7 GIS, LANDCOVER AND THE IDENTIFICATION OF CORRIDOR LOCATION IN ENGLAND

N J Brown & N Veitch

7 GIS, LANDCOVER AND THE IDENTIFICATION OF CORRIDOR LOCATION IN ENGLAND

The aim of the GIS part of this report is to show how the 'texture of the landscape' at a detailed scale can be displayed using GIS technology. The investigations have basically been in three forms:-

1. Full resolution display of a 'habitat' class from the ITE landcover map;
2. 1km summary data - regional/national scales;
3. Dorset heaths - a specific application of the landcover map.

A common link between these three forms has been the use of the ITE landcover map. Before describing the applications work it is worth describing the background to the landcover map itself.

7.1 THE ITE LANDCOVER MAP

There has been no complete map of the landcover of Britain since the early 1960s and no published map since the 1930's. The process of land use planning in Britain has been based, at best, on piecemeal surveys, which are often incomplete and may be incompatible.

The landcover mapping involves computer classification of paired summer and winter Landsat Thematic Mapper (TM) scenes to give 25 landcover types based on a 25 metre output grid or 'raster'. This study has used summer and winter data, in composite, to help separate the various target classes. Landsat TM data are geometrically corrected to the British National Grid. The imagery contains six bands of red and infrared data, chosen because they represent wavelengths with characteristic reflectances from vegetation, and are less affected by haze-problems than the blue-green end of the visible spectrum.

The classification is hierarchical, allowing users to access a few very basic cover-types, separated with high levels of accuracy, this classification then subdivides at various possible levels towards a shortlist of 19 spectrally distinct major classes. The procedure of classification is based on an extrapolation from sample statistics derived from examples of 'training data' defined on an image-analysis system. These training areas are selected to be typical examples of their class. They are based on knowledge derived in a field-reconnaissance survey. The extrapolation uses a maximum likelihood classifier to allocate all pixels in the scene to the nearest appropriate class.

Certain simple measures (e.g. of pattern) can be made in raster. For example, measures of landscape diversity will be based on calculating diversity indices per 1km square. Measures of dissection can be based on identifying boundary pixels (i.e those with differing neighbours) and scoring their proportion per 1km square: this is possible for any class, combination of classes or all 25 classes. Specific boundary combinations will overlay results from a specific class with those of another (e.g. a bracken boundary with a moorland boundary to record the bracken-to-moorland fringe. It is also possible to grow a raster buffer zone to calculate the proportional cover within fixed distances of a class. However ten pixels would be a realistic maximum. Where raster analysis is particularly limited is in identifying "polygons" (areas of defined cover type) and analysing these: for example, calculating the number, or average size of polygons per unit area is not possible for large areas within EIC's current analysis package. A class's area-to-boundary ratio gives a surrogate measure but takes no account of continuity and fragmentation.

Because of these limitations to raster analysis techniques it was important to make the raster landcover map available to a vector-based GIS to enable more complex vector analysis. Demonstration work started with the export of sample areas from the image analysis system to the GIS using proprietary data transfer software. These procedures have been used on a 75 km x 50 km test area centred on the Thames estuary. This was successfully converted from raster to vector form. Such conversion highlighted the problems of dealing with large databases, such as the cover map will provide. This relatively small area, one-sixtieth of all Britain, contained 80000 polygons. There is no commercial GIS which could realistically handle such detailed vector information for all of Britain. Simplification, by filtering out all small parcels, is possible, but risks throwing away useful information. Simplification was a necessary part of conventional cartography when a cartographer had to draw and classify every parcel. It is not a necessary part of raster image classification individually. So, unless it can be shown that the fine detail is 'noise' rather than data, the detail should not be lost for mere convenience. It is preferable to examine ways of storing and accessing raster data, converting to vector only where necessary, perhaps temporarily. The ITE GIS set up has this potential, and methods are being developed during the continuing GIS development of the landcover map.

7.2 GIS AND CORRIDOR ANALYSIS

The work described here has largely been carried out on two GIS's, The LaserScan HORIZON system and a smaller, PC-based system called Tydac SPANS. The HORIZON system is currently the major GIS in use at ITE Monkswood and is a powerful, workstation-based system that has a full range of data handling capabilities including the combined use of both vector and raster data. This system is the major vehicle upon which development and 'exploitation' of ITE's landcover map is taking place, and it has been the focus of recent applications of the landcover map to a number of environmental projects. The SPANS system is a much less powerful system that, nevertheless, possesses specific strengths in raster analysis functionality. It therefore lends itself well to the type of landcover analysis that is described later, in the section about lowland heath fragmentation in Dorset.

7.2.1 **Full Resolution Display of a 'Habitat' Class from the Landcover Map**

The first part of the study has involved the examination of a small area of the landcover map at its full resolution. The aim was to investigate whether certain habitat types represented by specific landcover classes displayed any form of corridor pattern.

The first stage was to chose a suitable habitat type that was of ecological interest in 'corridor' terms, and unimproved grass was chosen. This is represented in the landcover map primarily by three individual classes. These are meadow/rough grazing, marsh/rough grass and upland/grass moor. A number of combinations of these classes were examined, as well as some other landcover classes that can have a significant 'grass' component within them. A 100km square of landcover (square TL) was transfered to the HORIZON GIS from its permanent archive on optical disk. The image was displayed in its full colour and then the required classes selected out for individual display on the screen. A 10km grid was superimposed by the GIS to give a visual indication of the scale of the output. Figure 7.1 shows an area of about 40km square with the three grass classes combined into one colour. At this scale certain 'linear' features are clearly seen. The long straight band to the north west represents the grasses of the Ouse Washes. Further south east are some linear patterns of grasses which are shown at a larger scale in Figure 7.2. This map shows an area about 10km square. 'Patches' of grass probably representing large grazing fields are interspersed with small linear patterns possibly indicating rough grasses along field edges etc. However the most clear linear feature or 'corridor' is an inverted 'Y' shape. This clearly represents a fairly major physical feature such as the course of a river. This can be confirmed quickly within the GIS by the simple overlay of a suitable vector topographic base map. This, fairly simple, analysis is repeatable for any single class or combination of classes for any geographical area; for instance, selection of the bracken class reveals a pattern of linear bands in the area of the North York Moors where this habitat threatens to invade surrounding habitats such the moorland on hill tops.

On the national scale most of these type of patterns are not easily seen, particularly in the improved grassland class. However our study of a generalised version of the landcover map, described below, does lead to some success with another landcover class at a much smaller scale.

7.2.2 1km Summary Data - regional/national scales

The basis of this next area of study was primarily the result of requiring landcover information at a 1km resolution. This is the scale which is required for data used as part of ITE's Countryside 1990 Information System (CIS). This system, available for use on personal computers, provides environmental information about each 1km square of Britain. CIS includes items such as land availability, hedgerow lengths, mean altitude and many others.

The full resolution landcover data has been processed in a number of ways before being incorporated into CIS 1990. A fortran program was written by Monkswood GIS staff, that for each 1 km square, calculated the percentage of each landcover class present. An Oracle database table was constructed into which these percentages were inserted. Thus, for each 1 km square there is a record of its geographical position and a value for each landcover class from 0% to 100% derived from the 1600 25 metre pixels contained within each 1km square. This Oracle table is then accessed by the GIS system.

UNIMPROVED GRASS FOR PART OF CAMBRIDGESHIRE
(extracted from the ITE Landcover Map)

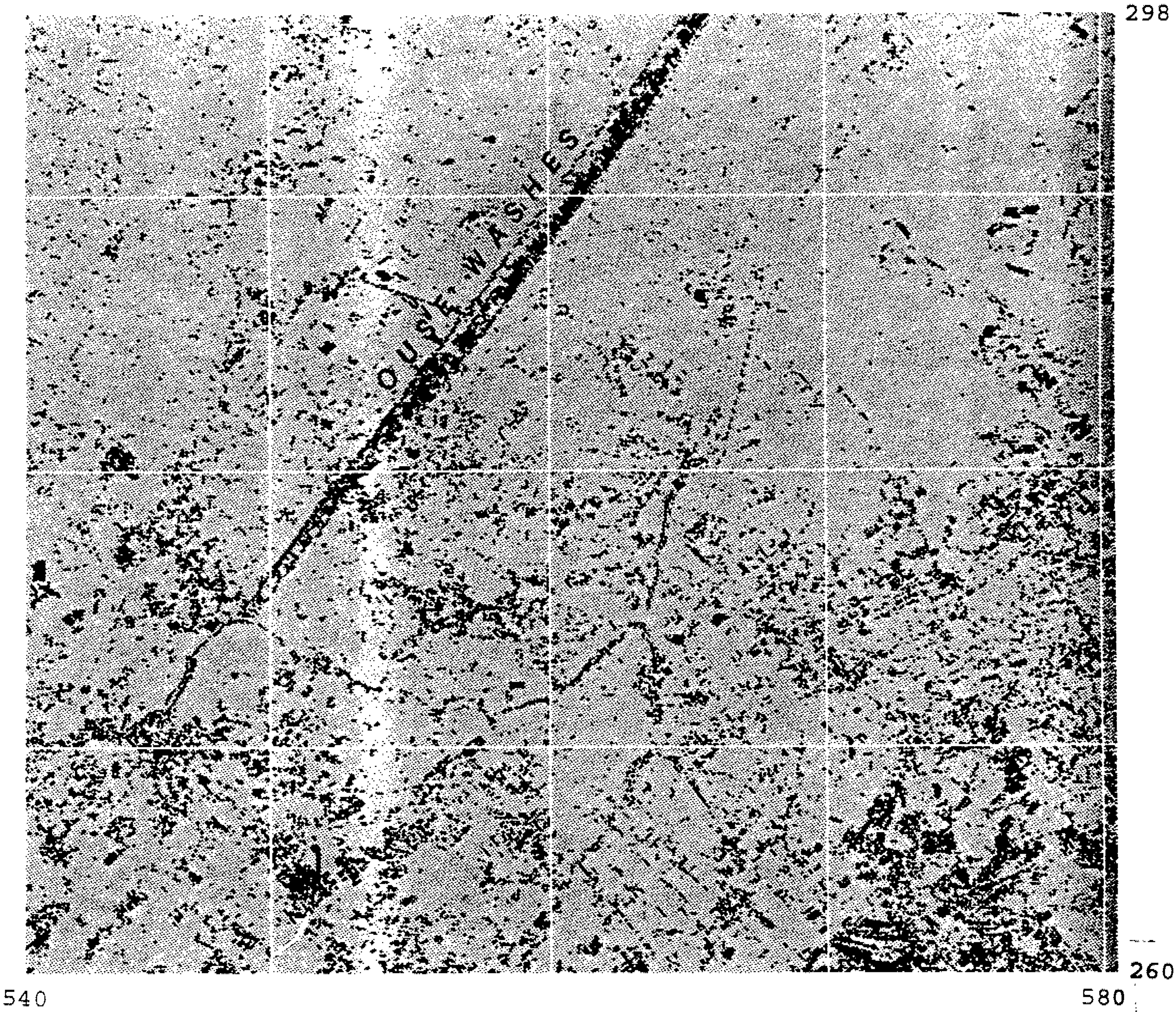

Figure 7.1

UNIMPROVED GRASS FOR PART OF CAMBRIDGESHIRE
(enlarged section from figure 7.1)

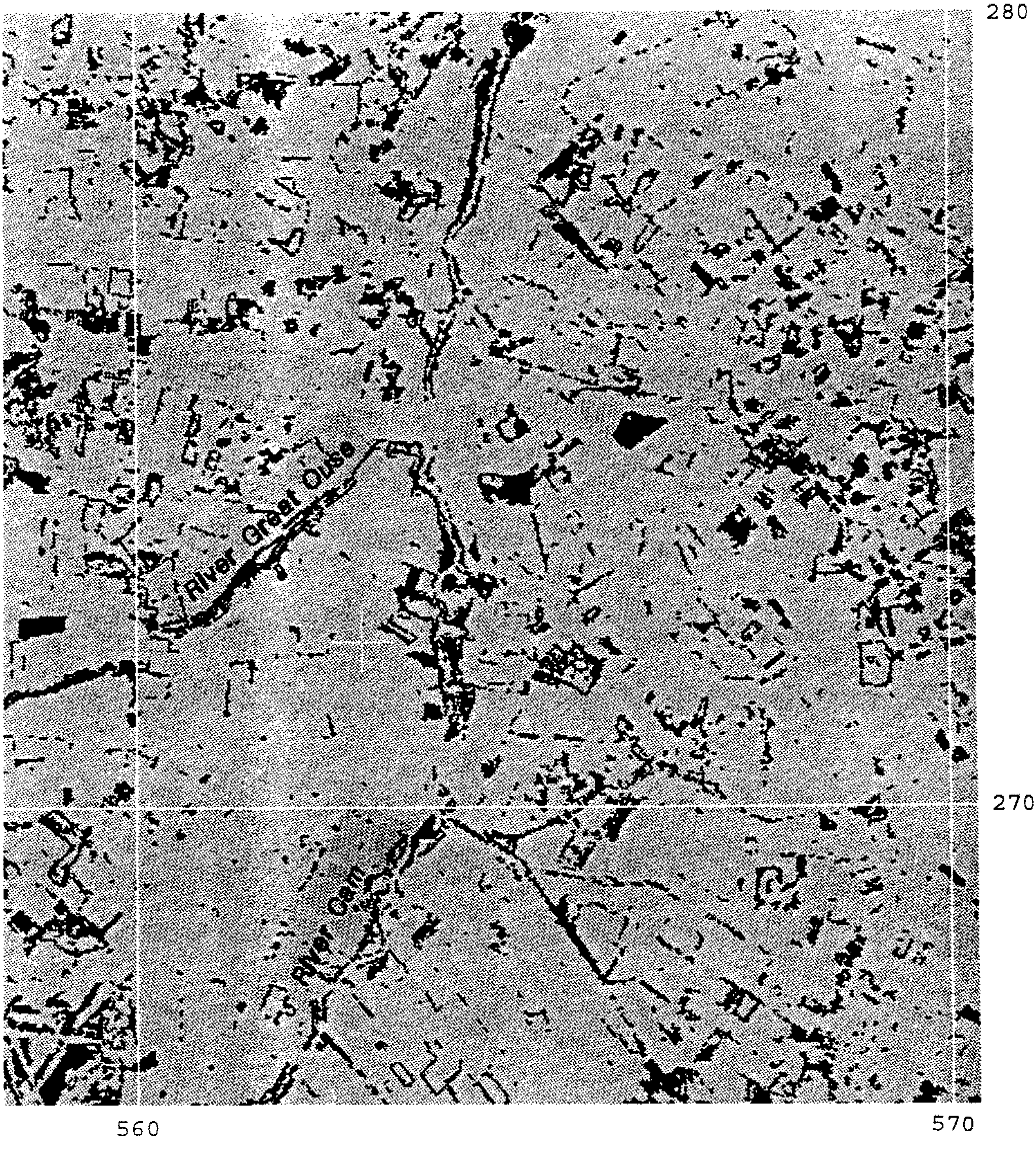

Figure 7.2

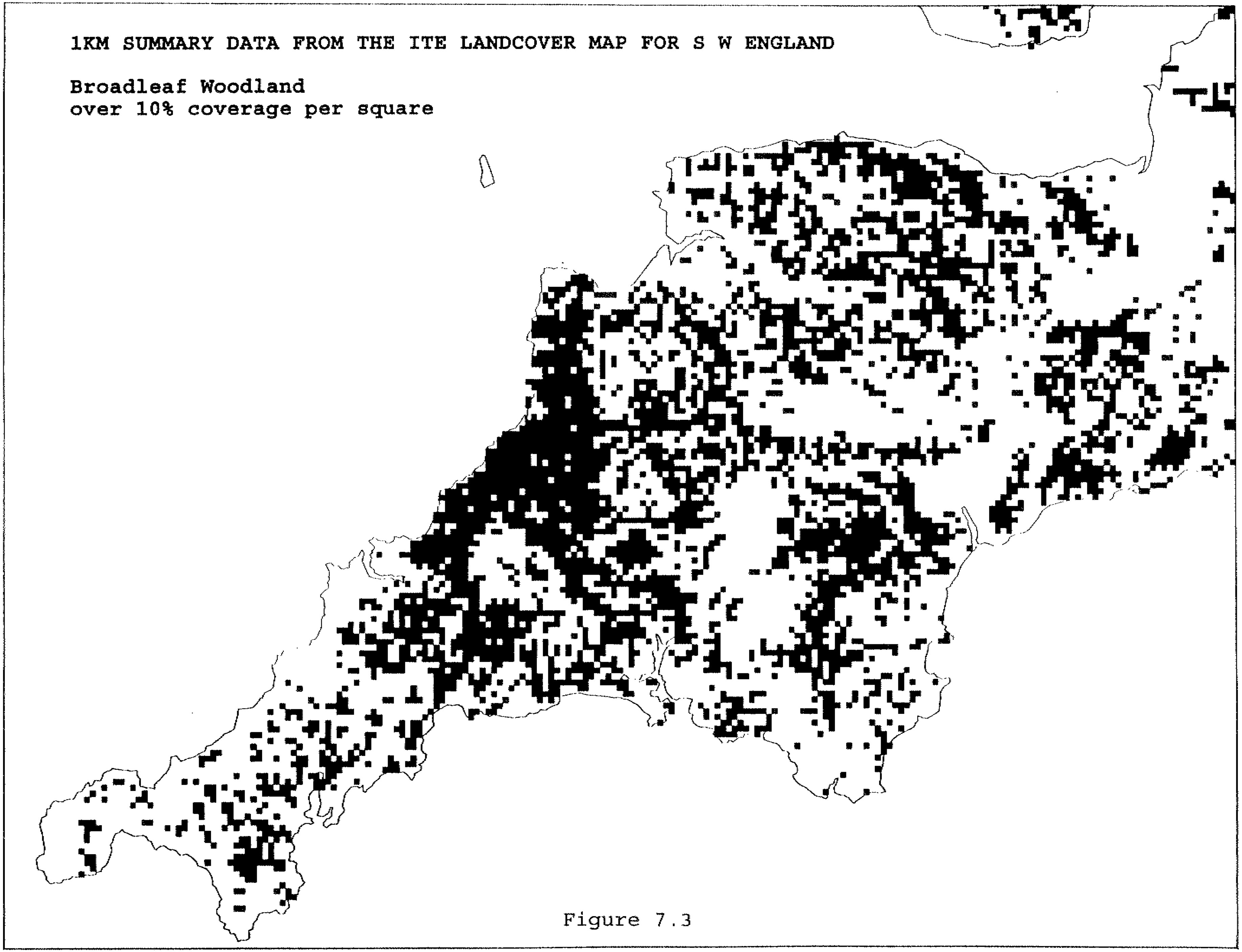
1KM SUMMARY DATA FROM THE ITE LANDCOVER MAP FOR S W ENGLAND
Broadleaf Woodland
over 10% coverage per square

Figure 7.3

First we requested information about the Broadleaf Woodlands (Deciduous woodland class) for South West England. We asked for 1km squares where woodland cover was 10% or over. A new table of information within the Oracle database was created and a standard GIS function used to convert each entry to an individual 1km pixel within a raster output file. This file, in its visual form, is then available for display as a map on the GIS screen (see Figure 7.3). This map gives a very simple example of the output from one very specific query about the woodland habitat. However the 'woodland only' Oracle table can be examined and displayed in many different ways. The user can request any combination of percentage cover values that he/she feels is of particular significance. For instance it may be known that a specific species can disperse readily where woodland cover is generally above the 10% level. The type of information shown in figure 7.3 may be useful in describing potential routes of movement of this species. However, further detail may be required and can be created in the form of a multi-coloured output showing varying levels of woodland cover as seen in Figure 7.4.

As stated earlier, landcover data at this broader 1km level does lend itself more readily to diplay and examination at smaller, regional or national scale. Subsequently the method of analysis described above was repeated for a larger portion of the landcover map. The same GIS procedures were followed and this smaller scale output produced. At this time, it was an intermediate version of the landcover map that was in use; some visual problems occurred. Figure 7.5 shows the distribution of 10% broadleaf woodland cover across a large part of Britain.

Some data are clearly missing, for instance most of Wales and sections of Hampshire and north east England. There is also a strip of anomalous data from the Humber estuary south towards the Isle of Wight. The gaps are now filled in the final landcover map. The anomalous strip follows the join between two strips of satellite imagery as it traversed the country. This 'noise' within the data has now been removed by the image analysis team responsible for the creation of the landcover map. With the landcover map now successfully completed and relevant database tables updated accordingly a repeat of the study would remove these effects. As we can see from this national map, and the earlier regional ones, the texture of the landscape with respect to the woodland habitat can be revealed in some detail using GIS technology and the ITE landcover map.

7.3 DORSET HEATHS - A SPECIFIC APPLICATION OF THE LANDCOVER MAP

This section describes a study carried out by Neil Veitch as part of a 3 year, Special Topic with the NERC Unit for Thematic Information Systems (NUTIS) at Reading University. It has been included in this report because of its close links with the ecological theory of 'corridors' or 'barriers to species dispersal' within the terrestrial environment. Most of the work has been done on the Tydac SPANS GIS but much is already being made available to other GIS platforms such as ARC/Info and IDRISI.

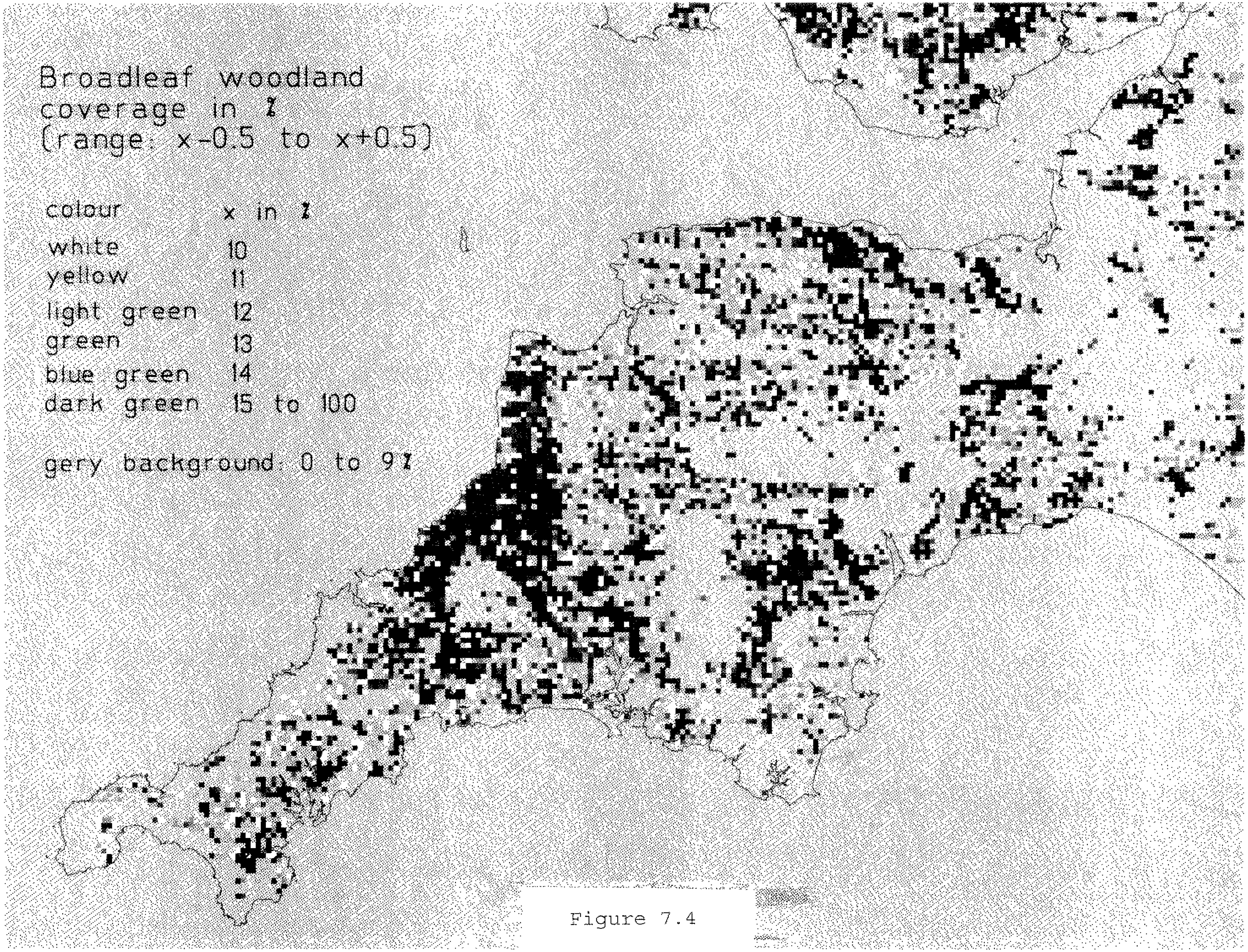
Broadleaf woodland
coverage in %
(range: x-0.5 to x+0.5)
colour x in %
white 10
yellow 11
light green 12
green 13
blue green 14
dark green 15 to 100
gery background: 0 to 9%

Figure 7.4

1KM SUMMARY DATA FROM THE ITE LANDCOVER MAP
(intermediate version of landcover map)

Figure 7.5

The Purbeck area of Dorset once supported the largest area of lowland dwarf-shrub heath in southern Britain. Since the turn of the century, increasing pressures from agriculture and urban development have fragmented this habitat and there is increasing need for its conservation and restoration.

The heathlands are characterised by being species poor. To be viable as heathland, a fragment must retain this characteristic. The fragmentation has resulted in the creation of many individual patches of heath. The number of species present in a fragment is related to the area and shape of the fragment. As a rule of thumb, large compact fragments are less prone to invasion (and therefore will have fewer species) than long thin fragments of the same area.

Information on the change in heathland distribution has been interpreted from a variety of historical map sources from 1811, 1896 and 1934, plus field surveys in 1960 and 1974. ITE carried out ecological surveys of the heathlands in 1978 and 1987 and the ITE landcover map provides the most up to date information.

Figure 7.6 shows the heath class extracted from the landcover map for the area around Hartland Moor. Fragments less than 10 hectares are considered to be too small to be viable, those less than 25 hectares are marginal and anything greater than 25 hectares is considered to be viable.

The separation of fragments of heathland may act as a barrier to the movement or spread of heathland species. One possible remedy for this is the restoration of non-heathland areas back to heathland or, put another way, the creation of corridors of heath between existing heathland fragments.

There is considerable interest in the potential for reconstructing areas of heath in Dorset. To assess the feasibility of this it is important to know the area of land that could be suitable for the re-establishment of heathland species. The specific conditions, particularly the nutrient-poor soils, under which heathland communities develop, may be modified to a greater or lesser extent by any subsequent land use on former heathland areas. By combining remotely sensed data with historic data on heathland extent it is possible to identify the current landuse and therefore give an indication as to the degree to which these soils may have been modified. Figure 7.7 shows how the raster/vector combinations employed within the GIS can provide a 'window' into an area of interest. Here the heathland areas from the 1811 maps have been combined with the full resolution landcover map to show the current landuse on what was, in the past, heathland. For instance, most of the area to the south east is now occupied by the urban area of Bournemouth. Agricultural grassland, particularly those areas that became grassland after 1960 and coniferous plantations, are believed to offer the best opportunities for reconstruction.

7.4 RELATED GIS DEVELOPMENTS

The procedures discussed so far have only scratched the surface of what is possible within the GIS, a brief description of some other related work will serve to illustrate further techniques that may be considered.

Current studies by ornithologists at ITE have led to increased interest in the use of GIS in studying the spatial properties of bird populations and their relationship with their habitat. The creation of the landcover map has magnified this interest. Pilot studies of the feeding characteristics of sparrowhawks (Newton 1986) are combining maps of nesting sites and woodland habitat with feeding ranges and are overlaying resulting polygons on the landcover map. For instance applying a 500 metre zone to identify how much of some other habitat type, such as grassland, is within 500 metres of woodland. This application relates to the breeding success of some bird species, such as sparrowhawk, appearing to be closely related to the proximity of woodland and grassland.

Vector-based GIS is operationally simpler for assessing the nature of polygon boundaries and boundary data are especially important in landscape terms. Therefore effort has been devoted to making some of these 'raster analysis techniques' operational within the vector based GIS, and applied to the landcover map. The analyses of pattern has examined cover information by itself but has also drawn in data from other sources: for example, it may be of interest to quantify cover types within fixed distances from roads as defined from published maps, to count woodlands on chalk soils or to estimate bracken boundary lengths above a mapped contour level.

Research continues within the ITE Monkswood GIS group on more complex analysis of the landcover map, building on the experiences described above. GIS is offering levels of data analysis not considered possible before and technological development of these GIS is, itself, removing previous limitations such as the raster/vector combination problems that have been mentioned. Simplification of processes and the customizing of systems to environmental investigation will lead to wider use of such systems by the environmentalists themselves rather than relying on the expert assistance of GIS specialists.

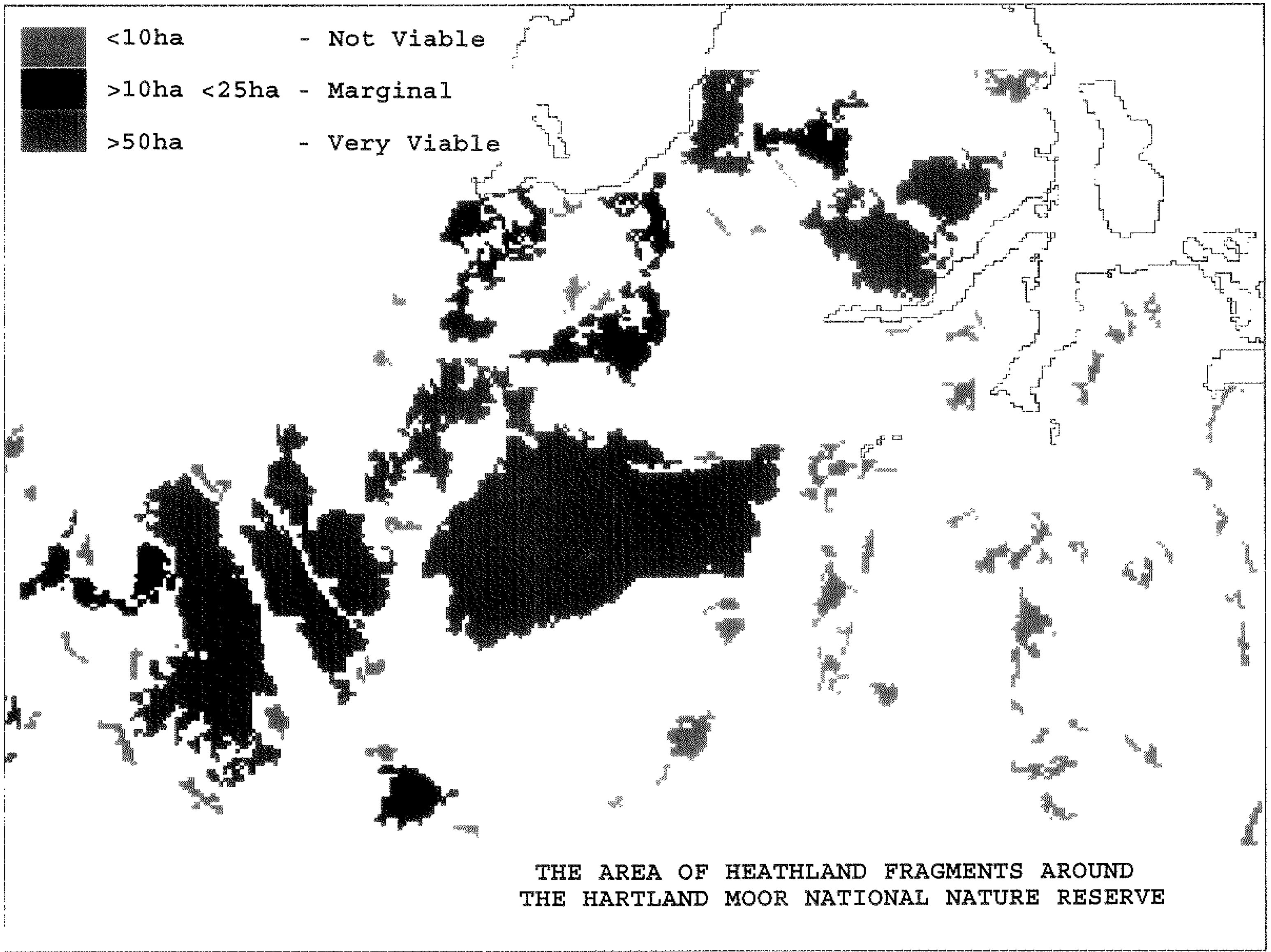
<10ha - Not Viable
>10ha <25ha - Marginal
>50ha - Very Viable
THE AREA OF HEATHLAND FRAGMENTS AROUND
THE HARTLAND MOOR NATIONAL NATURE RESERVE

Figure 7.6

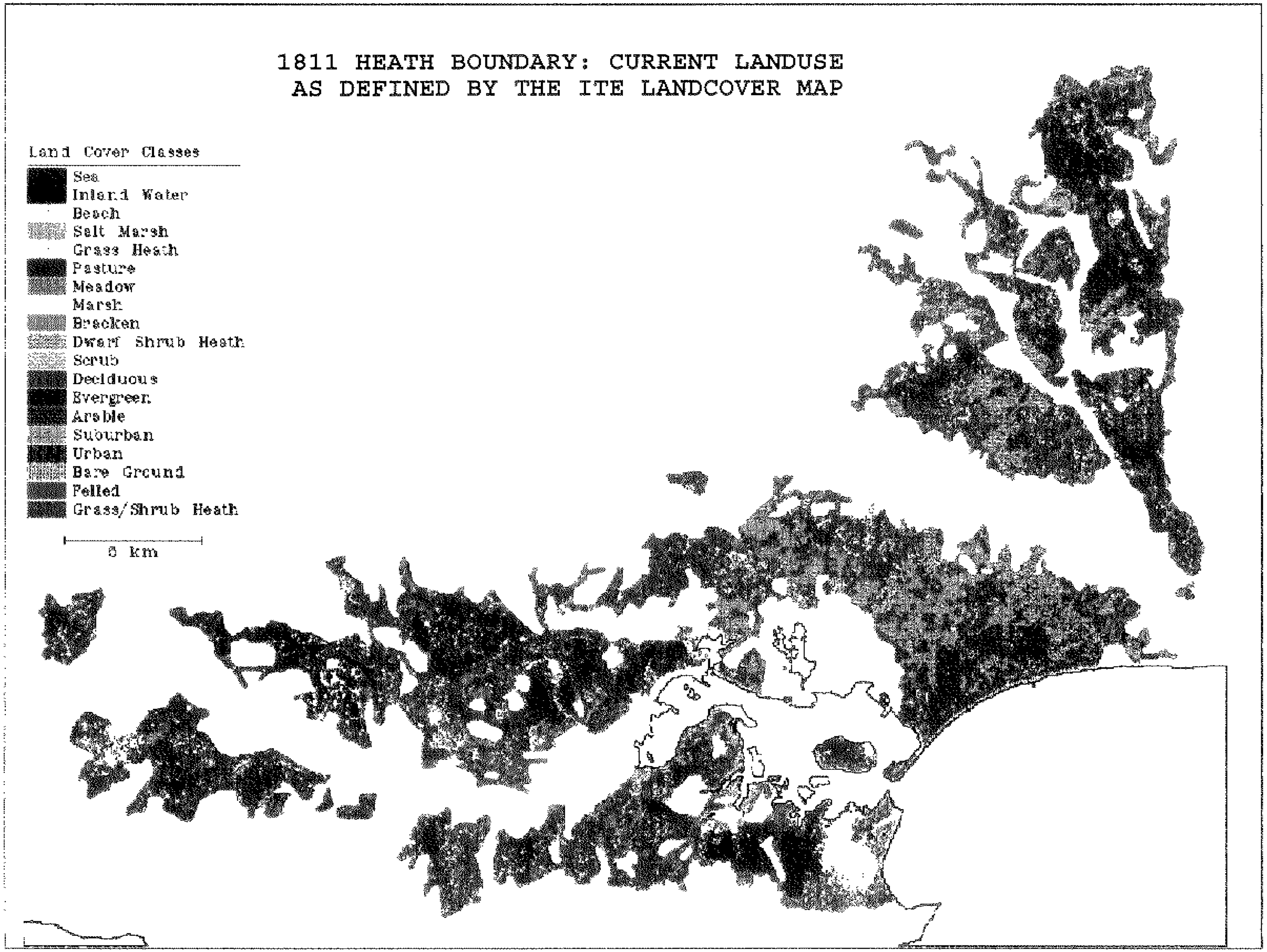
1811 HEATH BOUNDARY: CURRENT LANDUSE
AS DEFINED BY THE ITE LANDCOVER MAP
Land Cover Classes
Sea
Inland Water
Beach
Salt Marsh
Grass Heath
Pasture
Meadow
Marsh
Bracken
Dwarf Shrub Heath
Scrub
Deciduous
Evergreen
Arable
Suburban
Urban
Bare Ground
Felled
Grass/Shrub Heath
5 km

Figure 7.7