repeat. According to the findings from this project, it could be expected that changes are more likely in undesignated land in the uplands than in designated sites in coastal, heath and calcareous grasslands. Similarly, riverside landscapes may be subject to change resulting from a lack of protection.

The datasets provide a broadly defined distribution in England of four landscapes of interest including the habitats characteristic of the landscapes as well as areas with potential for these habitats. These data form valuable contextual information for further specific surveys and monitoring. The data sets also provide an objective characterisation and quantification of the land cover and vegetation within the defined areas of these landscapes by field survey of a stratified random sample of lkm squares within each landscape. The resultant data have been used to assess the distribution of species representative of the characteristic habitats and in the different sampling strata of the landscapes, and offer much potential for further work. The survey was the first time that a statistically rigorous assessment of ecological quality has been attempted across a wide range of ecologically important habitats using similar methods and standardised protocols. The assessment of quality has shown that, in general the areas of the characteristic habitats covered by designations are of higher ecological quality than those in non-designated areas. This result could indicate that such designations may therefore provide 'protection' for the threatened habitats but it may also reflect the original designation of high quality habitats. This is valuable information in the targeting of initiatives and funding designed to restore the given habitats.

The standardised design of the survey offers the opportunity for integration with future surveys of the status of the British countryside. The location of the vegetation plots have been permanently marked to facilitate future resurvey and are thus able to be monitored over time and as stated above would facilitate long term habitat monitoring linked to a range of drivers.

Acknowledgements

We thank all the land owners who kindly gave permission to survey their holdings in the survey sample squares in 1992 and 1993. Without their co-operation and assistance the Countryside Survey would not exist. We also acknowledge and thank all the field surveyors involved in each field campaign (H. Adams, T. Barden, E. Biron, R. Cummins, J. Davis, J. Day. R. Hewison, G. Levine, A. Marler, E. McDonnell, K. Pollock, S. Walters, M. Webb). The survey was funded by the Department for Environment (DOE) (now the Department for Environment, Food & Rural Affairs (DEFRA).

Author Contributions

CMW prepared the manuscript with contributions from all co-authors, and is the current database manager for the Land Use Research Group at CEH Lancaster. The sampling framework and survey strategy was based on methods designed by RGHB, and the field survey was overseen by CJB.

Earth Syst. Sci. Data Discuss., https://doi.org/10.5194/essd-2017-131
Manuscript under review for journal Earth Syst. Sci. Data
Discussion started: 8 December 2017

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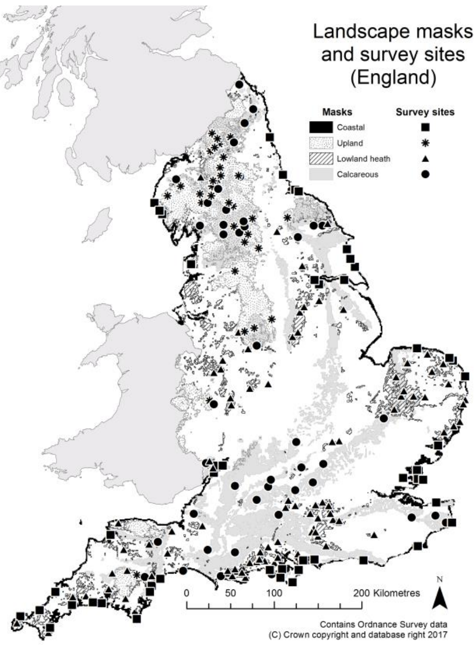

Figure 1: Distribution of spatial landscape masks and survey sites

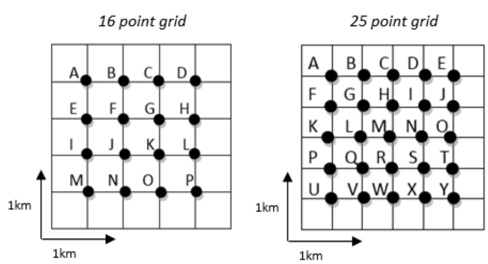

Figure 2: Gridded sampling structure for 1km survey squares

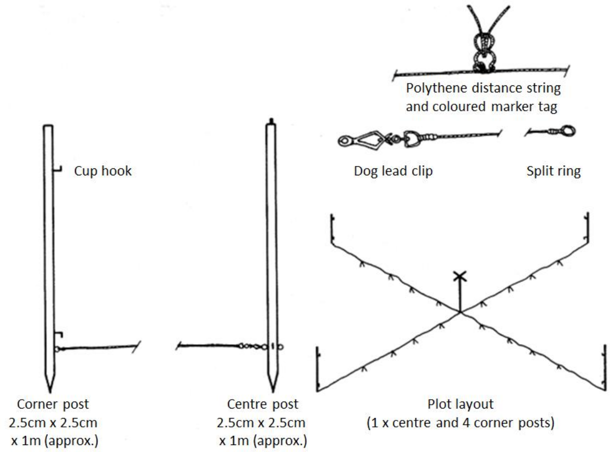

Figure 3. X plot construction

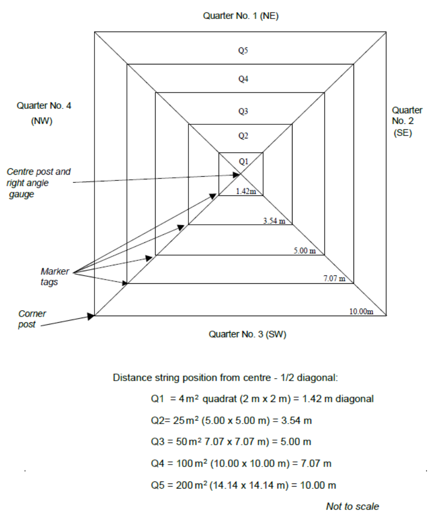

Figure 4. Layout of vegetation X plot.