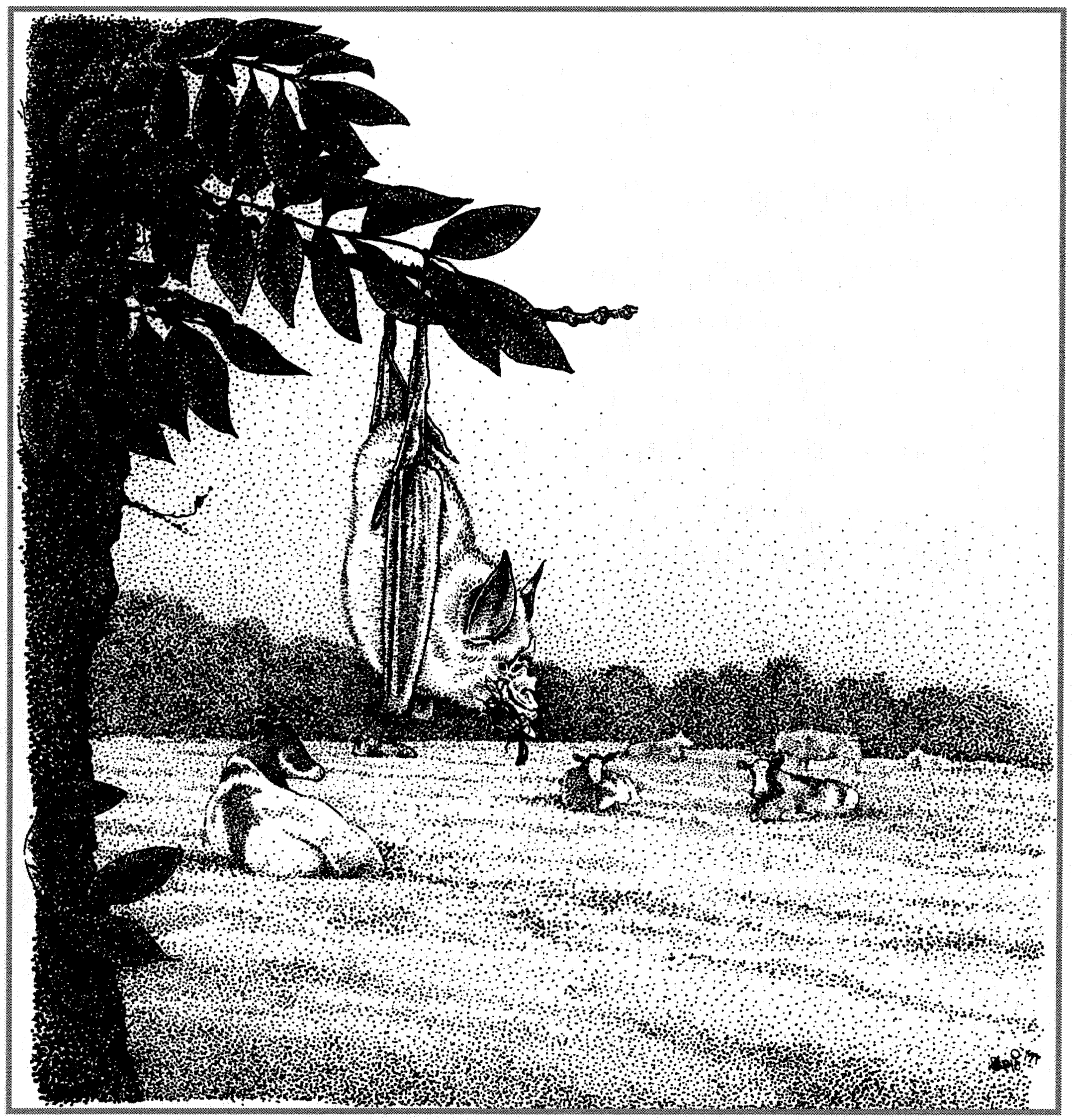
ENGLISH NATURE

Prime Biodiversity Areas

Definition, identification and conservation uses

No. 290 - English Nature Research Reports



working today
for nature tomorrow

English Nature Research Reports

Number 290

Prime Biodiversity Areas: definition, identification and conservation uses

R.G. Jefferson[1], H.J. Robertson[1], M.A. Wilkinson[1], M. Polley[2], C. Reid[1], A. Mitchell-Jones[1], N. Michael[1] & R. Cooke[3]

[1] Lowlands Team, English Nature
[2] Formerly Geographic Information Unit, Information Services Team, English Nature
[3] Strategic Development and Reporting Team, English Nature

ISSN 0967-876X

Contents

1. Introduction

1.1 Origin of the concept

The concept of Prime Biodiversity Areas was first mentioned in a conservation context in *Biodivesity: the UK Action Plan* (Anon 1994) where it formed one of the 59 targets or actions. It was further mentioned in the UK Steering Group Report on Biodiversity (UK Steering Group 1995). In relation to the implementation of national and local Biodiversity Action Plans, the need to identify specific areas of land for priority nature conservation action was expressed. Prime Biodiversity Areas were identified as one type of area that would qualify for such action. They are defined as areas where " particular concentrations of high priority habitats occur". PBAs are not regarded as formal designations but as tracts of countryside where action to conserve existing habitats and species and re-create habitats on intervening land is likely to be most cost-effective.

2. Prime Biodiversity Area project

2.1 Aims and objectives

The reference to PBAs in the UK Action Plan stemmed, in part, from an earlier (1993) internal paper by Dr Leo Batten (English Nature) which considered the role of Natural Areas and PBAs in a pan-European biological and landscape diversity strategy. This opened the debate within English Nature (EN) as to what PBAs are and how they might best be defined.

In 1996, it was decided to initiate a small project to:

- identify at Natural Area level what data might be useful for identifying PBAs and in what form;
- inform a discussion of the possible definition and uses of PBAs;
- provide some initial guidance for English Nature staff on the definition and uses of PBAs.

The aim of the project was not to arrive at a definitive corporate position on PBAs or to develop every conceivable approach to PBA definition.

2.2 The relationship between Natural Areas and Prime Biodiversity Areas

Natural Areas are 'biogeographic zones which reflect the geological foundation, the natural systems and processes and the wildlife in different parts of England, and provide a framework for setting objectives for nature conservation' (The UK Steering Group 1995).

English Nature uses Natural Areas as a framework for much of its work, and as the basis for its nature conservation advice to others (Cooke & Sibbett 1998). By comparing existing data on wildlife distribution against this new framework, we can identify the most important habitats and species groups in each Natural Area. This knowledge can then be used to specify in which Natural Areas national targets should be met, using a consistent approach. For example, National Biodiversity Action Plan targets for England have been broken down into appropriate Natural Area targets.

In 1997, profiles for all 120 Natural Areas were published. These describe the wildlife and natural features of each area and what makes it distinctive. They also discuss the issues currently affecting nature conservation and set out a range of nature conservation objectives.

Although Natural Areas represent an appropriate scale at which to divide England for nature conservation purposes, a finer scale is often required for more targeted local action. In these instances it is necessary to focus down on specific parts of the country, using Natural Areas as a basis, but accepting that in some circumstances the local distribution of specific habitats or species may encompass parts of several Natural Areas. Here, each Natural Area would be highlighted for action nationally, but locally only the relevant part of the Natural Area(s) concerned would be targeted. This is essentially what Prime Biodiversity Areas are - a means to target action at a local, sub-Natural Area level.

2.3 Methodology

A small project Team was established consisting of the following:

Mike Wilkinson (Three Counties Team), Richard Jefferson, Heather Robertson, Chris Reid, Tony Mitchell-Jones, Nick Michael (Lowlands Team) and Marcus Polley (Geographic Information Unit).

The project focused on the lowlands as it was considered that this was where the PBA approach would probably have most relevance. Many upland areas are relatively discrete and often support large tracts of semi-natural vegetation and some could be considered to be PBAs in their own right, depending on how PBAs are defined.

Within the lowlands, it was initially decided to select a few Natural Areas to use as pilots. Selection was pragmatic, ie pilot areas needed to support at least some priority habitats/species for which there were easily available datasets and it was also considered desirable to select contrasting Natural Areas in terms of types of habitats/species present and landscape type/pattern. Initially five Natural Areas were chosen, namely the Yorkshire Wolds, Dean Plateau & Wye Valley, Low Weald & Pevensey, High Weald, and the Vale of York & Mowbray. Ultimately, however, presentation of information has also included some additional adjoining Natural Areas and use was also made of information from the Cotswolds Natural Area.

A range of datasets were used for this project. These were easily available and in an appropriate format for use in MapInfo. These included English Nature (EN) habitat inventories, species distribution data and data on Sites of Special Scientific Interest (SSSI). Examples for use in this report were selected from the wide range of GIS analysis carried out on the data.

The examples presented used the following datasets:

- EN Lowland Grassland Inventory (see Jefferson *et al* 1997 for rationale and methodology).

- EN/RSPB Lowland Heathland Inventory (see English Nature 1994-1996, Evans *et al* 1994 for rationale and methodology).

- EN Ancient Woodland Inventory (see Spencer & Kirby 1992).
- EN data on the distribution of flood-meadows (see Jefferson 1997).
- Distribution data for woodland butterflies in the Dean Plateau & Wye Valley (supplied by Guy Meredith, Gloucestershire Naturalists' Society).
- EN bat distribution/roost data.
- EN dormouse distribution data from the Great Nut Hunt.
- Distribution data for rare/scarce vascular plants (source Biological Records Centre, ITE).
- SSSI area data.

In some cases, the data were manipulated prior to input into MapInfo; this is explained in further detail in the commentary on each of the maps in section 3. The data type varied but included point source, area, presence/absence in a 1km square, area/1 km square and species number/1 km square.

The results are presented as a series of map outputs together with a brief commentary on each.

3. Results

Figures 1-12 are a selection of examples to illustrate different approaches to the use of data for identifying and defining PBAs and represent the outputs from the project. With the exception of Fig 9, no attempt has been made to fix boundaries on potential PBAs identified by the approaches adopted.

The underlying assumption is that PBAs are concentrations of habitats/species of high priority for nature conservation value and can be defined for both single and habitat/multi-species interest features.

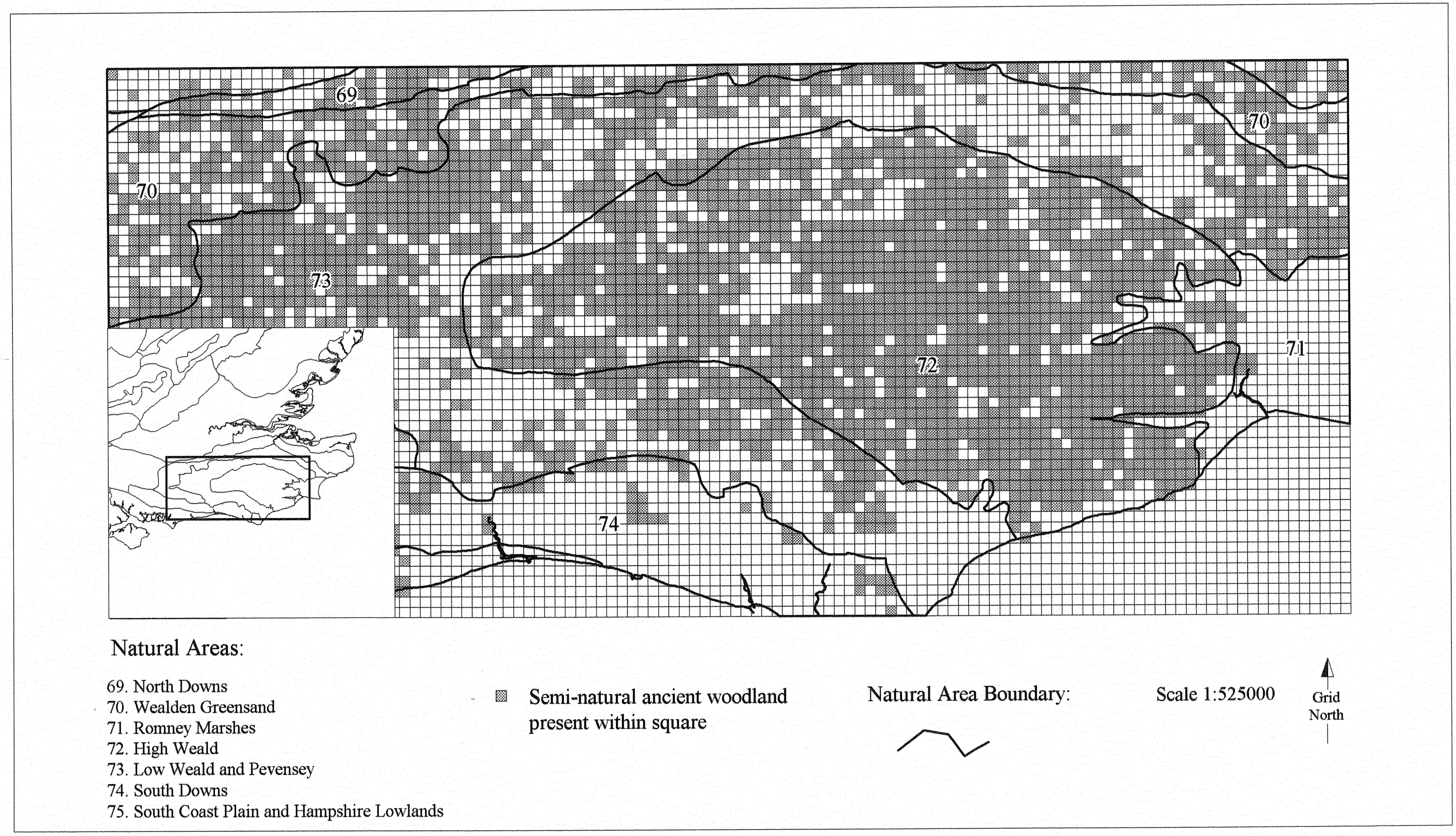
Figure 1: Presence of semi-natural Ancient Woodland in the High Weald

This plot shows the simple presence/absence of ancient semi-natural woodland in 1 km squares in the High Weald Natural Area. This shows that ancient woodland is abundant across the Natural Area and there is little scope for identifying PBAs for ancient woodland at sub-Natural Area scale using data in this form.

Figure 2: Extent of semi-natural Ancient Woodland in the High Weald

This is a plot showing the distribution and area of semi-natural ancient woodland against a 1 km square backdrop. Despite the refinement of showing area of woodland using proportional circles the conclusion is that given the abundance and spread of such woodland across the Natural Area there may be little merit in trying to select a woodland PBA at a smaller scale than the Natural Area in this instance.

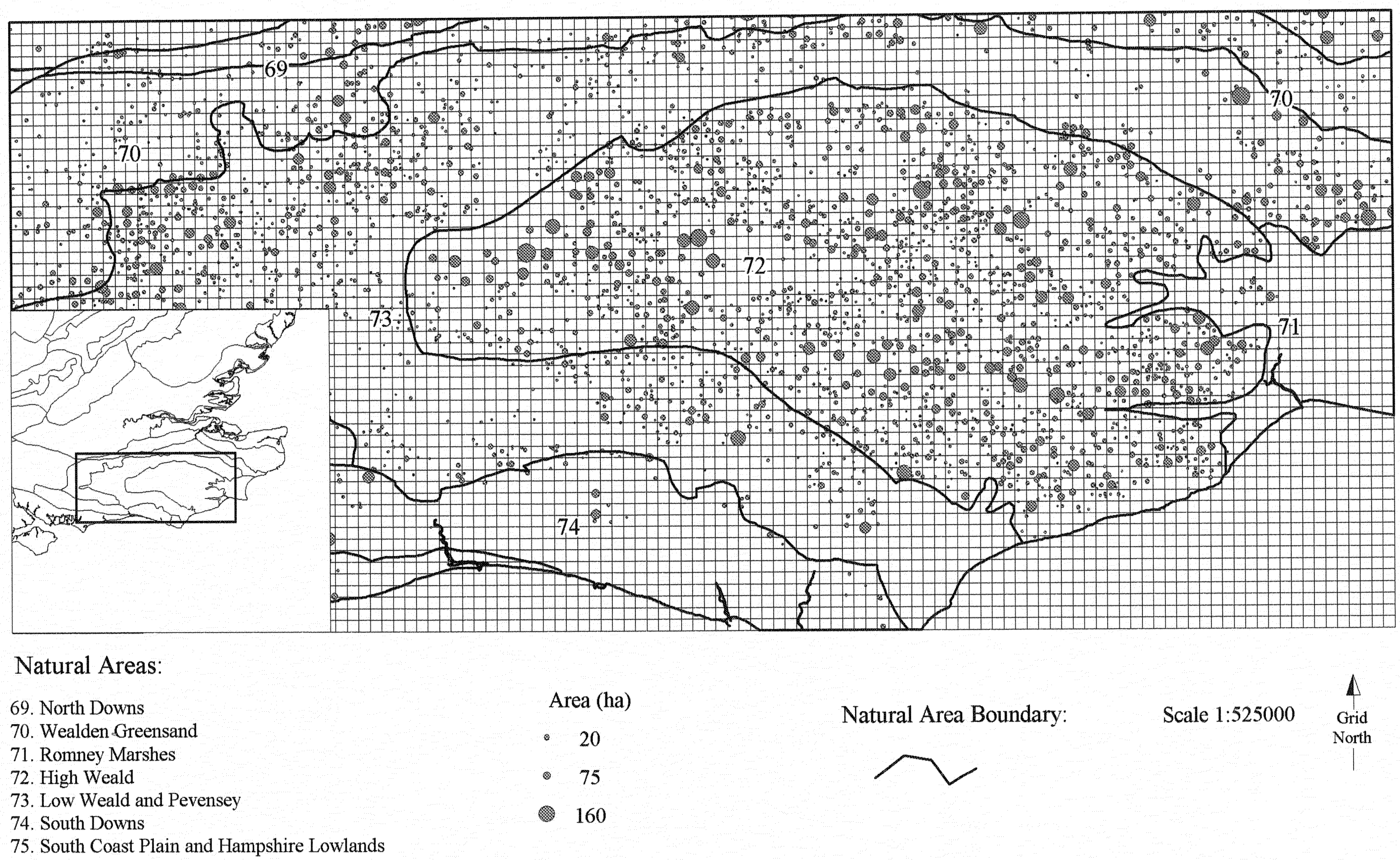
Figure 1 Semi-Natural Ancient Woodland in the High Weald



Natural Areas Revised to December 1996

Produced by English Nature, Northminster House, Peterborough PE1 1UA.

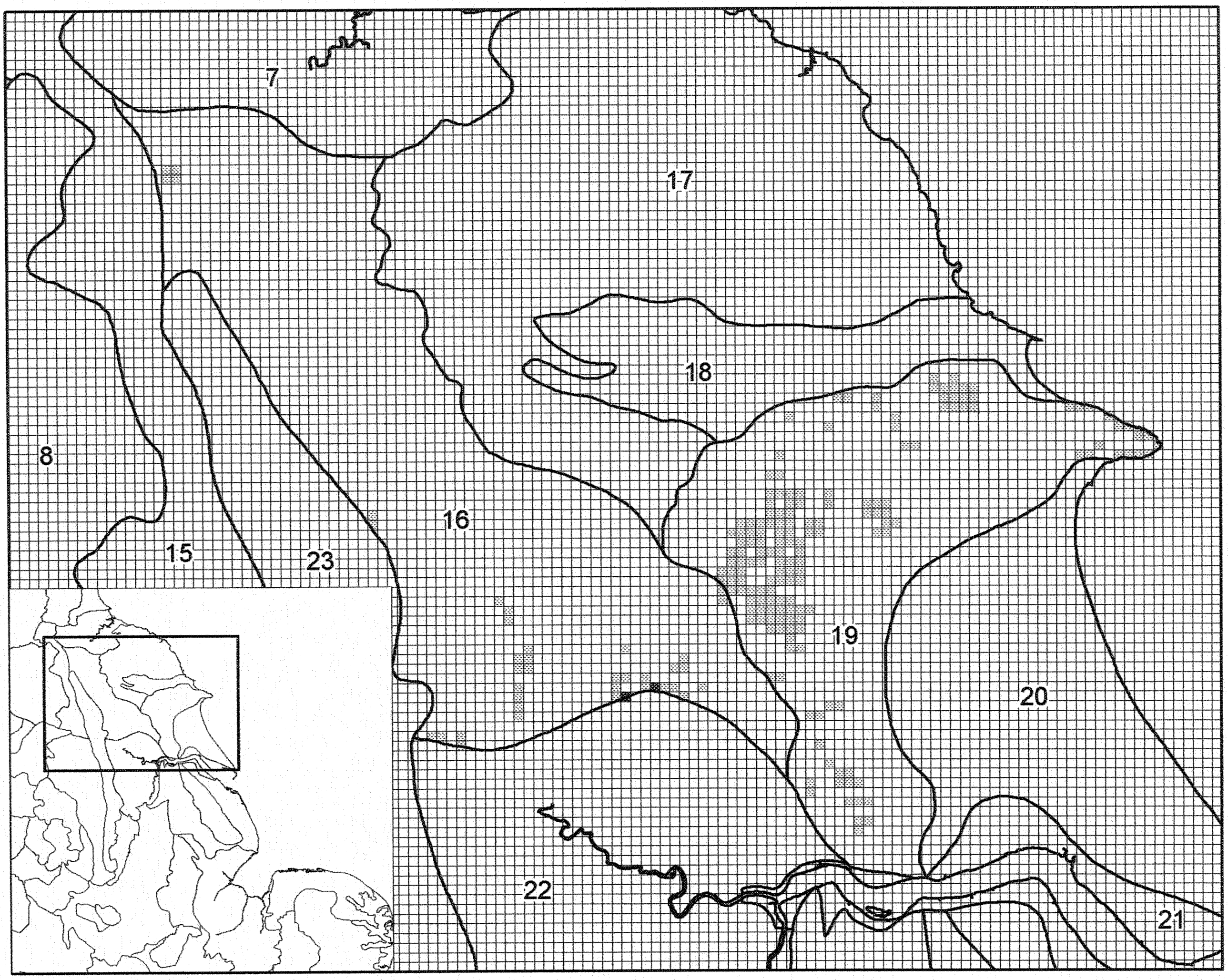
Figure 2 Semi-Natural Ancient Woodland in the High Weald



Produced by English Nature, Northminster House, Peterborough PE1 1UA.

Natural Areas Revised to December 1996

Figure 3 Grassland Score in North-East England



Natural Areas:

7. Tees Lowlands
8. Yorkshire Dales
15. Pennine Dales Fringe
16. Vale of York and Mowbray
17. North York Moors and Hills
18. Vale of Pickering
19. Yorkshire Wolds
20. Holderness
21. Humber Estuary
22. Humberhead Levels
23. Southern Magnesian Limestone

Grassland Score

1
3

Scale 1:750000

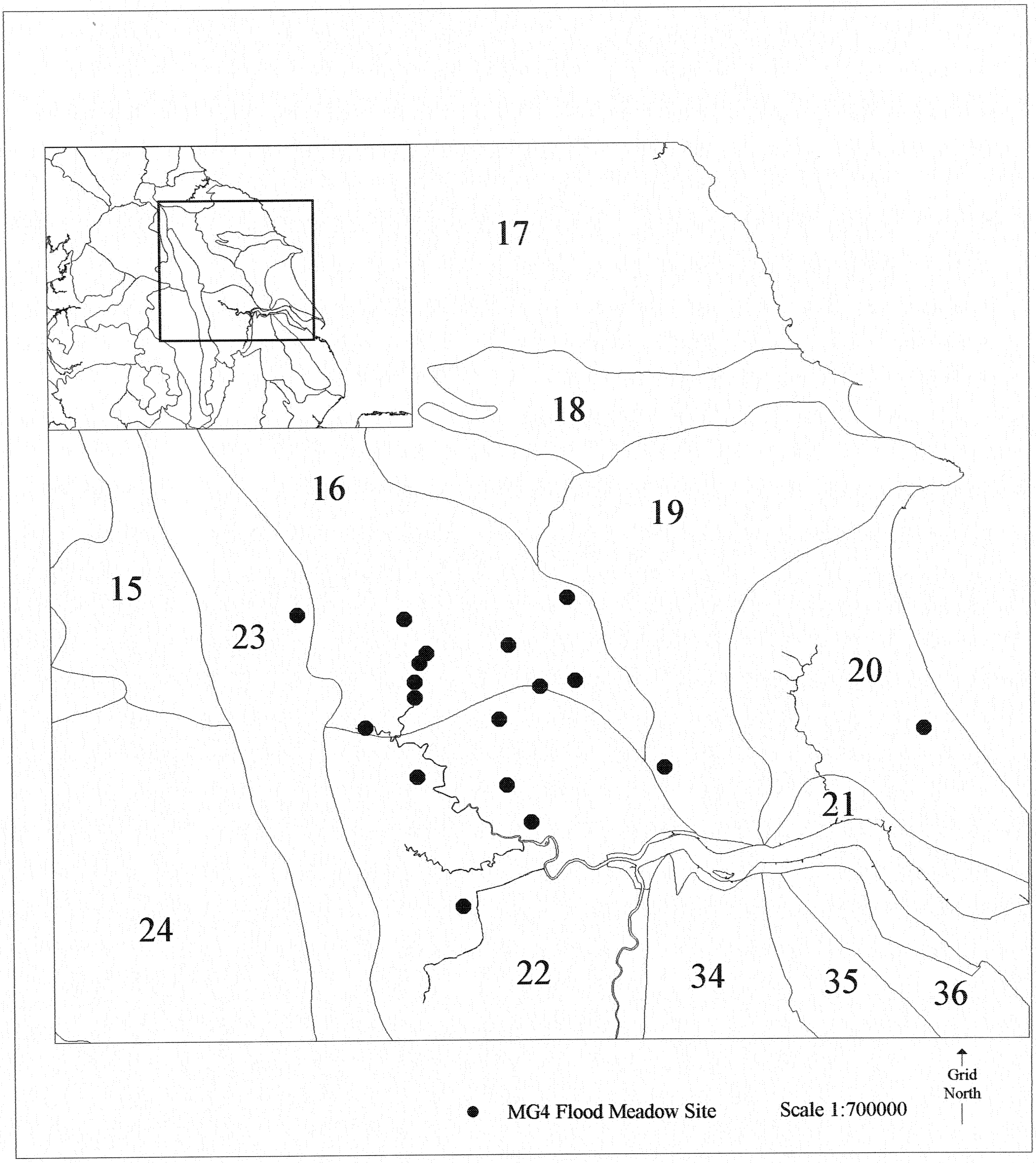
Grid North

Natural Area Boundary:

Natural Areas Revised to December 1996

Produced by English Nature, Northminster House, Peterborough PE1 1UA.

Figure 4 Distribution of MG4 Flood Meadow Sites by Natural Area in North East England

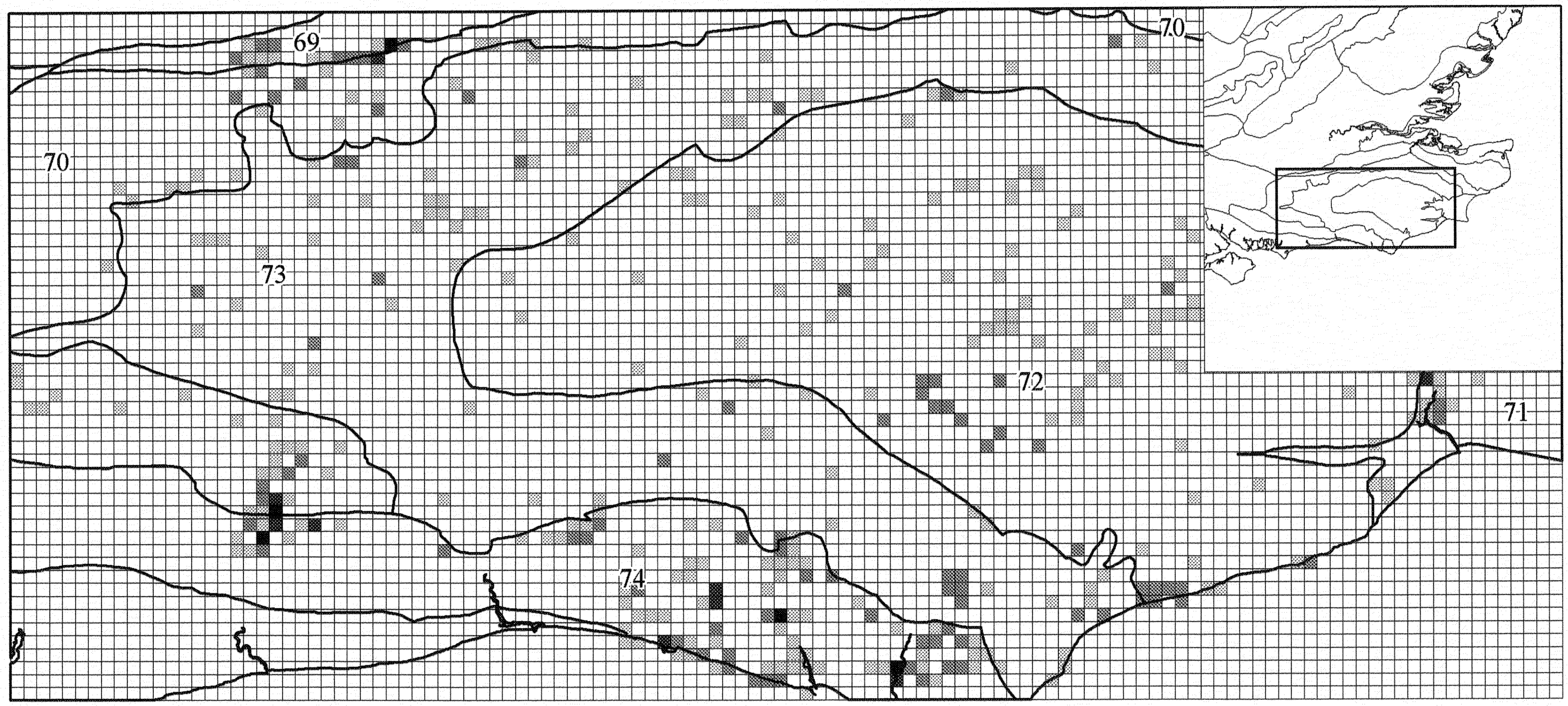


15. Pennine Dales Fringe
16. Vale of York and Mowbray
17. North York Moors and Hills
18. Vale of Pickering
19. Yorkshire Wolds
20. Holderness
21. Humber Estuary
22. Humberhead Levels
23. Southern Magnesian Limestone
24. Coal Measures
34. North Lincolnshire Coversands and Clay Vales
35. Lincolnshire Wolds
36. Lincolnshire Coast and Marshes

Revised to August 1996

Produced by English Nature, Northminster House, Peterborough PE1 1UA.

Figure 5 Rare and Scarce Plants in South-East England



Natural Areas:

69. North Downs
70. Wealden Greensand
71. Romney Marshes
72. High Weald
73. Low Weald and Pevensey
74. South Downs
75. South Coast Plain and Hampshire Lowlands

Rare and scarce plant score

- 6 to 7
- 4 to 5
- 2 to 3
- 1

Natural Area Boundary:

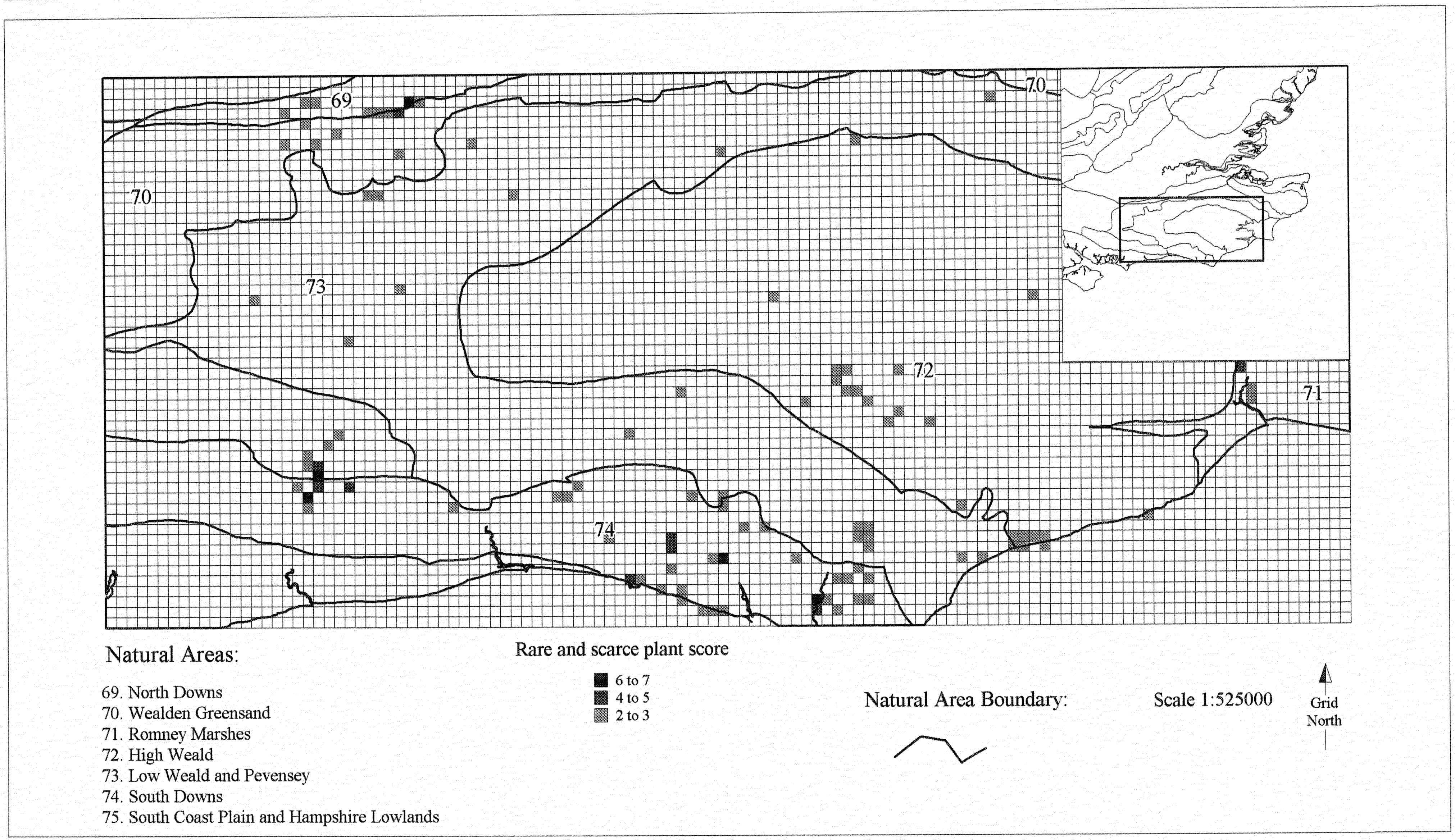
Scale 1:525000

Grid North

Produced by English Nature, Northminster House, Peterborough PE1 1UA.

Natural Areas Revised to December 1996

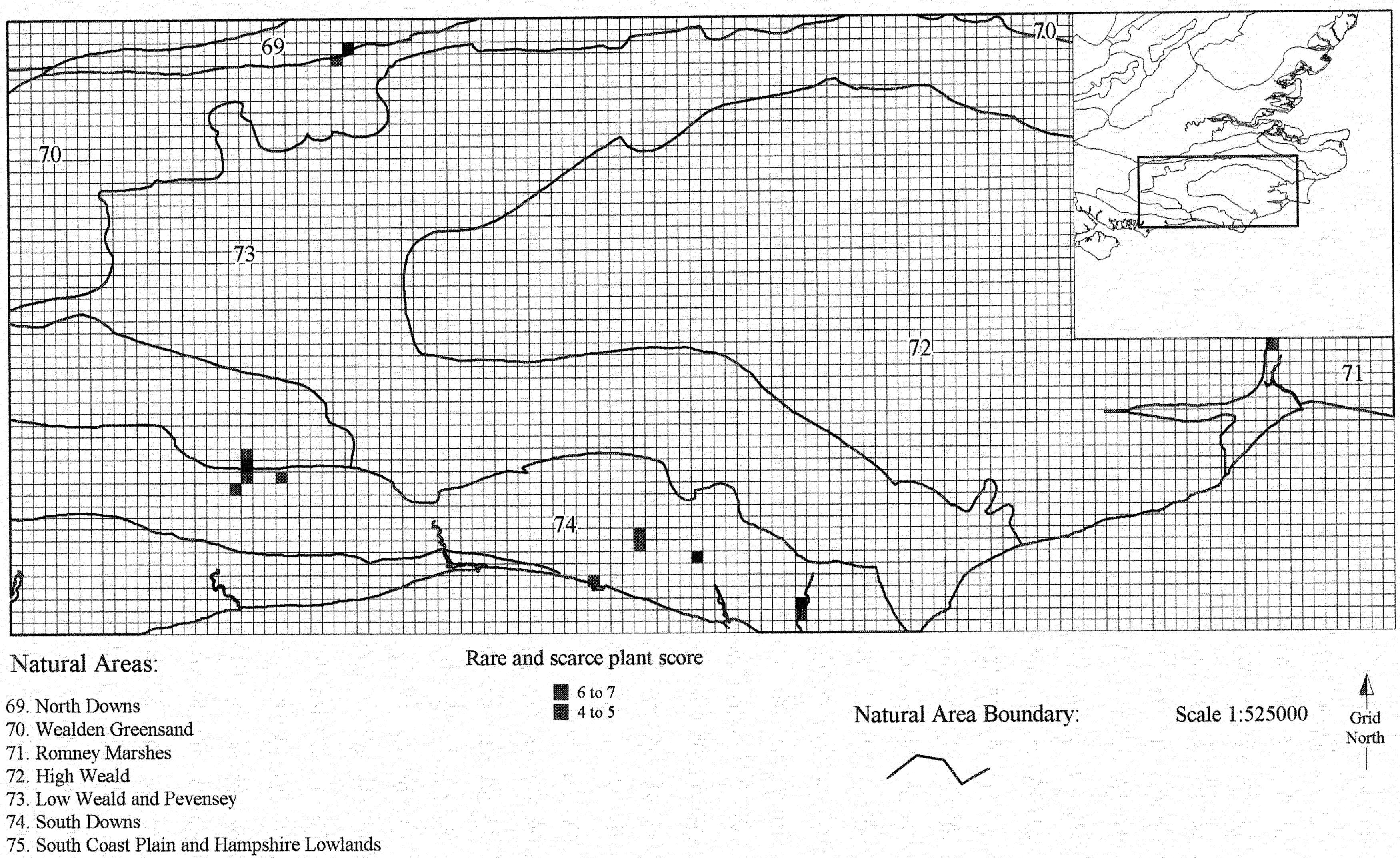
Figure 6 Rare and Scarce Plants in South-East England



Produced by English Nature, Northminster House, Peterborough PE1 1UA.

Natural Areas Revised to December 1996

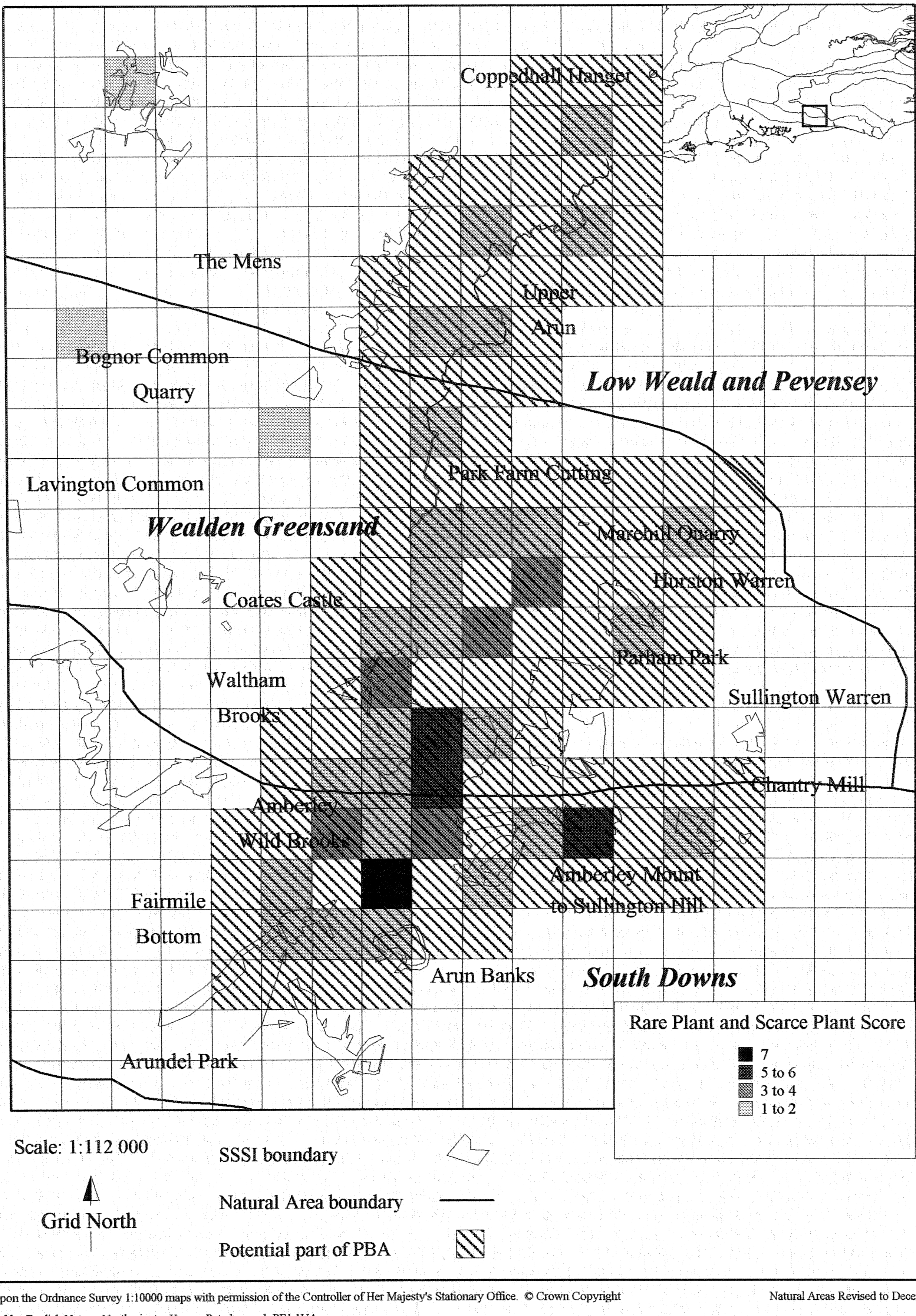
Figure 7. Rare and Scarce Plants in South-East England



Produced by English Nature, Northminster House, Peterborough PE1 1UA.

Natural Areas Revised to December 1996

Figure 8 Nationally Rare and Scarce Plant Scores Across Three Natural Areas

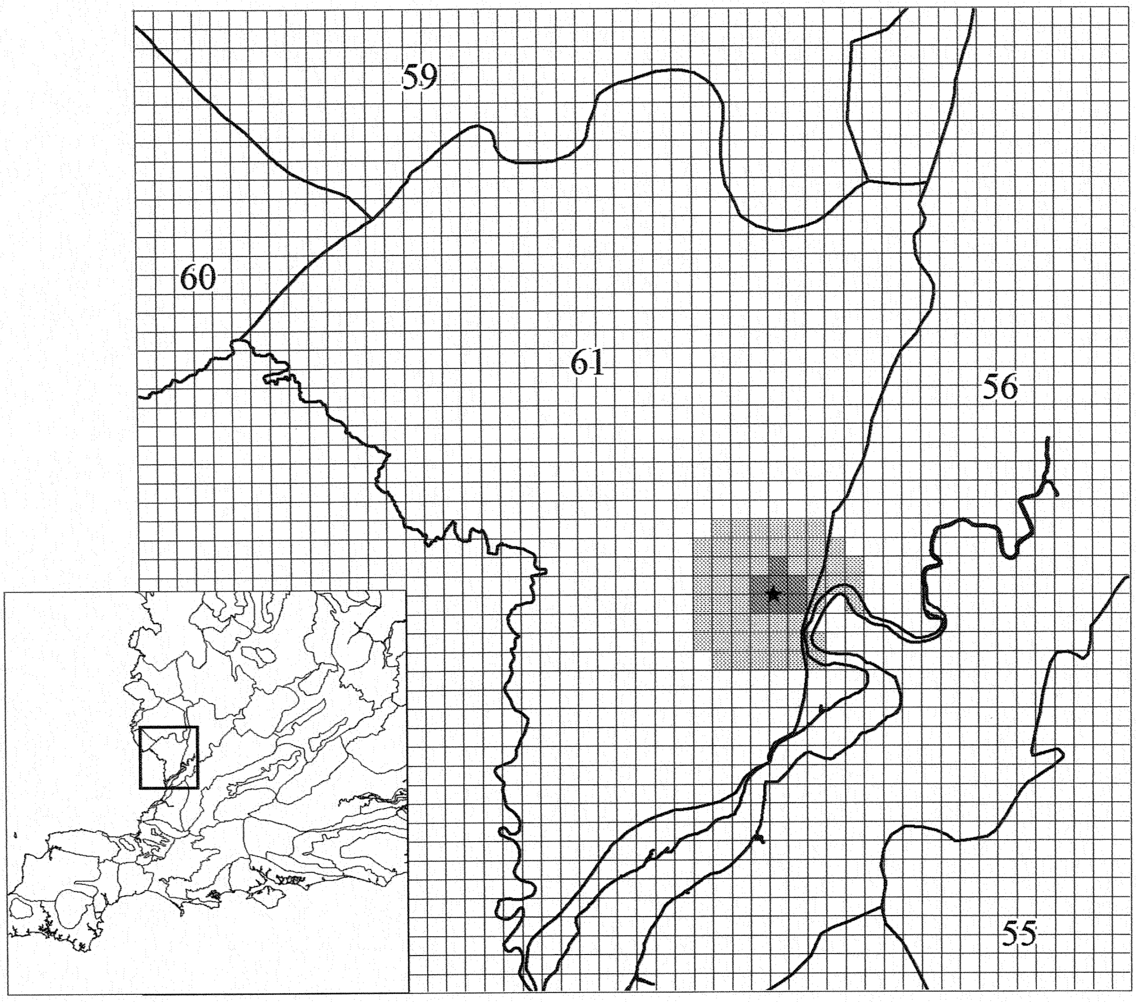


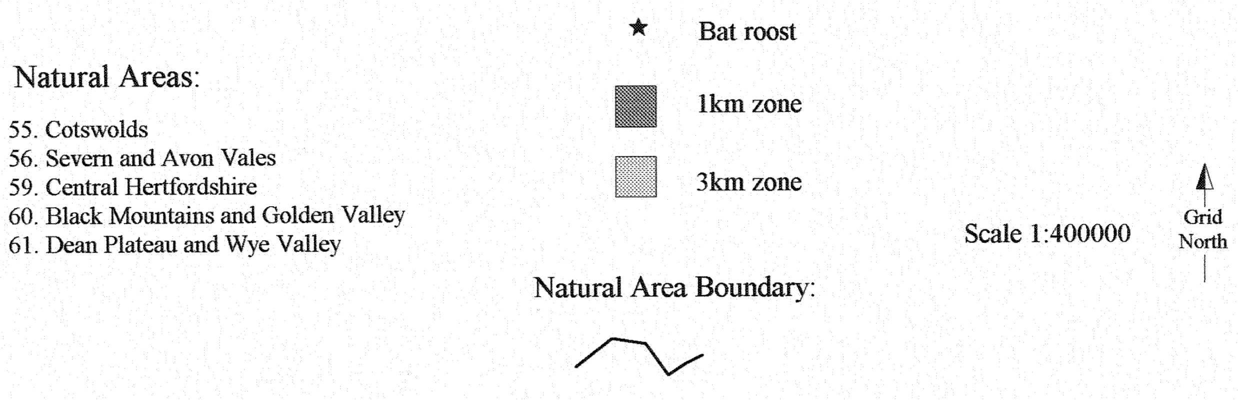
Based upon the Ordnance Survey 1:10000 maps with permission of the Controller of Her Majesty's Stationary Office. © Crown Copyright

Natural Areas Revised to December 1996

Produced by English Nature, Northminster House, Peterborough PE1 1UA.

Figure 9 Horseshoe Bat Feeding Area

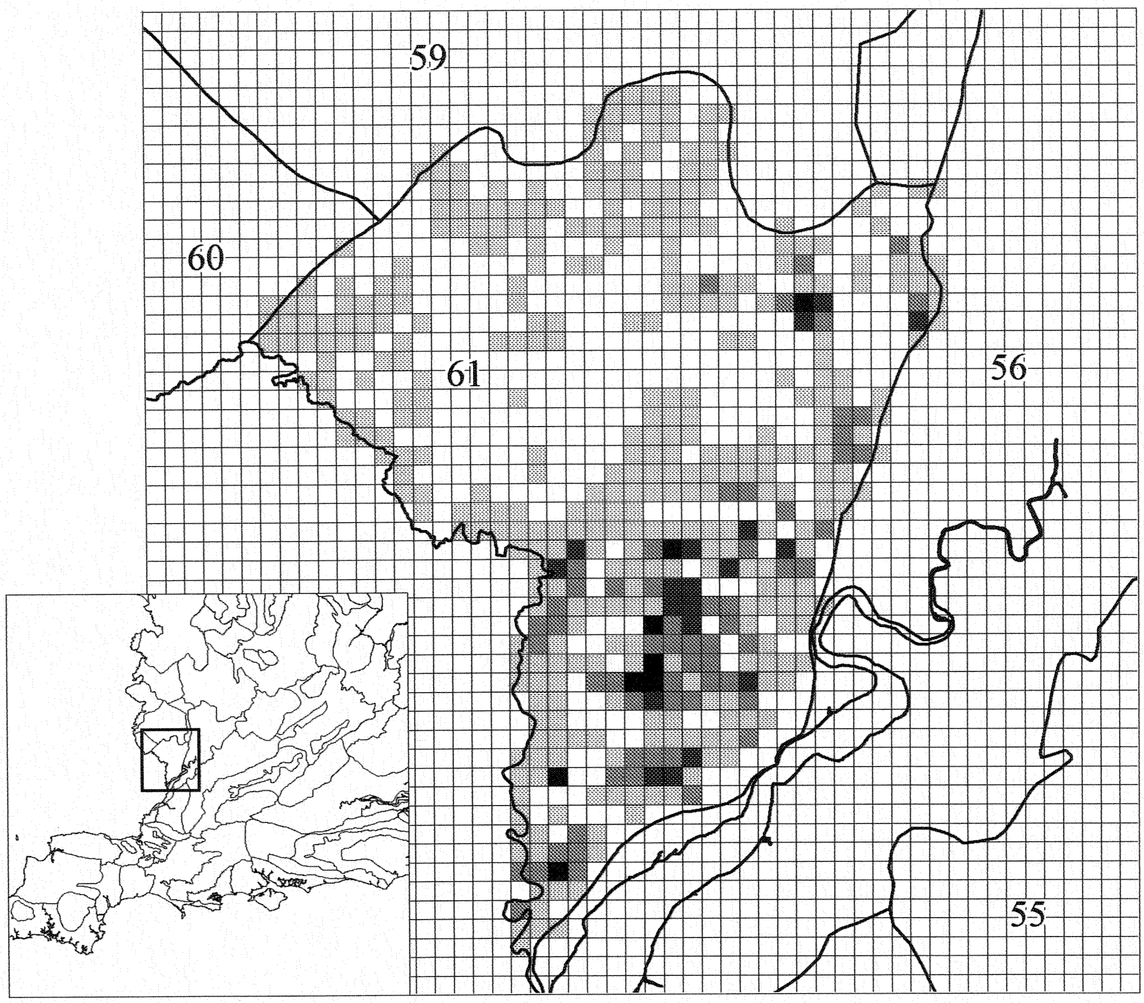




Produced by English Nature, Northminster House, Peterborough PE1 1UA.

Natural Areas Revised to December 1996

Figure 10 Woodland Biodiversity



Natural Areas:

55. Cotswolds
56. Severn and Avon Vales
59. Central Hertfordshire
60. Black Mountains and Golden Valley
61. Dean Plateau and Wye Valley

Variety Score

- 7 to 8
- 4 to 6
- 2 to 3
- 1

Natural Area Boundary:

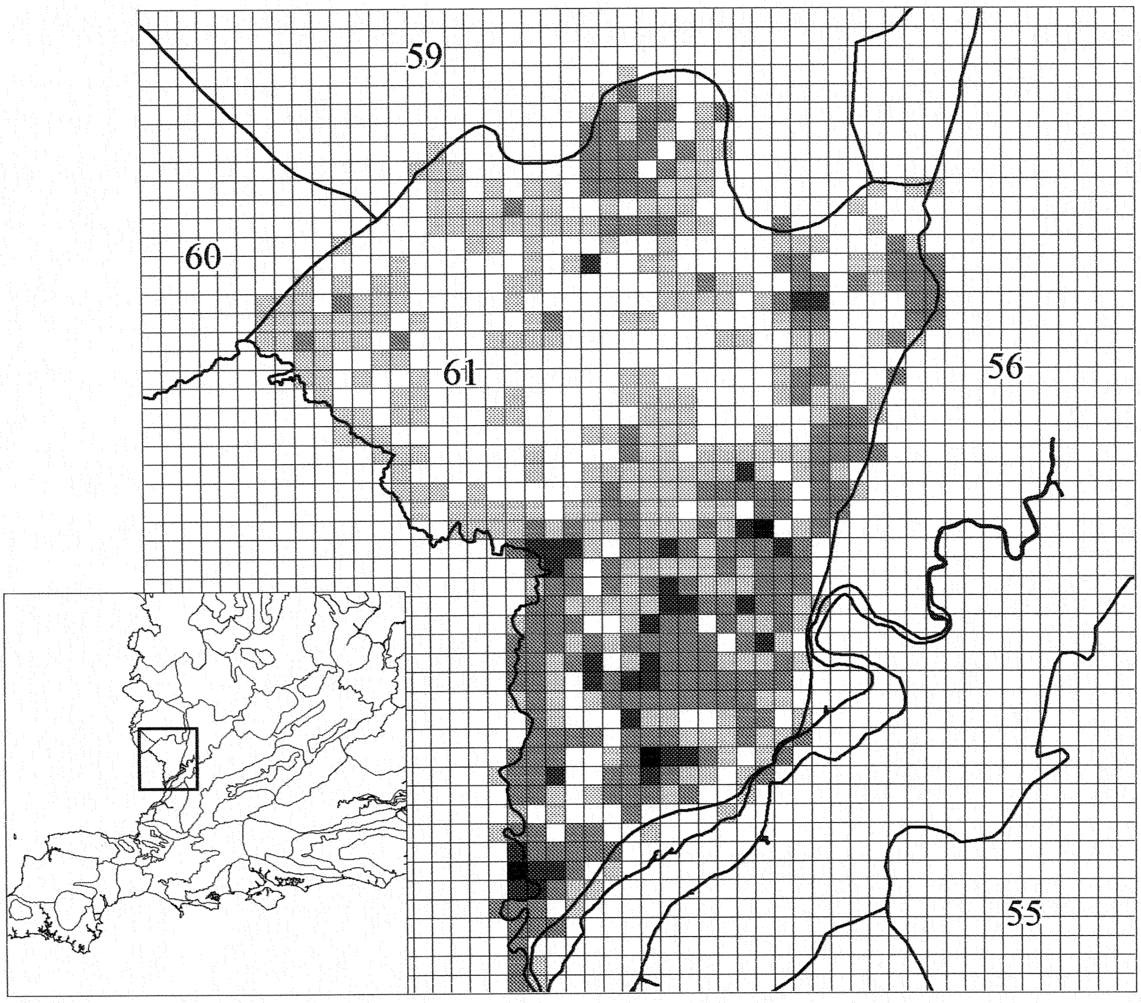
Scale 1:400000

Grid North

Produced by English Nature, Northminster House, Peterborough PE1 1UA.

Natural Areas Revised to December 1996

Figure 11 Biodiversity in the Dean Plateau and Wye Valley Natural Area



Natural Areas:

55. Cotswolds
56. Severn and Avon Vales
59. Central Hertfordshire
60. Black Mountains and Golden Valley
61. Dean Plateau and Wye Valley

Variety Score

- 11 to 18
- 6 to 10
- 2 to 5
- 1

Natural Area Boundary:

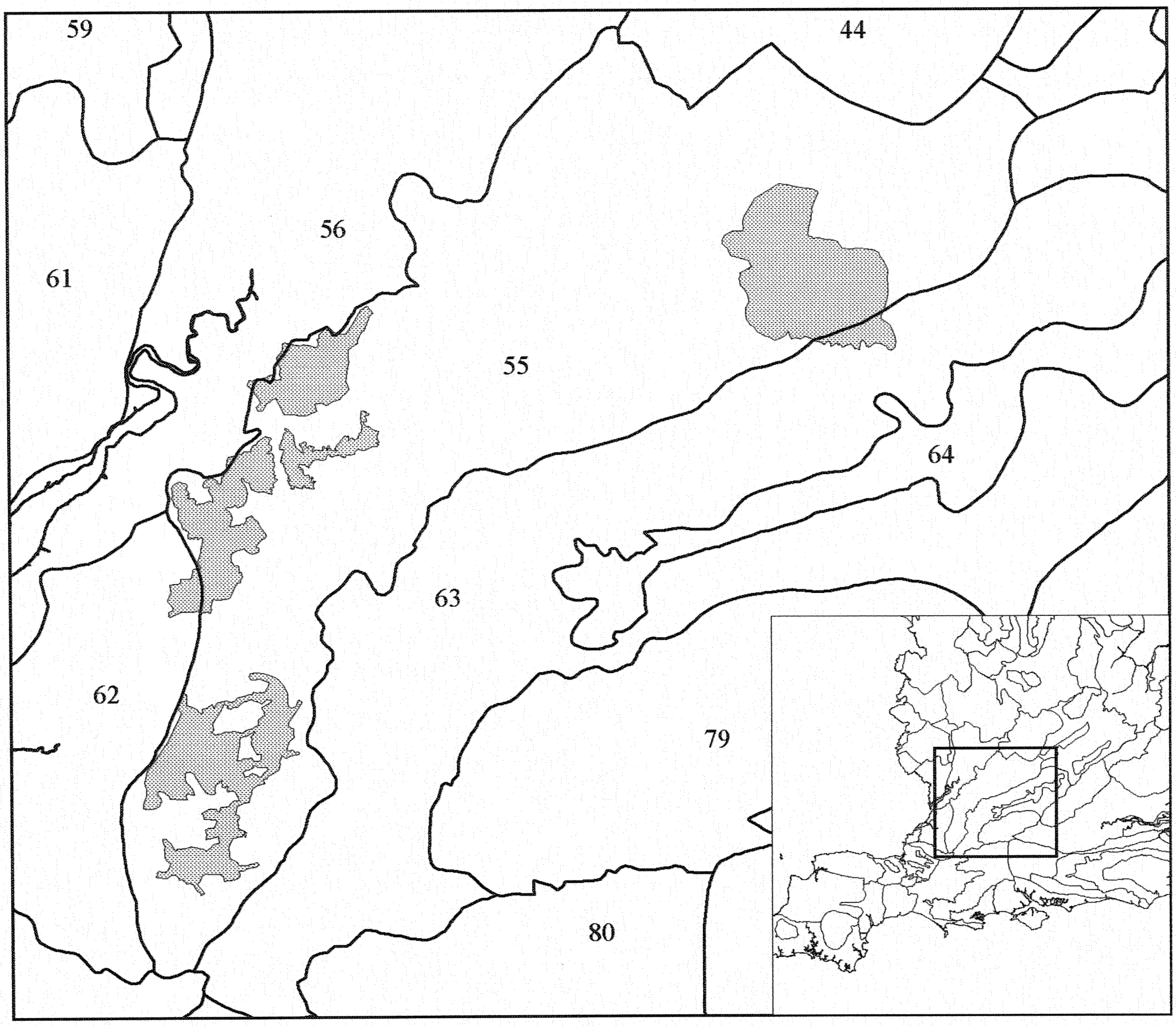
Scale 1:400000

Grid North

Produced by English Nature, Northminster House, Peterborough PE1 1UA.

Natural Areas Revised to December 1996

Figure 12 Location of Five Provisional Grassland and Woodland Prime Biodiversity Areas in the Cotswolds Natural Area



Natural Areas:

44. Midland Clay Pastures
55. Cotswolds
56. Severn and Avon Vales
59. Central Hertfordshire
61. Dean Plateau and Wye Valley
62. Bristol, Avon Valleys and Ridges
63. Thames and Avon Vales
64. Midvale Ridge
79. Berkshire and Marlborough Downs
80. South Wess

Provisional PBA

Natural Area Boundary:

Scale 1:770000

Grid North

Produced by English Nature, Northminster House, Peterborough PE1 1UA.

Natural Areas Revised to December 1996

Figure 3: Grassland score in North-East England

This plot used Grassland Inventory data for the Vale of York & Mowbray and Yorkshire Wolds Natural Areas. The inventory data consists of sites mapped onto 1:50000 OS maps originally reduced from 1:25000. This information was converted into scores for 1 km squares. One km squares were scored as follows 0 = no grassland; 1 = <50% cover of grassland or 3 = 50-99% coverage and 5= 100% cover. In this plot there were no squares with 100% occupancy of semi-natural grassland. The example shows that where a habitat is localised, data expressed in this form can readily be used to identify a number of PBAs within Natural Areas.

Figure 4: Distribution of MG4 flood meadow sites by Natural Area in North-East England

This shows the distribution of sites of the MG4 *Alopecurus pratensis - Sanguisorba officinalis* grassland type described by the National Vegetation Classification (Rodwell 1992) in a selection of Natural Areas in North-East England. Each dot represents the centroid of a site containing MG4 grassland. Data are taken from a review of the distribution of this grassland type (Jefferson 1997). MG4 is a rare grassland type of high nature conservation value which occurs in lowland river flood plains. It is listed on Annex 1 of the Habitats and Species Directive. Although, at first glance concentrations are not immediately apparent, there are two important concentrations, the first is associated with the River Ouse and its tributaries and the second with the River Derwent catchment. These are essentially linear PBAs and both cut across (North to South) the Vale of York & Mowbray and Humberhead Levels Natural Areas. This plot would need further refinement if it is to be used to identify PBAs for flood meadows. Use of a cover score per 1 km square may help (see Figure 3 which covers part of the same area) and, if definition of a hard boundary is deemed necessary, reference back to site boundaries would be required. It also illustrates the need to have reference geographic information such as watercourses.

Figures 5-8. Rare and scarce Plants in South-East England

Figure 5

This plot shows the distribution by 1 km square of nationally rare and scarce vascular plant species across selected Natural Areas in South-east England. Nationally rare plants are defined as those occurring in less than 15 10 km squares in Great Britain while Nationally scarce species occur in 16-100 km squares (see Stewart, Pearman & Preston 1994). In each case a score has been allotted to a square on the following basis: Each nationally scarce species = 1, nationally rare species = 2. These scores have been determined arbitrarily.

Figures 6 and 7 apply increasingly rigorous "filters" to the data.

Figure 6

This plot is similar to Figure 6 but shows only the 1 km squares scoring 2 or more. It is immediately obvious that a large number of 1 km squares are removed with this first filter adding clarity and thus facilitating the definition of potential rare plant PBAs.

Figure 7

This plot only shows those 1 km squares which score 4 or more. In practice, this filter is probably set too high as far as identifying PBAs are concerned.

Figure 8

This plot focuses in on one of the main clusters picked out by Figure 6. The filters have been removed and all squares scoring 1 or more are shown. The plot also shows the boundaries of Sites of Special Scientific Interest in the area. An attempt has been made to define a rare plant PBA. This is the hatched area on the map. All scoring squares are hatched plus those within 1 km square of a scoring square. This shows that a PBA can cross a number of Natural Areas as also demonstrated in Figure 4. The clustering of rare and scarce plants across the area where a number of Natural Areas boundaries are juxtaposed may be in part a reflection of the increased landscape and habitat diversity experienced.

There is a lack of close correspondence between the defined PBA and the SSSIs. This is likely to be due to the fact that some of the rare and scarce species are widely dispersed species which may not be closely linked to particular semi-natural habitats selected for the SSSI series, eg species associated with arable fields. This illustrates the value of the PBA approach for targeting the conservation of a selected group of priority species whose conservation may not be best served by a site-based approach.

Figure 9. Greater horseshoe bat *Rhinolopus ferrumequinum* feeding area

This plot shows the location of a greater horseshoe bat roost and associated feeding zones in the Dean Plateau and Wye Valley Natural Area. The definition of the zones is based on radio tracking studies which has shown that 90% of juvenile feeding sites lie within 1 km of the roost and more than 90% of adult feeding sites lie within 3 km of the roost (Ransome, 1997).

It shows the value of such information for the targeting of incentive schemes to support the conservation of a priority species. The definition of adequate PBAs for particular species may require this type of information rather than a single point on a map.

Figure 10. Woodland biodiversity

This plot combines semi-natural woodland and woodland butterfly data for the Dean Plateau and Wye Valley Natural Area. For each 1 km square, the ancient woodland inventory was used to derive scores of woodland cover such that: **0** = no woodland, **1** = <50% cover, **3**= > 50% and <99% and **5**= >99% cover. The basis is that areas with high cover of semi-natural ancient woodland have greater nature conservation value. The butterfly data at a 1 km square level represent a simple count/score of the number of woodland species. These are: small pearl-bordered fritillary *Boloria selene*, pearl-bordered fritillary *Boloria euphrosyne*, silver-washed fritillary *Argynnis paphia*, dark green fritillary *Argynnis aglaja*, high brown fritillary *Argynnis adippe*, green hairstreak *Callophrys rubi*, purple hairstreak *Quercusia quercus*, white-letter hairstreak *Strymonidia w-album*, white admiral *Ladoga camilla*, wood white *Leptidea sinapis* and purple emperor *Apatura iris*. The two scores for woodland cover and woodland butterfly species-richness were added together for each 1 km square to produce a score for each square which forms the basis for the plot (Maximum potential score =

11). Combining both habitat and species data should help to provide greater focus for identifying possible PBAs.

It is clear from the plot that the southern part of the Natural Area could form the basis for a woodland PBA with an outlier or "stepping stone PBA" to the north-west. The actual delimitation would depend on the method adopted for definition of a cluster or PBA.

Figure 11. Biodiversity in Dean Plateau and Wye Valley Natural Area

This is a combined plot at a 1km square level representing the following range of priority habitats and species:

Dormouse *Muscardinus avellanarius*: 0=absence 1=presence; **Bat species richness:** score 1 for each species present; **Rare/scarce vascular plant species:** Nationally rare = 2, Nationally scarce = 1; **semi-natural ancient woodland cover**: score as for Figure 10; **semi-natural grassland cover**: as for Figure 3; **butterfly species richness:** as for Figure 10; **SSSI cover**: score as for woodland/grassland cover. These scores were then summed for each 1 km square to produce the plot. The resulting plot is quite similar to the woodland biodiversity plot which is suggestive that the key elements of biodiversity in the Natural Area are often geographically coincident.

It would be interesting to see how the pattern would change with the addition of further data on other key features, eg birds. Given the range of habitats and species already represented, and the likely relationship between these and any additional features, it would seem unlikely that the pattern of biodiversity would change greatly. This is illustrated to some extent by the similarity of patterns in Figures 10 and 11.

Again it is possible to identify a southern PBA with some northern smaller " satellite" areas at least one of which could be linked to the large PBA depending on the decision rules used.

Figure 12. Cotswolds PBAs

In the Cotswolds Natural Area, English Nature defined provisional PBAs on the basis of two priority habitats, ancient semi-natural woodland and lowland semi-natural grassland. Section 5 provides more detail on the method and a discussion of the approach. PBAs were identified intuitively by plotting lines onto MapInfo displays of SSSI, grassland and woodland inventory sites. Figure 12 shows the location of the five PBAs. The main aim was to identify areas in which it would be beneficial to target resources to achieve conservation benefit.

4. Discussion

4.1 What are PBAs?

PBAs are generally considered to be areas where there are particular concentrations of species and/ or semi-natural habitats of high nature conservation value. They can be defined on the basis of total biodiversity (ie the summation of all species and semi-natural habitats) or on those features of biodiversity that are considered to be particularly important for biodiversity conservation at various scales, ie local, national or international. Thus PBAs could legitimately be defined on the basis of an individual species, assemblages of species (eg rare/scarce vascular plants), a single semi-natural habitat type (eg MG4 flood meadow), habitat assemblages (semi-natural ancient woodland and grassland) or a combination.

In lowland England, in terms of scale, it is probable that most PBAs will lie between sites and Natural Areas in size, although some may cross Natural Area boundaries. This is firstly a reflection of the current distribution and pattern of semi-natural habitats in the countryside and secondly the need to target resources at an appropriate scale.

4.2 Why have PBAs and what are their uses?

PBAs are areas that make an above average contribution to the biodiversity of an area. The area could be a Natural Area or an administrative district and so on. In some circumstances it follows that resources to maintain and enhance biodiversity may therefore have a disproportionate benefit if deployed to PBAs.

There may also be benefits in preferentially targeting the re-creation of habitats to PBAs in that they are likely to provide a large source pool of species, including specialist species, and have greater potential to create substantial areas of habitat or mosaics of different habitats likely to be required by certain wide-ranging species.

According to island biogeography theory small, isolated habitat patches will support fewer species than large, less isolated ones and will become progressively "impoverished" in species per unit area. Extinction rates also increase with increasing isolation.

For example, certain specialist woodland bird species do not or only rarely breed in small woods and are more likely to disappear from small woods after periods of unfavourable environmental conditions (Hinsley *et al* 1994).

A study of dormice in woodlands in Herefordshire (Bright, Mitchell & Morris 1994) showed that both site isolation and woodland area influence the occurrence of dormice. Woods less than about 20 ha are unlikely to support this species in the long term.

Such species could benefit from woodland restoration that targets the expansion of small woods and provides linkages between woods. The benefit of this is likely to be greater if targeted at PBAs which may include outlying smaller patches within its boundaries.

For species that have only moderate colonising powers increasing patch size and reducing the distance between or linking surrounding sites is more likely to create conditions for long-term persistence and recovery. Examples of species with suspected metapopulation structures include marsh fritillary (*Eurodryas aurinia*) (Warren 1994) and silver-spotted skipper (*Hesperia comma*) (Thomas & Jones 1993).

From a practical viewpoint, it is probable that larger areas are easier and cheaper to manage per unit area than small ones.

It would seem then that PBAs are primarily about targeting resources, effort or influence to those areas where the greatest benefits to biodiversity might be achieved. In particular, they could be used for targeting agri-environment schemes (see for example Figures 3 & 11), woodland and forestry schemes such as the Woodland

Improvement Grants Scheme (WIGS) (Figures 10 & 11) and species recovery-type programmes (Figures 8 & 9).

4.3 How might PBAs be identified?

4.3.1 Review of map ouputs

Data on the distribution of semi-natural habitats and species of conservation concern can be used to help in the definition of PBAs. However, the usefulness of the data depends on attributes like the scale at which it was collected, whether it is simply a point or has some measure of extent/cover for habitats or population estimates for species.

Information on habitats and species at a 1 km square scale would seem to be ideal for provisionally identifying PBAs. For data on semi-natural habitats or protected sites, some measure of cover (eg within a 1 km unit) or areal extent is necessary because a simple dot representing a site does not provide enough clarity to identify provisional PBAs (contrast for example Figures 3 & 4).

Scoring systems which weight habitats or species according to their perceived value, although subjective and arbitrary, also proved useful in assisting with PBA definition. In the examples used here, scoring was based on cover within a 1 km square; higher scores signifying high cover of a semi-natural habitat. This is based on the assumption that larger contiguous habitat patches are of greater conservation value. For species, "richness" values per 1 km square were used, and in some examples (Figures 5-8) scores were given according to conservation priority. Thus, nationally rare vascular plants scored higher than nationally scarce species. A filtering method whereby only the 1 km squares scoring above a specified arbitrary score are mapped may help to select potential PBAs (see Figures 5-8).

The example of the rare plants PBA (Figure 8) indicates that particular care needs to be exercised in identifying PBAs for particular species assemblages using habitat/protected area data as some species will not always be closely linked to larger tracts of semi-natural habitat. However, if a mixture of selected habitat and species datasets is used, it is possible that these can act as surrogates for other species/habitats where data is lacking or deficient.

In most of the examples used here no attempt has been made to define PBA boundaries on the map outputs. However, in a real situation this will need to be achieved and additional information such as the boundaries of habitat patches or species ranges may be required.

4.3.2 Other examples of PBAs at a local level

Cotswolds

In the Cotswolds Natural Area, English Nature defined provisional PBAs on the basis of two priority habitats, ancient semi-natural woodland and lowland semi-natural grassland. These two semi-natural habitats hold a significant part of the Cotswolds biodiversity. These habitats are not uniformly distributed across the Natural Area. PBAs were identified intuitively by plotting lines onto MapInfo plots of SSSI, grassland and woodland inventory sites. Figure 12 shows the location of the five PBAs. The main aim was to identify areas in which it would be beneficial to target resources to achieve conservation benefit.

Although not rigorously defined, the PBAs are recognisable clusters of semi-natural habitats or "wildlife hotspots". This applies not only to present species distribution but is reflected in the historical distribution of species. For example, the Cotswolds was formerly important for the large blue butterfly (*Maculinea arion*) which became extinct there in the 1960s. The Painswick - Slad Valley PBA (Figure 12) was a particular centre for this species and included about a third of all formerly recorded Gloucestershire sites.

These blocks of high biodiversity countryside make a disproportionate contribution to the conservation of the two semi-natural habitats and their component species. For example, the Painswick - Slad Valley PBA occupies 1.6% of the Natural Area but contains 7.9% of its ancient woodland and semi-natural grassland.

This is an example of a selective approach where only some elements of biodiversity are used to identify prime areas or "hotspots".

Batten *et al* 1996 provides further details of the Cotswolds approach to identifying PBAs.

Somerset: Mendips & Taunton Deane

In 1995, Mendip District Council published a local Biodiversity Action Plan as a response to the UK Biodiversity Action Plan. The study was commissioned from the Somerset Environmental Records Centre (SERC) and was part-funded by English Nature. Information used to identify PBAs (called High Biodiversity Areas in the published report by Butcher, Rowe & Cloughley 1995) consisted of the areas of semi-natural habitats on SSSIs and County Wildlife sites and records of notable species. Notable species included those that were legally protected, Red Data Book species, nationally scarce species or notable species in the county of Somerset.

The definition of High Biodiversity Areas was stated as:

"Places within an administrative unit that support the greatest diversity of species and the greatest extent and highest quality of semi-natural habitat, and which offer the greatest potential for restoration of habitat characteristic of the administrative unit."

These Areas were identified by combining distribution data for notable species with area data for semi-natural habitats on a tetrad (2x2 km squares) basis. For each tetrad two figures were found: 1) the number of notable species with at least one record, 2) the total area of all patches of semi-natural habitat which had their centre grid references in the tetrad. Next, the average number of notable species for all tetrads across the District, and the average area of semi-natural habitat in SSSIs and County Wildlife sites for all tetrads were calculated. Each tetrad was then assigned a species score and a habitat score by expressing the score of the number of species and habitat area in that tetrad as a percentage of the average species and habitat scores. The two resulting scores were then added together to give a "biodiversity index". The use of the average figures across all tetrads has the effect of smoothing the combined patterns of species richness and semi-natural habitat extent.

Clusters of tetrads with high combined species and habitat scores were named High Biodiversity Areas. The clusters were picked out by scaling circles so that a small number of overlapping sets of circles drew attention to the richest areas. Boundaries for these clusters were then drawn by looking at the known boundaries of habitats and locations of individual species. Inclusion of these was made by referring to distance rules, for example from the patch of semi-natural habitat nearest the centre of the tetrad with the highest combined score, all patches within 700metres were included, then any patches beyond these but within 600 metres of these patches were included and so on.

The same approach was adopted for identifying PBAs in the Somerset Borough of Taunton Deane (May & Butcher 1997). SERC have now adopted the term Prime Biodiversity Areas in the latter study in contrast to the Mendip report. Figures 13 & 14 reproduced from May & Butcher (1997) shows the results for the Borough. Figure 13 shows the distribution of tetrad biodiversity scores using proportional circles and Figure 14 shows the three PBAs defined.

The initial approach used in these examples is comparable with that reviewed in section 4.3.1. above.

The Somerset Wildlife Trust, is using PBAs for targeting land acquisition. The Heritage Lottery Fund has funded major acquisitions by the Trust within the three PBAs identified in the Mendips (Butcher pers. comm.) .

South Downs

Phillips (1996) used a summation approach using different biodiversity measures to initially identify clusters of tetrads of high conservation value in the South Downs Natural Area in West Sussex. The study used the most accessible and systematically surveyed taxa, namely higher and lower plants and birds together with semi-natural habitat extent. Only conservation priority species were used (local and national) and richness scores were derived for each tetrad. Semi-natural habitat cover from Phase 1 survey maps was scored from 1 to 5 according to % cover in a tetrad. Arbitrary distance or consolidation rules were developed for the range of habitats present to define clusters. The final PBA boundaries were drawn to reflect actual physical features on the ground. In addition a set of criteria were drawn up to direct identification of PBAs. These include size, presence of species/habitats of conservation concern, species/habitat richness and diversity. Three PBAs were identified using this approach in this Natural Area.

The initial approach used in this example is comparable with that reviewed in section 4.3.1. above.

Figure 13 & 14. Prime Biodiversity Areas in Taunton Deane Borough, Somerset.

Figure 13: Tetrad biodiversity scores

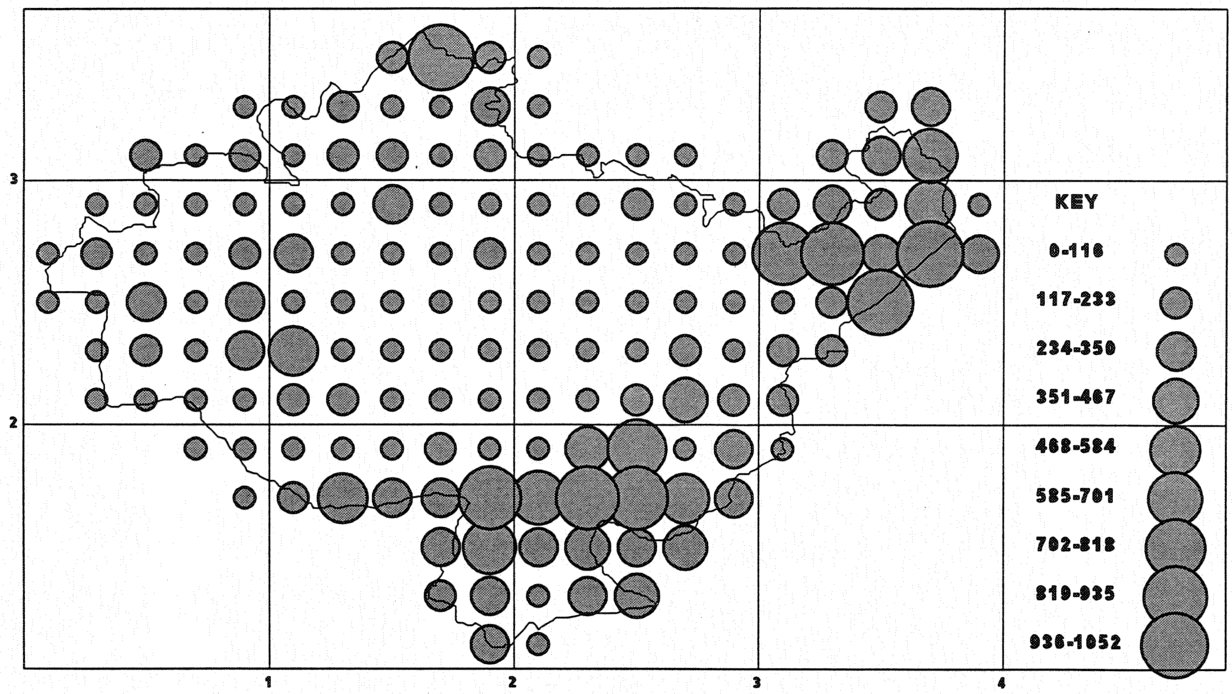
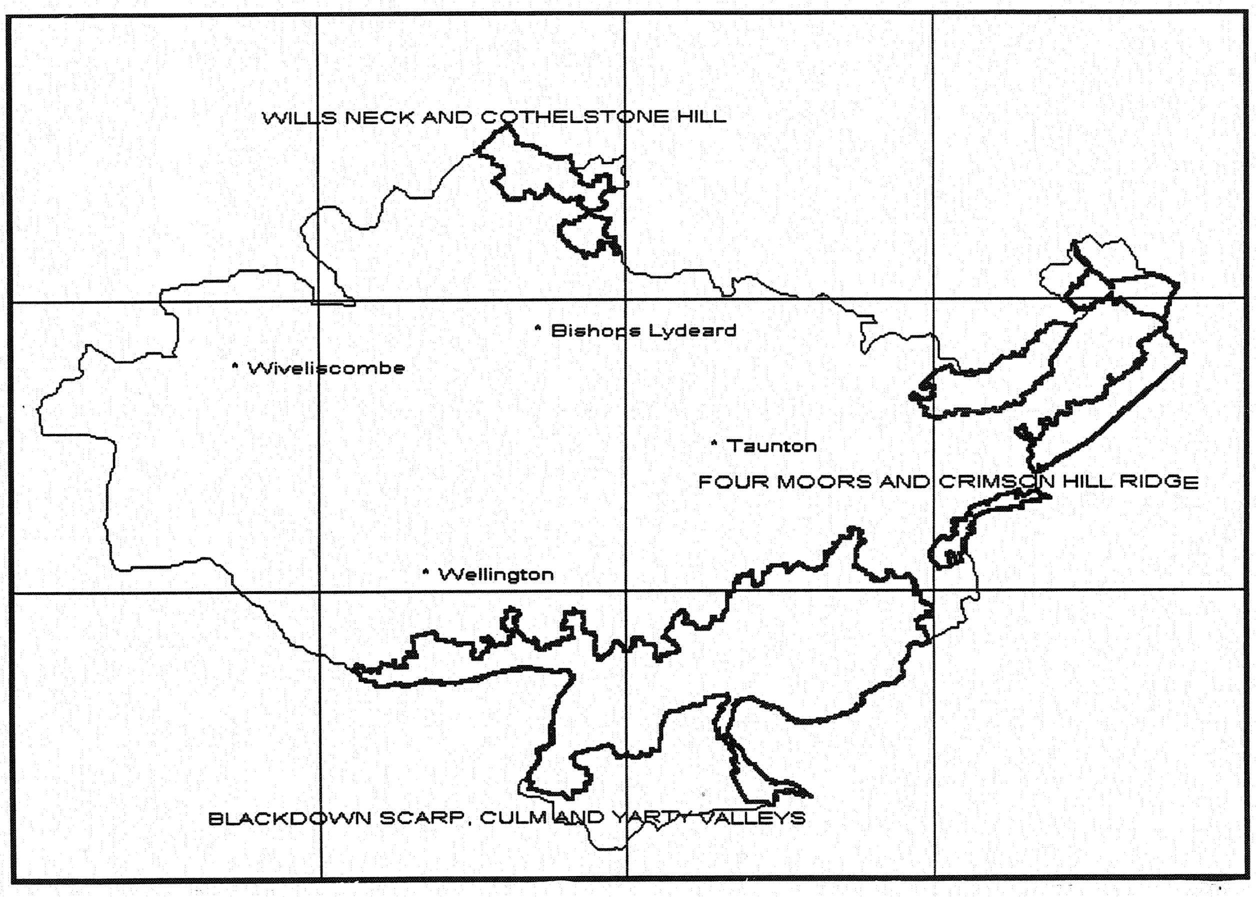


Figure 14: Prime Biodiversity Areas



From May & Butcher 1997 and reproduced with kind permission of Somerset Environmental Records Centre.

4.3.3 Related work

A number of studies have used species distribution data at the 10 km square level to identify so-called biodiversity "hotspots". A selection of these are briefly outlined below. With the exception of Carey, Hill & Fuller 1996 these studies were not primarily motivated by the practical requirements of conservation bodies.

Carey, Hill & Fuller (1996) used BRC and BTO species distribution data from four taxonomic groups (birds, invertebrates, bryophytes and vascular plants) to measure the biodiversity of each 10 km square in Scotland. The data for all species (2637 in total) were combined and given equal weighting. A national scale biodiversity map and similar maps for the 12 biogeographical zones have been produced. The former identifies squares of both high and low biodiversity ("hotspots and coldspots"). It is suggested that such areas need to be identified to allow policies and strategies that protect them to be developed on a national scale. Areas of low biodiversity can be further studied to discover the underlying causes and what might be done to enhance biodiversity.

Prendergast *et al* (1993) used BRC and BTO 10 km square data to examine the extent to which species-rich areas for different taxa coincide and whether species-rich areas contain substantial numbers of rare species. They used data for butterflies, birds, dragonflies, liverworts and aquatic vascular plants. The results indicated those species-rich areas "hotspots" do not often coincide for different taxa. Thus the British data provide only weak support for the notion that selecting a limited number of conservation areas that are good for one or two taxa automatically includes species-rich areas for other taxa.

Williams *et al* 1996 compared three different methods for choosing 5% of all the 10 x 10 km grid cells in Britain to represent the richness of breeding birds: 1) hotspots of overall species richness ("richness hotspots"); 2) hotspots of breeding bird species with restricted ranges ("rarity hotspots") 3) areas of complimentary richness, ie areas that in combination have the highest species richness. The latter method sought to represent all British breeding species at least once in the least possible number of grid cells and ensure representation of the species as many times as possible within approximately 141 grid cells (5% of grid cells). Like Prendergast *et al*, they found that hotspots of richness do not represent all bird species in Britain as the rarer species are not strongly nested within the distribution of the more widespread species. Thus in order to represent all species and restricted species there is a need to employ a method that embraces complementarity. Otherwise, a large number of selected areas will merely duplicate the representation of widespread species.

The above studies use 10 km square data from selected species groups to identify hotspots. The approach is unlikely to be of use for identifying PBAs as defined here as a limited selection of species alone are rarely likely to be surrogates for overall biodiversity and 10 km is probably too coarse a scale for the purpose of defining PBAs. Some measure of semi-natural habitat extent is likely to be required as used in the studies outlined in 4.3.2. In addition, further information on species home ranges or population extent may be required when PBA boundaries are being drawn.

4.3.4 Setting objectives

The starting point for identifying PBAs in support of conservation programmes is to identify the selection area (Natural Area, County, other) followed by the priority habitats and species which are being targeted. The nature and number of the latter will vary according to the nature of particular areas, the conservation objectives and priorities and the availability of data.

4.3.5 Data

The type of biodiversity measure used needs to be related directly to the goals of the PBA.

Total biodiversity mapping (ie mapping all available datasets), even if feasible, is rarely likely to be appropriate in a nature conservation context as for this purpose not all species and habitats are of equal value. Habitats and species have differing value for nature conservation which relate to parameters such as rarity, naturalness and intrinsic appeal. Selective biodiversity mapping is thus more likely to produce an outcome that will be useful to conservation agencies and other bodies. Thus semi-natural habitats and notable species are likely to be targeted, particularly those identified as being of high priority in Directives and National and Local Biodiversity Action Plans.

Where datasets do not exist for certain priority species/habitats, the extent to which other datasets act as surrogates for these could be assessed. In the South Downs example (Phillips 1996) there was a low degree of correlation between the richest areas for priority birds and the hotspots for plants and semi-natural habitats for which data were available. The work of Prendergast (1993) *et al* and Williams *et al* (1996) demonstrate that caution needs to be exercised in the selection of biodiversity measures which might be used as surrogates, because areas that may be hotspots for some taxa may not be for others. In an analysis of Biodiversity Action Plan priority species, 16% of species were associated with 2 or more broad habitat types or habitat mosaics (Thomas & Simonsen in prep). This can be overcome to an extent by ensuring the use of measures of semi-natural habitats or protected areas in addition to species data.

A range of biodiversity data are available for use in identifying PBAs. In this report, the examples have used habitat and SSSI inventories and species distribution data, the latter are normally available at a range of scales (6 figure grid reference, 1 km square, tetrad or 10 km square). Data collected at a 10 km square level is probably too coarse-grained for identifying PBAs within Natural Areas but it has been used for more theoretical work on the identification of biodiversity hotspots (see for example Prendergast *et al* 1993, Williams *et al* 1996).

The data can be used in a variety of ways. For example habitat/SSSI information can be converted to a score which reflects % occupancy of a 1 km square (see Figures 3, 10, 11). Species data for a particular taxon or groups of taxa can be simply summed at a 1 km or tetrad level to produce a richness score or different weightings can be given and to reflect levels of rarity (see Figure 5-8, 10, 11). The use of differential weightings to reflect different nature conservation priorities of habitats and species is in itself subjective as the weightings are chosen by the observer. Care should be exercised in the use of weightings as the extent to which these influence the location and definition of PBAs has yet to be evaluated.

Defining PBAs based on multi-interest features will require summations of values or scores (see Figure 11). This method could be considered subjective, but it does offer a practical method of identifying areas which are particularly rich in a range of priority species and habitats.

If hard PBA boundaries are felt to be desirable (see section 4.3.6. below), habitat data needs to have boundaries in paper or electronic form and species information needs to be spatially referenced (ie a grid reference or presence within a delimited boundary).

The quality of data may need consideration when selecting PBAs. Some datasets may be incomplete in their coverage in a Natural Area or seriously outdated. This could affect the outcome of PBA location and definition programmes.

4.3.6 Size and boundary definition

It is suggested above that a PBA would normally lie in scale between an individual site and a Natural Area or equivalent area. However, it is conceivable that a PBA may crosscut two or more Natural Areas or other defined regions such as one based on administrative districts. This is illustrated by Figure 8.

May & Butcher (1997) make the point that the three PBAs defined in the Taunton Deane do not stop at the borough boundary and that PBAs defined subsequently in adjacent districts will be part of the same ecological entities, but they will be treated and named differently. This is one of the issues of biodiversity planning on an administrative area and conceivably relates to other divisions of the landscape such as Natural Areas. The Mendips and Taunton Deane PBAs have been defined in relation to the average state of biodiversity at a district or borough level and not relative to each other or to an absolute value of high biodiversity. This would mean that a County or Natural Area-level PBA may not have the same boundary as that formed by grouping together district level PBA boundaries.

Definition of a cluster of habitats and species could be based on formalised decision rules (see Butcher, Rowe & Cloughley 1995, Phillips 1996) or by an intuitive subjective approach, as used in the Cotswolds. The former could use parameters such as the relative frequency or abundance of a habitat or species in a unit such as a 1km square, or use distance rules (for example between habitat patches or discrete species populations), to decide whether a unit is included within a PBA or not. Information on the known dispersal distances of priority species could also be used to inform the placement of a PBA boundary particularly where decisions are required regarding the inclusion or otherwise of fragmented habitat patches.

Decision rules for recognising clusters should vary depending upon the conservation resource being considered and its pattern of distribution.

The advantage of the Cotswolds method is its speed and simplicity. However, it is intuitive rather than systematic and hence it is not amenable to formal description. The systematic methods still involve arbitrary assumptions and they are more time consuming, but have the advantage that these methods can easily be described and repeated if necessary.

The question as to whether PBA boundaries should be "hard" or "soft" also needs to be considered. The various studies cited here opt for hard boundaries which follow recognisable features on the ground. More generalised boundaries ("soft") might be defined on a 1 km or tetrad basis (see for example Figure 8).

The advantage of the former approach is that the boundary is readily recognisable by conservation organisations and landowners. This may better facilitate the inclusion of land that conservation organisations may wish to influence in terms of it having an effect on the conservation status of sites in the PBA or the PBA as a whole. A disadvantage is that the boundary might come to be regarded as fixed and that a PBA is seen to represent yet another formal designation. The advantage of a soft boundary is that it might help to promote the concept of flexible PBAs. This is important as changes in the status of the biodiversity of areas which lie outside PBAs may necessitate their inclusion in the future. In addition, conservation priorities may also change over time.

An alternative method of defining PBAs with soft boundaries is to use clusters of parishes as the basis of their definition. This has the following advantages in addition to those mentioned above:

- it relates to readily understood patches of countryside;
- it brings Natural Areas and PBAs to a community scale promoting ownership/participation.

4.4 Potential PBAs

If PBAs are defined entirely on existing biodiversity there may be some Natural Areas where few or no PBAs may be defined. For example, the Vale of York & Mowbray Natural Area would be much less likely to have PBAs compared to the Culm Natural Area in Devon & Cornwall.

In certain cases it may be appropriate to consider the definition of potential PBAs. These might be defined in relation to the relative potential for re-creating a habitat type which is likely to be dependent on parameters such as soil type and fertility, past and present land use cover, hydrological status etc. This would be a mechanism for focusing countryside reconstruction to areas with the highest potential.

5. Conclusion

In conclusion, it would seem that PBAs are primarily about targeting limited resources to those areas where they will deliver the greatest benefits for biodiversity conservation and enhancement. Once defined they should not be viewed as quasi-designations, but as useful targeting tools for conservation programmes. PBAs have, to date, been defined and applied at a local level within a particular framework such as a Natural Area, an area covered by a Local Biodiversity Action Plan or an administrative area.

This was the original role for PBAs as outlined in the UK Steering Group (1995). In this way PBAs would be expected to contribute to the delivery of national Biodiversity Action Plan targets mediated through Natural Areas/Local Biodiversity Action Plan objectives and targets.

6. Recommendations/guidelines

- In terms of size it is anticipated that PBAs will lie between a site and a Natural Area although it is possible that a PBA could crosscut one or more Natural Areas;
- Prior to identification, the aims and objectives of a PBA should be clearly defined including the range of priority habitats and species being targeted.

These would normally be those identified by the UK Biodiversity Action Plan or in Local Biodiversity Action Plans and Natural Area profiles;

- PBAs can be selected for single or multi-interest features depending on the nature of the area/region being considered and the conservation objectives;

- Data for priority habitats and species should ideally be at a 1km or tetrad scale, (2 x 2 km) or less and for habitats, some form of cover or area information is essential. Data in electronic form allows the use of Geographical Information Systems which can greatly assist the process of identification of PBAs;

- The different methods of cluster and boundary definition are all arbitrary and have their advantages and disadvantages. It is suggested that at present, a pragmatic approach to PBA definition and boundary type is adopted. Thus the method chosen would be that which best suited the particular circumstances in a specified area;

- PBA boundaries will need to be kept under review as the conservation status of land in the vicinity of PBA boundaries changes due to increased knowledge and as a result of the implementation of conservation management targeted at PBAs;

- In the future, if there is a desire to produce a national series of PBAs, there may be a need to consider the production of more rigorous guidelines for their identification.

Acknowledgements

We are grateful to Tristan Owen and Chris Harniess for their help with data collation and manipulation. We would also like to thank the Biological Records Centre, ITE., Monks Wood for supplying distributional data for vascular plants, Guy Meredith, Gloucestershire Naturalists' Society for the woodland butterfly data and Bill Butcher of Somerset Environmental Records Centre for permission to reproduce Figures 13 and 14. Thanks are due to Keith Duff, Dr Leo Batten and Mark Felton for comments on the draft text.

References

BATTEN, L., KIRBY, K.J., MARSDEN, J., WILKINSON, M. & WHITMORE, M. 1996. England: Natural areas and prime biodiversity areas. In: P. Nowicki, G. Bennett, D. Middleton, S. Rientjes & R. Wolters (eds.) *Perspectives on ecological networks*. pp 71-91. European Centre for Nature Conservation Man and Nature Series No. 1.

BRIGHT, P.W., MITCHELL, P. & MORRIS, P.A. 1994. Dormouse distribution: survey techniques, insular ecology and conservation. *Journal of Applied Ecology*, 31: 329-339.

BUTCHER, W., ROWE, A. & CLOUGHLEY 1995. *Mendip Biodiversity Action Plan*. Taunton: Somerset Environmental Records Centre.

CAREY, P.D., HILL, M.O. & FULLER, R.J. 1996. Biodiversity hotspots in Scotland. *Scottish Natural Heritage Research, Survey and Monitoring report* No. 77.

COOKE, R. & SIBBETT, N. 1998 Nature's character. *Landscape Design*, 269: 18-21.

ENGLISH NATURE & RSPB (1994-1996) The Lowland Heathland Inventory. Peterborough: English Nature/RSPB (19 volumes).

EVANS, A., PAINTER, M., WYNDE, R. & MICHAEL, N. 1994. An inventory of lowland heathland: A foundation for an effective conservation strategy. *RSPB Conservation Review*, 8: 24-30.

HINSLEY, S.A., BELLAMY, P.E., NEWTON, I. & SPARKS, T.H. 1994. Factors influencing the presence of individual breeding bird species in woodland fragments. Peterborough: *English Nature Research Reports* No. 99.

JEFFERSON, R.G. 1997. Distribution, status and conservation of *Alopecurus pratensis-Sanguisorba officinalis* flood-meadows in England. Peterborough: *English Nature Research Reports* No. 249.

JEFFERSON, R.G., HARNIESS, C., EADY, P.N., OWEN, T.L., ROBERTSON, H.J., HOPKINS, J.J. & MORTIMER, C. 1997. Inventories of lowland grassland in England: rationale and methodology. Peterborough: *English Nature Research Reports* No. 215.

MAY, D. & BUTCHER, W. 1997. *Taunton Deane Biodiversity Action Plan*. Taunton: Somerset Environmental Records Centre.

PHILLIPS, M.R. 1996. A method for identifying Prime biodiversity Areas in a Natural Area in West Sussex. Peterborough: *English Nature Research Reports* No. 180.

PRENDERGAST, J.R., QUINN, R.M., LAWTON, J.H., EVERSHAM, B.C. & GIBBONS, D.W. 1993. Rare species, the coincidence of diversity hotspots and conservation strategies. *Nature*, 365: 335-337.

RANSOME, R.D. 1997. The management of greater horseshoe bat feeding areas to enhance population levels. Peterborough: *English Nature Research Reports*, No. 241.

RODWELL, J.S. (Ed) 1992. *British Plant communities 3: Grasslands and Montane Communities.* Cambridge: Cambridge University Press.

SPENCER, J.W. & KIRBY, K.J. 1992. An inventory of ancient woodland for England and Wales. *Biological Conservation*, 62: 77-93.

STEWART, A., PEARMAN, D.A. & PRESTON, C.D. 1994. Scarce Plants in Britain. Peterborough: JNCC.

THE UK STEERING GROUP. 1995. *Biodiversity: the UK Steering Group Report.* London: HMSO.

THOMAS, C.D. & JONES, T.M. 1993. Partial recovery of a skipper butterfly *Hesperia comma* from population refuges: lessons for conservation in a fragmented landscape. *Journal of Animal Ecology*, 62: 472-481.

THOMAS, R.C. & SIMONSEN, W. in prep. *UK Biodiversity Action Plan: species associations with habitats*. Peterborough: English Nature.

WARREN, M.S. 1994. The UK status and suspected metapopulation structure of a threatened European butterfly, the marsh fritillary *Eurodryas aurinia*. *Biological Conservation, 67:* 239-249.

WILLIAMS, P., GIBBONS, D., MARGULES, C., REBELO, A., HUMPHRIES, C. & PRESSEY, R. 1996. A comparison of Richness Hotspots, Rarity Hotspots, and Complementary Areas for Conserving Diversity of British Birds. *Conservation Biology*, 10: 155-174.