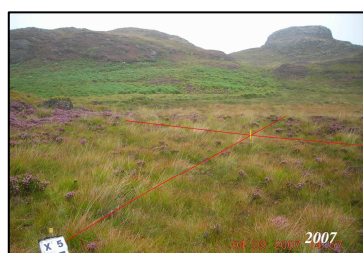


Countryside Survey:

Measuring Habitat Change over 30 years

1978 Data Rescue - Final Report

(CEH Project no.: NEC03689)



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1. Introduction

The Countryside Survey programme field records for land-cover and landscape features are held by the Centre for Ecology & Hydrology in hard copy format. These data have been collected at varying intervals (1977/78, 1984, 1990, 1998/99 and 2007) in Great Britain to form a globally unique long-term, large-scale monitoring dataset.

The data from 1984, 1990 and 1998 were scanned as part of a previous project (CS2000 FOCUS - Scoping and Pilot study for scanning Countryside Survey primary field data documents). The linework for these years was digitised prior to 2000, and the 2007 data were recorded directly onto rugged field computers.

However, the 256 annotated land-cover maps for the 1978 Countryside Survey squares had never been digitised into a GIS format before 2009 (although the areas and lengths had been recorded using rudimentary digitising tools in the 1980s). Before this data rescue project was undertaken, these primary source records of long-term monitoring of land-cover and landscape features from the 1978 Countryside Survey programme were at considerable risk of damage, loss or destruction. In addition, the data were unavailable in a spatial form as a resource on a daily basis to CEH staff or to a wider range of researchers. The Countryside Survey 1978 Data Rescue project has allowed digitisation of the maps, which provide the ability to analyze Countryside Survey data in relation to Broad Habitat categories as far back as 1978, which was previously not possible.

Converting the 1978 Countryside Survey land-cover maps into digital form effectively adds a completely new survey dataset for land-cover to the existing surveys carried out in 1984, 1990, 1998 and 2007. For the first time, this allows us to extend the time series of matched vegetation and Broad Habitat data back to a critical period that coincides with the culmination of post-WWII intensification of agriculture. This increases the reliability and power of the entire time-series for estimating stock and change in Broad Habitats across the full thirty year period. It will also provide new information on the impact of land-use as a driver of ecological variation in plant species composition and soils in 1978.

During the project, the field codes used in 1978 were allocated to BAP Broad Habitats (Jackson, 2000) and individual areas were scrutinised to enable consistency between the 1978 dataset and data from later years' surveys. It is now possible to characterise the mosaic of broad habitats as they existed across GB thirty years ago, in terms of coincident plant species and soil data (pH and Loss on Ignition) recorded at the same time.

This report incorporates a summary of work completed on the dataset and also comments and discussions made at a Workshop in Grange-over-Sands and project meetings involving Colin Barr, Bob Bunce, David Howard, Simon Smart, Claire Wood, and Peter Henrys (CEH project NEC03689, 2009-2011).

2. History of the 1978 Survey and Background to Data

A preliminary ecological survey was undertaken in Cumbria in the mid-1970s (Bunce and Smith, 1978) following an earlier, smaller successful survey in Shetland. These surveys consisted of vegetation plots only (16 plots per 1km square). For further details, refer to Firbank *et al.* (2003).

Building upon these smaller surveys, the Great Britain survey of 1978 planned to study eight randomly located vegetation plots per 1km square. This total was then reduced down to five for reasons of efficiency with additional plots to represent rivers, roads and hedges. A problem arose in that the plots could not guarantee to capture variation across all the habitats in a survey square. On the field survey training course in 1977 it was suggested that mapping areas of habitats would address this issue. The field handbook from 1978 has a paragraph explaining the methodology for doing this (refer to paragraph entitled 'Sketch Map' in the 1978 field survey handbook (Barr and Bunce, 1978)). The first few habitat maps were hand drawn sketches on blank paper, then later transferred onto Ordnance Survey 1:10 000 base maps. The sketches and field maps were transferred onto the base maps using a set of 80 codes (refer to Appendix ii) which were mainly species

descriptions but were based on traditionally taught divisions which, in most cases, have helped them translate easily to Broad Habitats (Jackson, 2000) and in some cases, Priority Habitats (BRIG, 2007).

3. Issues to address regarding the 1978 Dataset

By digitising this dataset and making it possible to use alongside other Countryside Survey datasets, certain issues have arisen in the years following the 1978 survey which must be addressed.

- 1) One such issue was a worry that the data might not be consistent (both internally, in terms of recording differences between surveyors (and their development during survey), and with mapping done in following surveys). This has been addressed by visually comparing the datasets against other years' survey data (see section 5). The comparisons showed that the data are highly consistent and real change can be reliably identified.
- 2) It has been suggested that a clear source of bias was introduced when the field sheets were transferred and coded to base maps (introducing error from interpretation rather than recording surveyors' observations). However, it could be said that similar bias was introduced when digitisers played a similar role in later Countryside Surveys, and at least in 1978, the bias was introduced consistently by one person.
- 3) Concern has been expressed there was no quality assurance at the time of the survey to assess the quality of the habitat surveying. Again, this has been addressed by scrutinising the 1978 dataset in comparison with species data and later survey data (see section 5).

Notwithstanding any of these criticisms, the data (in a non-spatial form) have been used in several models and projects since 1978 indicating the data are robust. In the 1980s, the NERC Experimental Cartography Unit (ECU) suggested ways of doing overlay analysis studies and these suggestions gave rise to (among others - refer to p121, Bunce *et al.*, 1993):

- *Landscape Changes in Britain* – Identifying changes in habitats between 1978 and 1984 (Barr *et al.*, 1986)
- *The Wood Energy project* – Converting grassland areas into yield classes for potential wood plantations (Mitchell *et al.*, 1982)
- *LUAM (Land Use Allocation Model)* (Jones *et al.*, 1995)

The original analysis procedure involved quantifying areas with a measuring tool and tabulating the figures. These tabulated sheets still exist at CEH Lancaster. National estimates were calculated using these tabulated figures and were published in Bunce and Heal (1984) and also the Countryside Survey 1990 Report (Barr *et al.*, 1993) (refer to Section 8). Changes between 1978 and 1984 were investigated after a second survey was undertaken (Barr *et al.*, 1986).

4. Digitization Procedure

Firstly, the maps were scanned on an auto-feed scanner at CEH Lancaster and are available in .jpg format and .pdf format. As there are now electronic backups, the original maps were removed from storage in a fire safe and are now stored in the FAB (field assessment booklet) boxes, alongside the other years' data. Plot data sheets have also been scanned and placed in the FABs.¹

The maps were then digitized by ADAS in summer 2009, according to the protocol set out in Appendix ii of CS1978 – Data Rescue Scoping study for digitizing Countryside Survey primary field data documents, Final Report (Wood, 2008). The maps are now stored in a Geographical Information System based at CEH Lancaster.

5. Data Checking and Validation

In the first instance, the data were checked for any obvious omissions, queries or errors arising from the digitizing process in comparison with the original field maps.

Once these anomalies were remedied, it was necessary to check for any inconsistencies in the 1978 dataset versus other years' survey data. In order to do this, each survey square for each survey year was arranged onto individual sheets (see example in figure 1 below).

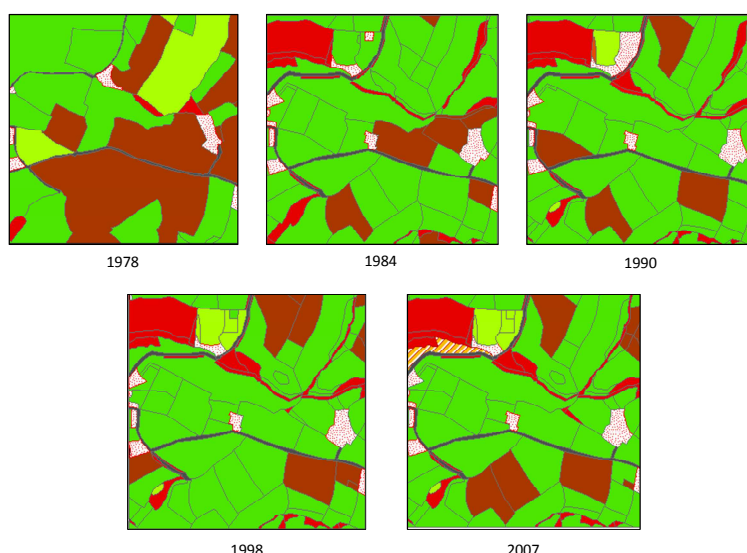
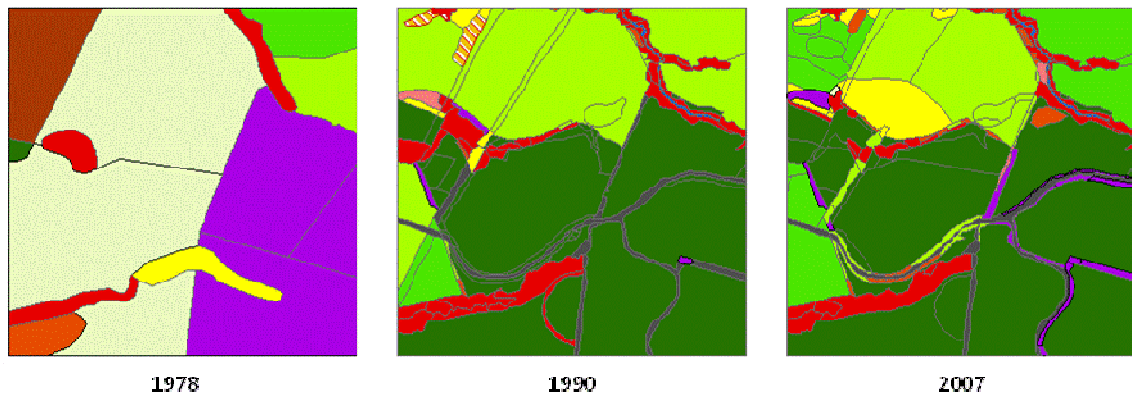


Figure 1. Comparison of a 1km square surveyed in 1978, 1984, 1990, 1998 and 2007. (Refer to legend overleaf).

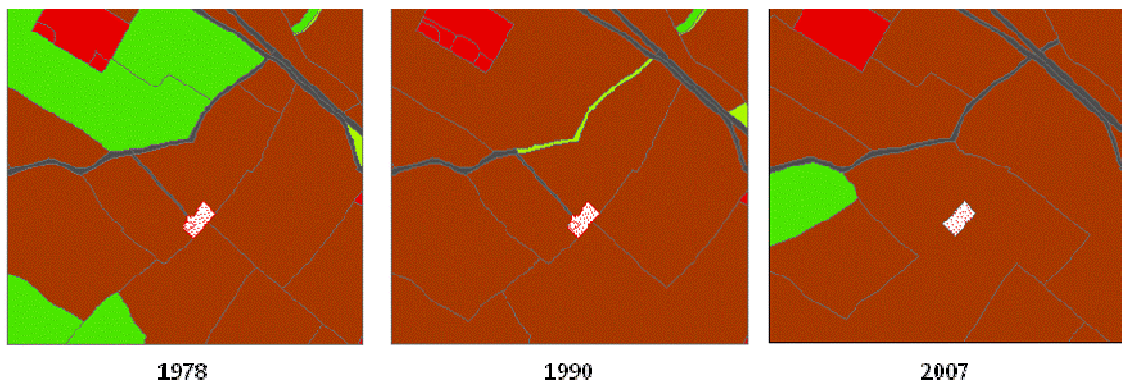
Note the location of CS field survey squares is not disclosed to maintain the scientific integrity and relevance of CS. Consequently, the squares in Figure 1 have been spatially manipulated to prevent identification of the square's location.

This enabled changes in the data between 1978 and other years to be identified. With the help of staff who were involved with the 1978 survey, maps were assessed to see whether changes between 1978 and other years were real changes or changes due to error. This was achieved by checking plot data and original species data recorded on the maps. After having undergone this process, it was felt that the 1978 dataset had levels of quality and consistency comparable that of the other Countryside Survey datasets, allowing direct comparisons of change to be undertaken at a future date. Further examples of squares illustrating land use change can be seen in figure 2.

¹ Scanned sheets can be found in: S:\PARR Section\LUS\resources\CS_digital_images\CEH\Sq_no\1978



Survey square showing an area of Acid Grassland and Dwarf Shrub Heath in 1978 being replaced with conifer plantations by 1990 – a typical scenario reflecting an increase in forest planting since the late 1970s. By 2007, an area of fen in the top left corner has grown in size, and there are signs that grassland improvement has taken place.



A typical lowland survey square showing few major changes between 1978 and 2007. The square illustrates changes from Improved Grassland to Arable and Horticulture and vice versa. Similar squares of this Land Class type also appear to show a downward trend in areas of Improved Grassland.



A survey square showing a range of small changes. There is increased urbanisation, increased conifer and broad leaf planting and changes between grassland types. Again, the increased urbanisation and woodland planting are changes which may be seen in many survey squares.

Legend – Terrestrial Broad Habitats

Acid Grassland	Broadleaved Mixed and Yew Woodland	Improved Grassland	Sea
Arable and Horticulture	Calcareous Grassland	Inland Rock	Standing Open Waters and Canals
Bog	Coniferous Woodland	Mosaic	Urban
Boundary and Linear Features	Dwarf Shrub Heath	Neutral Grassland	
Bracken	Fen, Marsh, Swamp	Rivers and Streams	

Figure 2. Examples of land use change taken from Countryside Survey Squares in 1978, 1990 and 2007.

Note the location of CS field survey squares is not disclosed to maintain the scientific integrity and relevance of CS. Consequently, the squares in Figure 2 have been spatially manipulated to prevent identification of the square's location.

6. Broad Habitat Allocations

Whilst the majority of the 1978 codes were straightforward to translate to BAP Broad Habitats (e.g. 1978 Code 56: Conifer Woodland = BH 2 Coniferous Woodland), there were a few categories which proved problematic (e.g. 1978 Code 69: *Mixed Upland Moor* could be Bog, Dwarf Shrub Heath or Acid Grassland) (see appendix ii for full code lists). For areas with ambiguous allocations, the original habitat maps (annotated with species) and vegetation plot data where possible, were used to clarify the correct Broad Habitat allocation. A visual check of every square was essential to resolve any issues.

6.1 Issues arising from the 1978 Broad Habitat Allocations

- Upland codes proved to be the more difficult codes to delineate and allocate to Broad Habitats. However, this issue is not confined to the 1978 dataset and these habitats can be inherently difficult to delineate in areas of heterogeneous upland landscape; habitats may be spatially indistinguishable or within a wider area patches may be smaller than the minimum mappable unit. In later surveys, areas such as this could be defined as a 'Mosaic' by surveyors (Maskell *et al.*, 2008).
- *Code 23: Herb rich pasture* was used in 1978 to define Calcareous Grassland. However, this code might also have been used for Acid Grassland or even Dwarf Shrub Heath. Areas of Calcareous Grassland were scrutinised in comparison to other years' maps and with reference to vegetation plot data where possible in order to identify the areas correctly.
- Areas of Inland Rock are overestimated in 1978, as in 1978 the code was a primary code whereas in later years it became possible to record rock as a secondary code. Differences are also partly due to differences in the methodology for mapping cliffs (lines seen from above vs. surface area). This will be reflected in any calculations of national estimates for 1978.
- 1978 code translation to Neutral and Improved Grassland were not straightforward. Reference to vegetation plot data and notes were used where possible to define the areas correctly.
- During digitization, the CS2000 area and line maps were all interpreted with 1984 and 1990 maps to produce a single set of line work (so as to avoid slivers in data). The 2007 data were largely based on the 1998 line work. Hence the 1984, 1990, 1998 and 2007 datasets are very similar in terms of line work. Conversely, the 1978 dataset was digitised independently. Despite this, after scrutinising the datasets, it is apparent that the 1978 line work is highly consistent with the other datasets.
- In certain cases, Priority Habitats (BRIG, 2007) could also be identified. These include Coastal Saltmarsh, Blanket Bog and Purple Moor Grass Rush Pasture.

7. Note Regarding the ITE Land Classifications

In 1978, the method of locating sample squares and the method for the production of national estimates used the original ITE Land Classification (Bunce *et al.*, 1981). Squares on the intersection of a 15 x 15 km square grid across Britain were classified in this original classification (1215 of the 1228 squares were classified – although that includes some just off the coast that were moved to the nearest land). Indicator Species Analysis (ISA) generated a key that was used to classify a further 4,824 squares distributed around those originally classified, producing 6,039 used for analysis. The areas of Land Class were based on areas of the country as a proportion to these classified squares. The reason for the sampling approach was not only the constraints of computing and analytical power (matrix algebra with potential 250,000 x 80 variables), but also that data had to be collected by hand. With a few exceptions, only the original 1215 squares were used for survey square selection (256 in 1978, 384 in 1984, 508 in 1990, 569 in 1998 and 591 in 2007). At a simple level, the procedure for calculating national estimates of habitat areas involved using the surveyed data to find the mean amount of habitat per 1km square in a Land Class, multiplying this mean by the Land Class area, then summing these totals for Great Britain as a whole.

The first 'All Squares' classification was derived in the 1980s and was improved for the 1990 survey using Ralph Clarke's twin analytical approach (Barr *et al.*, 1993). The reclassification was conservative, using the original as a training set and seeking to match this classification. For 1998, the Scottish land classes were separated (32 to 40 classes) and for 2007, Wales was isolated (to 45 classes) (Barr, 1998; Bunce *et al.*, 1996a; Bunce *et al.*, 1996b; Howard *et al.*, 1998). Refer to Appendix iii for a summary flowchart of the evolution of the Land Classification.

8. Results: National Estimates of Broad Habitat Stock 1978

National estimates of stock for Great Britain have been calculated for a selection of Broad Habitats for the 1978 survey (habitats shown are those reported in the 2007 survey report² (Carey *et al.*, 2008)).

It is important to note that these estimates are not directly comparable to those for later surveys published in the Countryside Survey report for 2007 (Carey *et al.*, 2008). This is primarily for two reasons; the first being that due to the limited sample size of 256 1km survey squares, estimates have been calculated using the 1990 ITE Land Classification (with 32 classes) rather than the revised 2007 Land Classification (with 45 classes) (see section 7), as there are statistically not enough sample survey squares per class with 45 classes. Secondly, due to the way Broad Habitats have been allocated retrospectively (as is also the case with data from 1984 and 1990), habitats may not necessarily equate directly to the later datasets.

It is not within the scope of this report to comment on the significance of the estimates in comparison with later years' results; it is intended further work will focus on this in the future. When considering calculating change between 1978 and later years using the consistent statistical model used for calculating the 2007 results, it must be noted that the addition of an additional dataset (1978) to the time series will create minor changes to the results published for later years in 2008 (Carey *et al.*, 2008). Also, the revised 2007 Land Classification cannot be used to calculate change from 1978-2007 due to the lack of samples in certain classes in 1978.

Stock of Broad Habitats in Great Britain, 1978 ('000s ha)

1978				
Broad Habitat	Mean Area (<i>'000s ha</i>)	Lower 95% Limit (<i>'000s ha</i>)	Upper 95% Limit (<i>'000s ha</i>)	% area of GB
Broadleaved, Mixed and Yew Woodland	995	774	1287	4.3
Coniferous Woodland	1413	916	1866	6.1
Linear Features	364	302	417	1.6
Arable and Horticulture	5105	4532	5664	21.9
Improved Grassland	5188	4611	5794	22.3
Neutral Grassland	1442	1186	1749	6.2
Calcareous Grassland	53	8	108	0.2
Acid Grassland	1786	1390	2190	7.7
Bracken	258	144	402	1.1
Dwarf Shrub Heath	1677	1191	2148	7.2
Fen, Marsh and Swamp	231	157	321	1
Bog	2004	1598	2407	8.6
Standing Open Water and Canals	360	104	698	1.5
Rivers and Streams	75	34	150	0.3
Inland Rock	190	127	261	0.8
Urban ^a	1441	1091	1817	6.2
Other Land	249	58 ^b	509 ^b	1.1
Unsurveyed Urban	482	N/A	N/A	2.1
Total Area	23313			100

Table 1. Stock of Broad Habitats in Great Britain, 1978

^aThe land in urban areas from within Great Britain was excluded from the estimation of Broad Habitats and is accounted for as a constant value in 'Unsurveyed Urban'; ^bLimits summed from the component habitats

² Excluding montane; in 1978 there were not enough sample survey squares to produce a valid estimate for this small habitat

8.1 Comparison of New Results with Previously Published Data

The set of results created from the newly digitized data published here differ from those published in previous publications (Bunce & Heal, 1984; Barr *et al.*, 1993). The differences along with likely explanations for the differences are put forward here. Note that the Barr *et al.* (1993) figures are rounded one place higher than the other two sets of estimates. See footnotes for categories reported in Bunce and Heal (1984) and Barr *et al.* (1993).

1978					
Broad Habitat	Newly digitized Lower limit (‘000s ha)	Newly digitized Mean Area (‘000s ha)	Bunce & Heal, 1984 Mean Area (‘000s ha)	Barr <i>et al.</i> , 1993 Mean Area (‘000s ha)	Newly digitized Upper limit (‘000s ha)
Broadleaved, Mixed and Yew Woodland	774	995	803 ¹	980 ¹³	1287
Coniferous Woodland	916	1413	1405 ²	1410 ¹⁴	1866
Linear Features	302	364	720 ³	390 ¹⁵	417
Arable and Horticulture	4532	5105	4428 ⁴	4530 ¹⁶	5664
Improved Grassland	4611	5188	-	-	5794
Neutral Grassland	1186	1442	-	-	1749
Calcareous Grassland	8	53	-	30	108
Total grass (excl. Acid)	5805*	6683	6385 ⁵	6700 ¹⁷	7651*
Acid Grassland	1390	1786	1641 ⁶	2530 ¹⁸	2190
Bracken	144	258	361 ⁷	290 ¹⁹	402
Dwarf Shrub Heath	1191	1677	-	1450 ²⁰	2148
Fen, Marsh and Swamp	157	231	374 ⁸	220 ²¹	321
Bog	1598	2004	-	880 ²²	2407
Bog & Dwarf Shrub Heath	2789*	3681	3337 ⁹	2330	4825*
Standing Open Water and Canals	104	360	-	350 ²³	698
Rivers and Streams	34	75	-	110 ²⁴	150
Total water	138*	435	726 ¹⁰	450	848*
Inland Rock	127	190	169 ¹¹	170 ²⁵	261
Urban	1091	1441	2278 ¹²	1980 ²⁶	1817
Other Land	58*	249	243	470	509*
Unsurveyed Urban	N/A	482	-	480	N/A
Total Area		23313^a	22870	22970^a	

Table 2. Comparison of new 1978 results with previously published data

*Limits summed from the component habitats ^aExcludes figures in bold italics. Note: Figures in red fall outwith the new upper or lower limits given

¹Broad-leaved wood + Scrub

²Conifer

³Communications

⁴All crops

⁵All grass

⁶Rough grass + Mixed rough grass + Mountain grass

⁷Pteridium dom.

⁸Juncus dom.

⁹Molinia dom. + Eriophorum + Calluna dom. + General moorland

¹⁰Aquatic

¹¹Inland rock

¹²Buildings etc.(includes unsurveyed urban)

¹³Broadleaved/mixed woodland (– perennial crops)

¹⁴Conifer woodland

¹⁵Communications

¹⁶Tilled + Non-cropped arable + Broadleaved/mixed woodland (perennial crops)

¹⁷Managed grass (– calcareous grass, –upland grass, –maritime grass)

¹⁸Moorland grass + Upland grass

¹⁹Dense bracken

²⁰Open heath (–Drier northern bogs) + Dense heath

²¹Wetland

²²Wet heaths & saturated bogs + Drier northern bogs

²³Lake

²⁴Running water

²⁵Rock

²⁶Built up

Broadly, the differences between the sets of published results can be explained by one of three things:

1. In many cases, the Broad Habitat classes reported here were not directly comparable with the Reporting Classes (see footnotes for table 2) used in the previous publications (both of which used slightly different aggregations of classes), making comparisons difficult. This is especially the case with the grassland categories (Neutral, Improved, Acid, Calcareous) and upland categories (Dwarf Shrub Heath, Bog).
2. In some cases, the polygon codes used in 1978 proved difficult to allocate to a specific Broad Habitat class (see Appendix ii and Section 6), resulting in variations in the national estimates for these classes. Additionally, during the comparison process with later data, certain 1978 areas may have been edited to be consistent with later data where it was obvious (with reference to available species data) that no real change had taken place. This means the new dataset analysed in 2011 has slight differences to the original data analysed.
3. One major difference is that Bunce and Heal (1984) used the original ITE Land Classification created in 1978, whereas the results published here used the revised 'All Squares' Land Classification created in 1990 (also used in Barr *et al.*, 1993). In light of this, it should be expected that the new results published here have more similarity to those published in Barr *et al.*, (1993) than to those in Bunce and Heal (1984).

8.1.1 Notes regarding Specific Habitats

In table 2, it can be seen that certain of the previously published data (Bunce and Heal, 1984; Barr *et al.*, 1993) are outwith the limits calculated from the rescued dataset. These values are highlighted in red. Possible reasons for the discrepancies are put forward below.

Boundary and Linear Features

*The published estimate in Bunce and Heal (1984) is higher than the upper limit published here. The difference is likely to be explained by the different (1978) Land Classification used in Bunce and Heal (1984) which is known to have a tendency to overestimate smaller habitats (Howard *et al.*, in prep).*

Arable and Horticulture

The new mean estimate is higher than both of the previous estimates, with the Bunce and Heal (1984) estimate falling below the lower limit. Again this will be largely due to the version of Land Classification used in analysis.

Acid Grassland, Dwarf Shrub Heath, Fen, Marsh and Swamp, Bog

These classes are perhaps the most difficult to compare due to the different reporting classes in each of the publications. Confusions between these classes explain any differences between the published results.

Fen, Marsh and Swamp

The Bunce and Heal (1984) value is above the upper limit for the rescued data. As with the Boundary and Linear Features habitat, this can be explained by the use of the 1978 Land Classification overestimating the results of a small habitat type. Additionally, the Fen, Marsh and Swamp category is not well defined in the published 1978 results. The value for 'Juncus dom.' has been selected as the closest to a fen category. However, this is likely to include areas of grassland, thus inflating the estimate.

Urban

*The urban figure from Bunce and Heal (1984) includes the unsurveyed urban land, excluded from the other estimates. Unsurveyed urban land was not taken into account in the original 1978 Land Classification and therefore is not published separately in Bunce and Heal (1984). When the Land Classification was improved in 1990, urban land and sea corrections were taken into account (see Barr *et al.*, 1993). Therefore unsurveyed urban land became a constant value at 482 000 ha.*

9. References

- Barr, C.J. and Bunce, R.G.H. (1978) **Ecological Survey of Great Britain: Survey Field Handbook 1978**. Institute of Terrestrial Ecology.
- Barr, C.J., Benefield, C.B., Bunce, R.G.H., Ridsdale, H. & Whittaker, M. (1986) **Landscape Changes in Britain**. Institute of Terrestrial Ecology.
- Barr, C.J., Bunce, R.G.H., Clarke, R.T., Fuller, R.M., Furse, M.T., Gillespie, M.K., Groom, G.B., Hallam, C.J., Hornung, M., Howard, D.C., Ness, M.J. (1993) **Countryside Survey 1990: main report**. (Countryside 1990 vol.2). London, Department of the Environment, 174pp. (ITE Project No:T02051m5)
- Barr, C.J. (1998) **The Sampling Strategy for Countryside Survey**, DETR CONTRACT No. CR0212
- Biodiversity Reporting and Steering Group (BRIG) (2007) **Report on the Species and Habitat Review** (available online at http://jncc.defra.gov.uk/PDF/UKBAP_Species+HabitatsReview-2007.pdf)
- Bunce, R. G. H., Barr, C. J., Whittaker, H. A. (1981) **An integrated system of land classification**. Annual Report of the Institute of Terrestrial Ecology, 1980. 28-33.
- Bunce, R.G.H. & Heal, O.W. (1984) **Landscape evaluation and the impact of changing land use on the rural environment: the problem and an approach**. Planning and Ecology (eds R.D. Roberts & T.M. Roberts), pp. 164-188. Chapman and Hall, London.
- Bunce, R.G.H., Barr, C.J., Clarke, R.T., Howard, D.C. & Lane, A.M.J. (1996a) **ITE Merlewood Land Classification of Great Britain**. Journal of Biogeography, 23, 625-634.
- Bunce, R.G.H., Barr, C.J., Clarke, R.T., Howard, D.C. & Lane, A.M.J. (1996b) **Land classification for strategic ecological survey**. Journal of Environmental Management, 47, 37-60.
- Bunce, R. G. H., Howard, D. C., Hallam, C. J., Barr, C. J., Benefield, C. B. (1993) **Ecological consequences of land use change**. (Countryside 1990 vol.1). NERC/Institute of Terrestrial Ecology. (ITE Project No:T02051e1)
- Bunce, R.G.H. & Smith, R.S. (1978) **An ecological survey of Cumbria**. Kendal, Cumbria County Council and Lake District Special Planning Board, 51pp. (Structure Plan Working Paper, 4).
- Carey, P.D., Wallis, S., Chamberlain, P.M., Cooper, A., Emmett, B.A., Maskell, L.C., McCann, T., Murphy, J., Norton, L.R., Reynolds, B., Scott, W.A., Simpson, I.C., Smart, S.M., Ulliyett, J.M. (2008) **Countryside Survey: UK Results from 2007**. NERC/Centre for Ecology & Hydrology, 105pp. (CEH Project Number: C03259).
- Firbank, L.G, Barr, C.J., Bunce R.G.H, Furse, M.T., Haines-Young, R., Hornung, M., Howard, D.C, Sheail, J., Sier, A., Smart, S.M. **Assessing stock and change in land cover and biodiversity in GB: an introduction to Countryside Survey 2000**, Journal of Environmental Management, Volume 67, Issue 3, March 2003, Pages 207-218, ISSN 0301-4797.
- Howard, D.C., Barr, C.J. & Scott, W.A. (1998) **The validity of using Countryside Survey sample data from Great Britain to estimate land cover in Scotland**. Journal of Environmental Management, 52, 131-146.
- Howard, D.C., et al (in prep) **The influence of devolution on landscape research in Britain: Adjustments to sampling strategies**, *journal to be determined*.

Jackson, D.L. (2000) **Guidance on the interpretation of the Biodiversity Broad Habitat Classification** (terrestrial and freshwater types): Definitions and the relationship with other classifications, JNCC Report 307, 73 pages, ISSN 0963 8091 (available online at: <http://www.jncc.gov.uk/page-2433>).

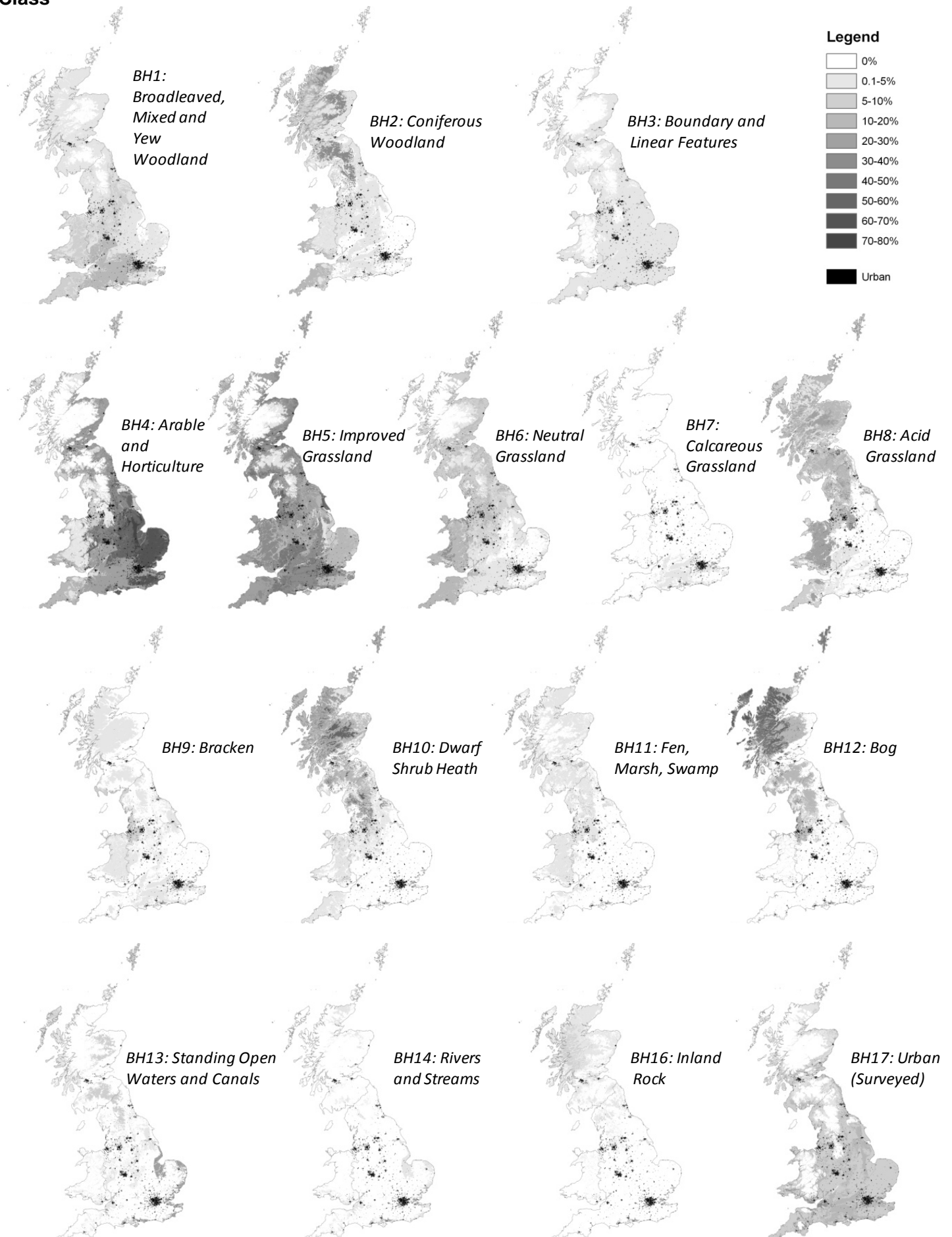
Jones, P.J., Rehman, T., Harvey, D.R., Tranter, R.B., Marsh, J.S., Bunce R.G.H. and Howard, D.C. (1995) **Developing LUAM (Land Use Allocation Model) and modelling CAP reforms**, CAS Paper 32, Centre for Agricultural Strategy, The University of Reading (1995).

Maskell, L.C., Norton, L.R., Smart, S.M., Carey, P.D., Murphy, J., Chamberlain, P.M., Wood, C.M., Bunce, R.G.H. & Barr, C.J. (2008) **CS Technical Report No.1/07 Field Mapping Handbook** Centre for Ecology and Hydrology (Natural Environment Research Council).

Mitchell, C.P., Brandon, O.H., Bunce, R.G.H., Barr, C.J., Tranter, R.B., Downing, P., Pearce, M.L. & Whittaker, H.A. (1982). **Land availability for production of wood energy in Great Britain**. In: Energy from biomass, edited by A. Strub, P. Chartier & G. Schleser, 159-163. (Proc. European Community Conf., 2nd, Berlin, 1982). London: Applied Science.

Wood, C.M. (2008) **CS1978 – Data Rescue. Scoping study for digitizing Countryside Survey primary field data documents. Final Report**. NERC/Centre for Ecology & Hydrology, 15pp.

Appendix i: Maps to show 1978 Broad Habitat Stock estimates represented as percentages by Land Class



Appendix ii: Habitat Code Lookup Table

1978 Code	1978 Description	Broad Habitat Allocation ^{1,2}
1	Perennial rye-grass ley	Improved Grassland
2	Italian rye-grass ley	Improved Grassland
3	Rye-grass/cock's-foot ley	Improved Grassland
4	Cock's-foot ley	Improved Grassland
5	Unspecified ley	Improved Grassland
6	Cut hay/silage	Improved Grassland
7	Perennial rye-grass pasture	Improved Grassland
7	Perennial rye-grass pasture	Neutral Grassland
8	Mixed permanent pasture	Neutral Grassland
9	Improved pasture	Improved Grassland
10	Neglected pasture	Neutral Grassland
11	Bent/fescue pasture	Acid Grassland
11	Bent/fescue pasture	Calcareous Grassland
12	Mixed upland pasture	Acid Grassland
12	Mixed upland pasture	Fen Marsh and Swamp
13	Rush infested	Acid Grassland
13	Rush infested	Fen Marsh and Swamp
14	Bracken infested	Acid Grassland
15	Hair-grass/mat-grass	Acid Grassland
16	Heather	Dwarf Shrub Heath
17	Bilberry	Dwarf Shrub Heath
18	Bracken	Bracken
18	Bracken	Acid Grassland
18	Bracken	Dwarf Shrub Heath
18	Bracken	Fen Marsh and Swamp
19	Rush marshland	Fen Marsh and Swamp
20	Purple moor-grass	Purple Moor Grass Rush Pasture
20	Purple moor-grass	Fen Marsh and Swamp
20	Purple moor-grass	Dwarf Shrub Heath
20	Purple moor-grass	Bog
21	Hare's-tail cotton grass	Bog
21	Hare's-tail cotton grass	Blanket bog
22	(Unassigned)	No allocation
23	Herb-rich pasture	Calcareous Grassland
23	Herb-rich pasture	Dwarf Shrub Heath
23	Herb-rich pasture	Acid Grassland

24	Ploughed/fallow	Arable and Horticulture
25	Derelict	Urban
26	Wheat	Arable and Horticulture
27	Barley	Arable and Horticulture
28	Oats	Arable and Horticulture
29	Sugar beet	Arable and Horticulture
30	Kale	Arable and Horticulture
31	Roots	Arable and Horticulture
32	Potatoes	Arable and Horticulture
33	Horticulture	Arable and Horticulture
34	Beans/peas	Arable and Horticulture
35	Orchards	Arable and Horticulture
36	Roads	Boundary and linear features
37	Urban	Urban
38	(Unassigned)	No allocation
39	Railway	Urban
40	Cliffs/sand/mud	Supra-littoral rock
40	Cliffs/sand/mud	Inland Rock
40	Cliffs/sand/mud	Littoral Sediment
40	Cliffs/sand/mud	Supra-littoral sediment
41	Canal/stream	Rivers and Streams
41	Canal/stream	Standing Open waters and canals
42	Lake	Standing Open waters and canals
43	Quarry/pit	Inland Rock
44	Formal recreation areas	Urban
44	Formal recreation areas	Improved Grassland
45	(Unassigned)	No allocation
46	Rock	Inland Rock
46	Rock	Supra-littoral rock
47	Hardwood copse	Broadleaved Mixed and Yew woodland
48	Mixed copse	Broadleaved Mixed and Yew woodland
49	Conifer copse	Coniferous woodland
50	Hardwood shelter belt	Broadleaved Mixed and Yew woodland
51	Mixed shelter belt	Broadleaved Mixed and Yew woodland
52	Conifer shelter belt	Coniferous woodland
53	Gillside wood	Broadleaved Mixed and Yew woodland
54	Scrub	Broadleaved Mixed and Yew woodland
55	Hardwood	Broadleaved Mixed and Yew woodland
56	Conifer woodland	Coniferous woodland
57	Mixed woodland	Broadleaved Mixed and Yew woodland
58	Timothy	Improved Grassland
59	Lucerne	Arable and Horticulture
60	Maize	Arable and Horticulture

61	Mat-grass	Acid Grassland
62	Mixed peatland	Bog
62	Mixed peatland	Blanket bog
63	Subarctic vegetation	Montane
63	Subarctic vegetation	Dwarf Shrub Heath
63	Subarctic vegetation	Bog
64	Bilberry mixture	Dwarf Shrub Heath
65	Cross-leaved heath	Bog
66	Rye	Arable and Horticulture
67	Heath rush	Acid Grassland
68	Mixed upland grassland	Acid Grassland
69	Mixed upland moor	Dwarf Shrub Heath
69	Mixed upland moor	Bog
69	Mixed upland moor	Acid Grassland
69	Mixed upland moor	Blanket bog
70	Deergrass/heather	Bog
70	Deergrass/heather	Blanket bog
71	Rush mixture	Bog
71	Rush mixture	Blanket bog
72	Heather/cotton grass	Bog
72	Heather/cotton grass	Blanket bog
73	Heather/bilberry	Dwarf Shrub Heath
74	Burnt	Dwarf Shrub Heath
75	Parkland	Neutral Grassland
76	Maritime grassland	Supra-littoral rock
77	Oilseed rape	Arable and Horticulture
78	Oats/barley	Arable and Horticulture
79	Salt marsh	Salt marsh
79	Salt marsh	Littoral Sediment
80	New urban	Urban
81	Sea	Sea
999	Unsurveyed	No allocation

1. Where alternatives to the Broad Habitat Allocation were identified, species data were inspected where available to determine the correct allocation.
2. Priority Habitats Saltmarsh, Blanket Bog and Purple Moor Grass Rush Pasture were identifiable from the data available

Appendix iii: Summary of the ITE Land Classification

Brief History of the ITE Land Classification

1. 1978 - Initial Land Classification (& 1st Field Survey)

- ISA (*Indicator Species Analysis*) used to create 32 classes from environmental variables from 1228 1km squares (centre squares of 15x15km grid, 1215 of the 1228 were classified).
- Later, 4 squares surrounding original centre square classified. Total: 6039 km squares.
- Area of each Land Class estimated using the 6039 classified squares as proportions of GB.
- 8 km squares per Land Class surveyed (total 256).
- National estimates of habitat areas (from field survey) calculated by:

Mean area of habitat per square in each Land Class x area of that Land Class

Estimates later published in: Bunce, R.G.H. & Heal, O.W. (1984) *Landscape evaluation and the impact of changing land use on the rural environment: the problem and an approach*. Planning and Ecology (eds R. D. Roberts & T. M. Roberts), pp. 164-188. Chapman and Hall, London.

2. 1984 - 2nd Field Survey

- 2nd field survey, 12 km squares surveyed per land class (total 384).
- National estimate calculations used 1978 Land Classification

Limited results published in: Barr, C.J., Benfield, C.B., Bunce, R.G.H., Ridsdale, H. & Whittaker, M. (1986) *Landscape Changes in Britain*. Institute of Terrestrial Ecology.



3. 1990 - 'All Squares' Land Classification (& 3rd Field Survey)

- Land Classification revised to incorporate data from all 1km squares in GB. Conservative revision, but some survey squares changed class. Urban and sea corrections incorporated.
- 3rd Field Survey, 508 km squares surveyed.
- National estimate calculations used 1990 Land Classification

Results published in: Barr, C.J.; Bunce, R.G.H.; Clarke, R.T.; Fuller, R.M.; Furse, M.T.; Gillespie, M.K.; Groom, G.B.; Hallam, C.J.; Hornung, M.; Howard, D.C.; Ness, M.J.. (1993) *Countryside Survey 1990: main report*. (CS 1990 vol.2). London, Department of the Environment, 174pp.



4. 1998 - Revised Land Classification (& 4th Field Survey)

- 4th field survey, 569 km squares surveyed
- 1990 Land Classification updated to allow separate Scottish reporting of national estimates. Number of Land Classes increased to 40.

Results published in: Haines-Young, R.H. et al (2000) *Accounting for nature: assessing habitats in the UK countryside*, DETR, London ISBN 1 85112 460 8



5. 2007 - Revised Land Classification (& 5th Field Survey)

- 5th field survey, 591 km squares surveyed
- 1998 Land Classification updated to allow separate Welsh reporting of national estimates. Number of Land Classes increased to 45.

Results published in: Carey, P.D.; Wallis, S.; Chamberlain, P.M.; Cooper, A.; Emmett, B.A.; Maskell, L.C.; McCann, T.; Murphy, J.; Norton, L.R.; Reynolds, B.; Scott, W.A.; Simpson, I.C.; Smart, S.M.; Ulyett, J.M.. (2008) *Countryside Survey: UK Results from 2007*. NERC/Centre for Ecology & Hydrology, 105pp. (CEH Project Number: C03259).



For further information, refer to: Barr, C.J. (1998) *The Sampling Strategy for Countryside Survey*, DETR CONTRACT No. CR0212