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Wildlife habitat in Cumbria

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CONTENTS Page

List of tables and appendices

List of figures

List of photographs

SUMMARY

This report presents the results of the Phase 1 Habitat Survey of Cumbria carried out in 1983-87.

The whole of Cumbria, 6,820 km^2, was mapped in terms of vegetation and land-use by field survey, using standard NCC methodology, on 330 map sheets at 1:10,000 scale, supported by descriptive notes and area measurements, to give a coherent and detailed picture of the wildlife habitat resource of the county.

The results are presented here in the form of tables, pie-charts and maps indicating the distribution of abundance on a 5 km grid.

Semi-natural habitats (excluding intertidal areas) cover 2,676 km^2, 39% of the county area, the majority occurring in the uplands in the form of acid grassland, blanket bog and heathlands. Half of the semi-natural vegetation occurs within the Lake District National Park.

The most abundant semi-natural habitat types are acid grassland (1,107 km^2), blanket bog (314 km^2), heathlands (314 km^2), bracken (205 km^2), broadleaved woodland (198 km^2) and marshy grassland (121 km^2). There are also 296 km^2 of intertidal habitat.

Important, though less abundant, semi-natural habitats are standing water (72 km^2), flush and soligenous mire (66 km^2), rock and scree (56 km^2), saltmarsh (39 km^2) and raised bog (30 km^2).

Scarce habitats, each contributing less than 1% to the semi-natural total, are neutral grassland (23 km^2), calcareous grassland (22 km^2), coastal rock, shingle and sand above HWM (22 km^2), running water (19 km^2), valley and basin mires (16 km^2), dunes (15 km^2), dense scrub (13 km^2) and coniferous and mixed woodland (12 km^2). Very scarce habitats are limestone pavement (7.8 km^2), tall herb and fern (3.1 km^2), swamp and fen (2.2 km^2) and maritime cliff (0.8 km^2).

The remainder of the county area is made up of improved grassland and arable land (2,841 km^2), semi-improved grassland (646 km^2), coniferous plantations (358 km^2), built-up land (265 km^2), quarries, spoil and refuse-tips (20 km^2) and broadleaved and mixed plantations (16 km^2).

The extent, nature and distribution of each habitat type are discussed against a background of the geology and geography of Cumbria, and the factors threatening the survival of each habitat are indicated.

Note

The taxonomic names of flowering plants are those used in Clapham, Tutin and Warburg 1981, and the English names are from Dony, Jury and Perring 1986. The geological account is based on Moseley 1978 and Taylor et al. 1971.

More detailed information on wildlife habitats and sites of conservation interest in Cumbria can be found in A Nature Conservation Review (Ratcliffe 1977), The Lake District (Pearsall & Pennington 1973) and other references cited in the text. For further information on nature conservation see Nature conservation in Great Britain (NCC 1984) and the Annual Reports of the Nature Conservancy Council. The NCC also publishes a series of booklets on the conservation and wildlife of various habitats.

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1 INTRODUCTION

1.1 Cumbria

1.1.1 Introduction

Cumbria is the second largest county in England, covering 6,820 km^2, with a further 300 km^2 between high and low water marks. It is also one of the most mountainous, with many of the highest mountains in England and a large area of land over 400 m.

The total population is 484,000 (Registrar General 1985), most of whom live in a few large towns, so that the majority of the county is sparsely populated. The overall population density of 0.7 per ha is less than that of any other English county except Northumberland.

The mountainous nature and low population density of Cumbria have contributed to the survival of a high proportion of semi-natural vegetation in the county, whilst the diversity of its geology and topography is reflected in the exceptionally wide range of habitats and species which are present.

Internationally renowned for its scenery and its rich cultural heritage, Cumbria is of national and possibly international importance for many of its wildlife habitats. Its mountains, lakes, rivers, moorlands, coastlands, peatlands, woodlands, grasslands and limestone outcrops all make major contributions to the natural heritage of Britain: their collective contribution is outstanding and their juxtaposition provides an added dimension which is truly unique.

The significance and extent of this natural heritage are reflected in the existence of the Lake District National Park, the largest of Britain's National Parks, which covers one third of the county area. A further 3% of the county, east of Sedbergh, forms part of the Yorkshire Dales National Park.

1.1.2 Relief

As can be seen from Figure 1, Cumbria is a mountainous county, with approximately half its land lying over 200 m above sea level and some over 800 m. Upland and montane habitats therefore make major contributions to its natural history.

The central massif of the Lake District fells is an uplifted dome of ancient hard rocks, rising to 980 m at Scafell Pike and deeply dissected by valleys radiating outward, many of which contain large lakes where they have been widened and deepened by glaciers in the past. These sheltered valleys contain a variety of woodland, grassland and wetland habitats, while the steep-sided ridges between them are characterised in many cases by an abundance of rocky cliffs, corries, ridges and summits, some of which are notable for their alpine flora. Others, less steep, are dominated by grass and heather moorland and provide grazing for sheep.

The long, broad ridge of the Pennines marks the eastern boundary of the county and reaches its highest point at Cross Fell (890 m). Much of this ridge is dominated by blanket bog with acid grassland and upland heather on its flanks, but the northern part has been extensively afforested.

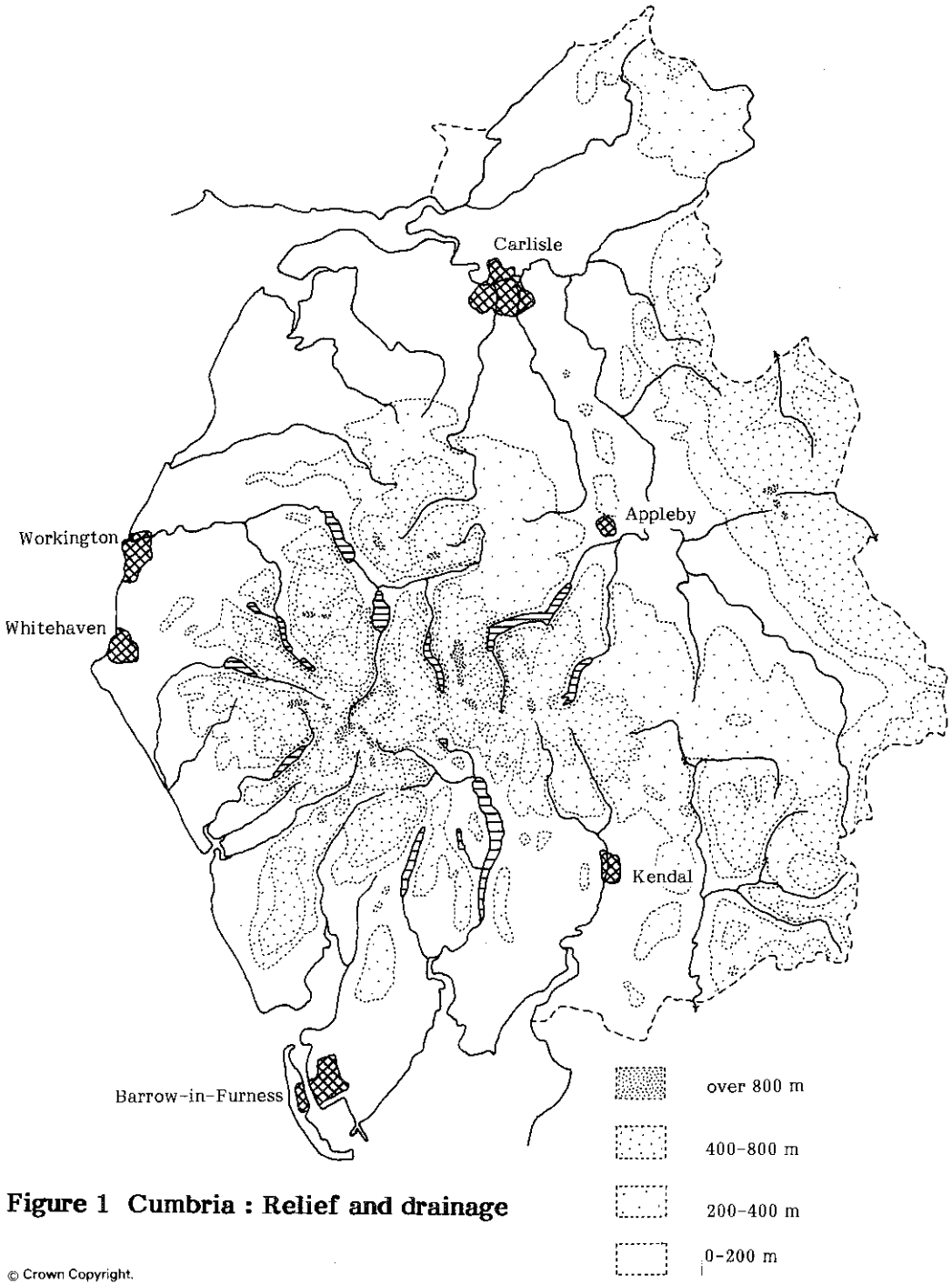


Figure 1 Cumbria : Relief and drainage

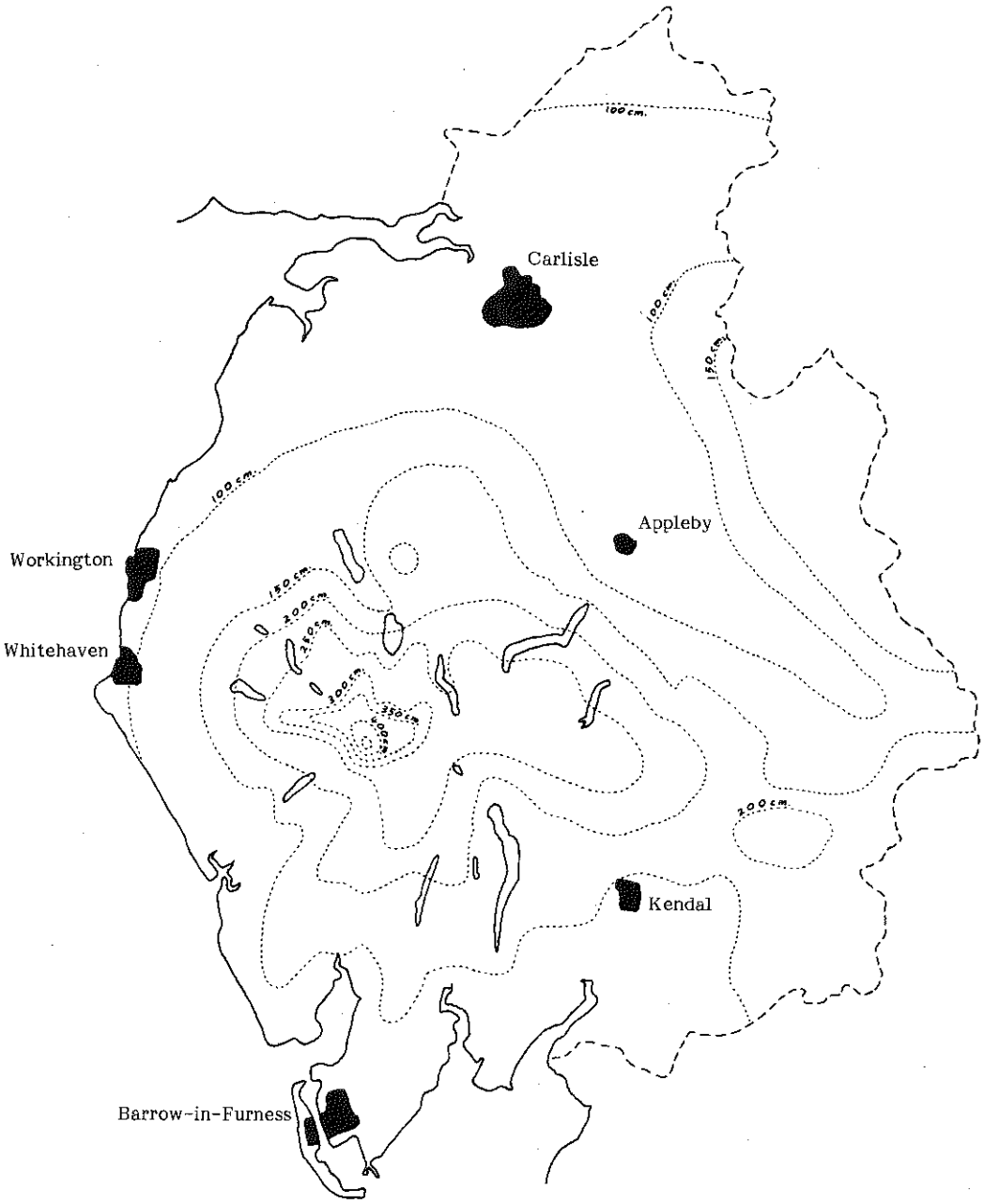


Figure 2 Cumbria : Annual rainfall (after Pearsall & Pennington 1973)

In the south-east of the county, the Howgills and neighbouring fells connect the Pennines with the eastern fells of the Lake District, being separated from these blocks by the Mallerstang and Lune gorges respectively. North of this, the two upland blocks are separated by the broad Vale of Eden, which opens out northwards onto the Carlisle Plain. The Lake District uplands are flanked to the north and south by relatively broad, low-lying plains along the Solway and Morecambe Bay coasts and by a narrower coastal plain on the west coast. Much of these lowland areas is agricultural land, grazing on the poorer soils and arable on the richer alluvial deposits, but the lowlands also provide some important woodland and wetland habitats and the lowland raised mires are of major importance, as are the vast intertidal areas of Morecambe Bay and the Solway.

1.1.3 Climate

The climate of the region is strongly influenced by its relief and particularly by the effect of relief on the prevailing westerly air-flow from the Atlantic.

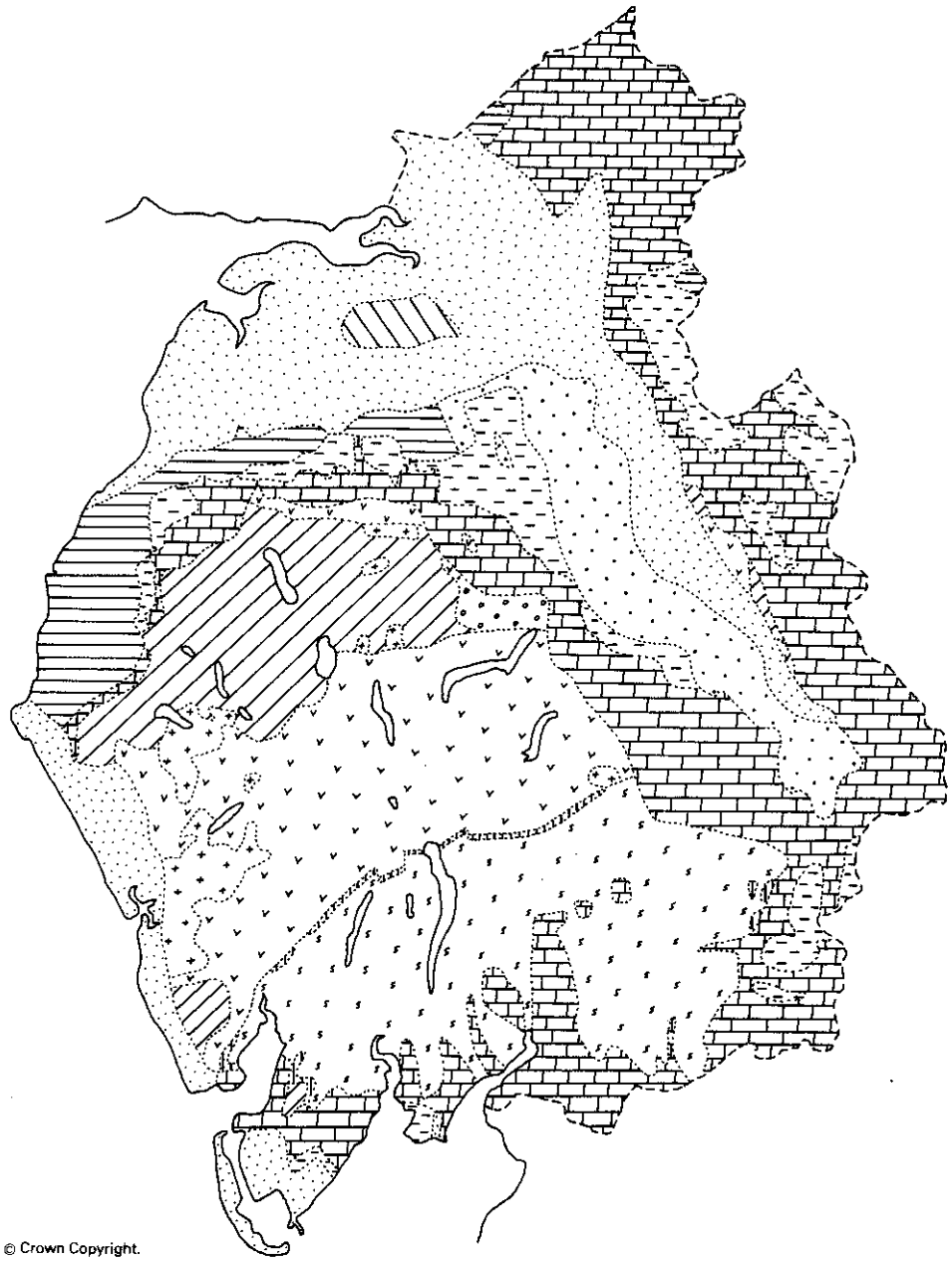
The coastal areas tend to have warm summers and mild winters with low annual rainfall (100 cm or less), while inland the valleys of the Lake District have a generally mild but markedly wetter climate with up to 250 cm of rain annually. The high mountains of the Central Fells are much more cold, wet and windy and the rainfall here may exceed 400 cm annually. In winter much of this falls as snow, which may lie on the fells for over 100 days per year.

As shown in Figure 2, the Eden Valley has a relatively dry climate, lying in an area of rain-shadow behind the Lake District fells. The Pennines also experience a reduced rainfall, but cold easterly winds and hard frosts produce a harsher climate than that found in the Lake District.

1.1.4 Geology

The topography of Cumbria is largely determined by the underlying geology, and the two in combination influence the nature and distribution of semi-natural habitats in the county. The distribution of geological strata is shown in Figure 3, but it should be borne in mind that in many parts of the county these may be overlain by deposits of glacial drift, sand and gravel, or peat, which may be of considerable depth.

The old, hard rocks of the Lake District have been repeatedly uplifted by movements of the earth's crust and worn down again by the processes of erosion and weathering. They consist of two series of ancient sedimentary rocks separated by a series of volcanic lavas and exposed in a chronological sequence from north to south. The oldest rocks, the Skiddaw Slates, were laid down as mud on the sea bed in Ordovician times, some 400 million years ago, and have since been crumpled, faulted and uplifted to form the mountains of Skiddaw and Blencathra and the northern fells. The central belt, forming the highest fells, consists of a series of lava flows and consolidated volcanic ash, the Borrowdale Volcanic series, probably erupted in shallow seas at the end of the Ordovician period. These rocks are harder than the Skiddaw Slates but contain faults, dykes and shatterbelts where they have cracked during crustal movements and consequently give rise to a rugged terrain of steep-sided fells with rocky crags and gills. Although generally acidic, the Borrowdale Volcanics include some fairly base-rich rocks and can give rise to moderately fertile brown-earth soils in the valleys, which support oak woodlands and neutral grasslands. The rocks of southern Lakeland are Silurian slates and shales, laid down during a period of marine subsidence which followed the Ordovician volcanic activity some 350 million



Key

- Jurassic (Liassic limestone)
- Triassic sandstones and mudstones
- Permian sandstones and shales
- Coal Measures
- Millstone Grit
- Carboniferous Limestone
- Devonian (Mell Fell conglomerate)
- Silurian slates and grits
- Upper Ordovician (Coniston Limestone)
- Ordovician Volcanics (Borrowdale and Eycott groups)
- Lower Ordovician (Skiddaw Slates)
- Igneous intrusions

Figure 3 Cumbria : Geology (after Moseley, 1978)

years ago. Subsequent folding, uplifting and glaciation have produced a characteristic landscape of rocky knolls which adds considerably to the charm of the Lake District. With the exception of some calcareous mudstones, these rocks are generally base-poor, but they are relatively soft and weather easily to give fairly deep soils, which carry oak woodland and bracken on the slopes and good farmland on the valley bottoms where more base-rich material from other strata has accumulated.

An abundance of small tarns mires and flushes is to be found in the intricately sculptured landscape of the Lake District, among the rocks of the Borrowdale Volcanic and Silurian series and where other richer rocks occur locally. A narrow band of metamorphosed limestone, the Coniston Limestone, which was laid down in shallow seas at the end of the Ordovician period, runs between the Borrowdale Volcanics and the Silurian slates and gives rise to lime-rich rock outcrops and flushes at intervals along its line.

Intrusions of granite at Shap to the east of the Lake District, near Skiddaw in the north and around Eskdale to the west probably date from the Devonian period, a time of major folding and uplifting of the Lake District rocks, which initiated the present form of the landscape. Granites weather slowly to give poor, thin, acid soils, which often carry heather moorland. Coarse sandstones and conglomerates in the Mell Fell area represent weathered material eroded during this period of uplift.

Around the edge of the Lake District, forming an incomplete ring, is a broad belt of Carboniferous Limestone, laid down in shallow tropical seas during a period of subsidence which followed some 50 million years after the previous mountain-building epoch. These relatively level strata are often overlain by glacial drift so that their influence is not as widespread as may appear from the solid geology shown in Figure 3, but where they are exposed the Carboniferous Limestones support a rich and attractive vegetation in the form of calcareous grasslands, woodlands and flushes and in the unique flora of limestone cliffs and pavements (see Section 3.9).

Carboniferous Limestones also outcrop in the east of Cumbria on the Pennines, where they are topped by Carboniferous Sandstones, Millstone Grits and Coal Measures. These strata give rise to the rather species-poor acidic moorland of the Pennines, but where the limestone outcrops a richer flora is found and ash woodland thrives in sheltered ravines. Late Carboniferous strata also occur north-west of the Lake District, in the form of the West Cumbrian Coalfield, which is currently being worked by opencast mining.

A second period of mountain-building followed at the end of the Carboniferous and a third during the Tertiary period, accompanied by millions of years of erosion culminating in the intense glacial activity of the Quaternary period which gave the landscape its present form.

In the Eden Valley and on the Carlisle Plain the Carboniferous strata are overlain by New Red Sandstones of the Permian and Triassic periods, and these strata also make up the western coastal plain from St Bees Head south to Barrow-in-Furness. The strata are generally level and low-lying and are overlain in many places by glacial drift and alluvium, producing good farmland, but where the sandstone is exposed lowland heath may develop on the sandy soils, as at Lazonby near Penrith. The later Triassic and Jurassic sediments of the Solway Plain are largely overlain by glacial drift.

The glaciation of the Quaternary period was of considerable importance in shaping the landscape and ecology of Cumbria. It not only carved out the deep valleys and lakes of the Lake District, but spread vast sheets of glacial drift over much of the remainder of the county. During the period which followed, alluvial deposits accumulated in valley and estuaries, including Morecambe Bay and the Solway, and blanket peat developed on the Pennines and raised bog peat on the coastal flats.

1.2 **The survey**

1.2.1 Introduction

This report presents the results of a survey of the semi-natural vegetation and wildlife habitats of Cumbria. It is generally considered that Britain has little or no truly natural vegetation. Apart from a few steep cliffs and remote mountain tops, there is no part of the countryside which has not been affected by the hand of man. Even the wildest of our woodlands, heathlands, moorlands and mires owes its present form, directly or indirectly, to the activities of man over many centuries and can be best described as semi-natural.

More recent widespread changes in the way land is used for agriculture, forestry, public amenities, industry, recreation and housing have resulted in the loss and modification of much of this semi-natural vegetation and a decline in the populations of both rare and common plants and animals.

The Nature Conservancy Council has a statutory duty to ensure that what remains is adequately conserved and to advise on the probable consequences for nature conservation of future developments in the countryside. In order to do this effectively it is necessary to ascertain the extent, condition and distribution of the various kinds of wildlife habitat in the country.

Surveying animal populations is a difficult and often lengthy process and it is not practicable to carry out such surveys over large areas for the many different species which inhabit the countryside. However, plant and animal species can only survive where there is suitable habitat for them, and many studies have demonstrated a relationship between the diversity of animal communities and the diversity of their habitat. It is a much more practical proposition to survey the vegetation and topography of an area and to consider these in terms of their value as wildlife habitat.

With this aim in view, the NCC has devised a system for classifying, mapping and recording wildlife habitats in the field. The system, known as Phase 1 ecological survey or habitat survey, provides the basis for a systematic and uniform survey of the countryside in terms of wildlife habitat. Phase 2 provides a more detailed description of the habitats in terms of defined communities, with species lists and quadrat data.

The Phase 1 system, as used in the present survey, was devised by the England Field Unit of the NCC (NCC 1982, 1983) and based on earlier systems used by the NCC in south-east Scotland, north-west England and south-east England (see Bonner 1979; Selmes 1981). It has been adopted by the Royal Society for Nature Conservation and has been used in habitat surveys carried out by the NCC, local naturalists' and conservation trusts and local authorities throughout England and Wales. A draft revision has been produced (NCC 1986) and a definitive version is expected shortly.

The Phase 1 survey of Cumbria, which started in 1977 using an early version of the habitat classification system, was one of the first of its kind in Britain and provides a valuable record of the wildlife habitat of that time. Unfortunately this survey was terminated, owing to lack of funds, in 1980, when less than one third of the county had been covered.

The present survey arose out of the opportunity presented by the Manpower Services Commission's Community Programme to obtain funding for projects of benefit to the community, provided that personnel were recruited from the long-term unemployed. Since there was at that time a pool of unemployed graduates with relevant skills and experience, a decision was made to resume the survey of Cumbria using MSC funding. In the event this enabled not only the completion of the survey but also the resurveying of all areas previously surveyed between 1977 and 1980. The design of the project was based on that of two similar projects which surveyed Somerset and Dorset in 1982-83 at a scale of 1:25,000 (NCC, SW England Region 1983a, 1983b).

The project spanned four years, from July 1983 to June 1987, and the resulting survey gives a complete and coherent picture in qualitative and quantitative terms of the wildlife habitat resource of Cumbria in the mid-1980s.

1.2.2 Objectives and purpose

The objective of Phase 1 survey is to provide a complete and up to-date record of the wildlife habitats of the whole of a given area, including information on their extent, location and conservation value. This is achieved by comprehensive field-mapping at a scale of 1:10,000, to produce a series of colour-coded habitat maps, supported by brief descriptive notes summarising the interest of particular sites. Habitat area data derived from measurements on the maps are compiled for appropriate administrative units in order to show the relative abundance of each habitat type and its distribution.

The advantage of field survey over aerial photography or remote sensing is that it can yield information on the plant and animal species present at any site and also on the current management and possible threats to that site. Being comprehensive, the survey can give information on sites which have been overlooked by more selective surveys, and the present survey has from time to time brought to light new sites of local and regional importance.

The completed survey provides a basis for the selection of sites for more detailed survey (Phase 2), for the the preparation of site inventories of particular habitat types and for the selection of sites for designation as Sites of Special Scientific Interest, Local Nature Reserves, etc.

The reports and statistical data produced by the survey provide a context within which individual sites can be evaluated and a basis for the development of habitat conservation strategies. The maps, notes and statistics also constitute a baseline from which future habitat change can be measured.

Phase 1 survey provides the basic information on conservation value needed in dealing with planning and other enquiries, as in the case of proposed farm improvements, building developments, road improvements and opencast mining. Many of these enquiries can be answered without further survey and, where additional information is needed, the Phase 1 survey gives a useful overview of the area, indicating where effort should be directed. Most importantly, sites are not lost or damaged through lack of information.

Phase 1 survey is also a valuable planning tool at county and district levels, providing information on the status and distribution of individual habitats within an administrative unit as well as more specific site-related information. Such information is particularly useful to local authorities in the preparation of local, structure and subject plans, unitary development plans and nature conservation strategies.

In areas where comprehensive Phase 1 survey is available, as in West Yorkshire, Cheshire and Wigan, local authorities have come to regard it as an important planning tool, particularly where maps and other survey data can be readily accessed by computer.

1.2.3 Staffing and organisation

The survey was funded by the Manpower Services Commission through a series of Community Programme (CP) schemes from July 1983 to June 1987 (see Appendix 4). Initially these schemes were administered by the NCC and the staff consisted of a survey supervisor, four surveyors, a cartographer and a typist, based at the NCC Regional Office, Windermere. From June 1985 a second survey team was added, with its own support staff, based in Workington, and the scheme was administered by Cumbria County Council. From April 1985 the survey was directed by a Survey Co-ordinator, under contract to the NCC, who was also responsible for recruitment, training, technical supervision and liaison.

The field team was made up of graduate biologists, selected for their knowledge of ecology and experience in field botany, experience in the use of large-scale maps in the field, physical fitness, willingness to endure the rigours of protracted fieldwork, and interest and enthusiasm for the project. The supervisors, with similar but more extensive experience, worked in the field with the surveyors, rotating staff and checking their work to maintain quality and consistency in the survey.

In order to facilitate coverage of the county it was found necessary to base the survey teams away from the Regional Office for much of the time. Thus in 1983 the survey team was based for a time at Newton Rigg College of Agriculture, near Penrith, and in 1985 a team was based in a rented farmhouse near Penrith, from which they surveyed much of Carlisle and Eden Districts. A second survey team, which surveyed Allerdale and Copeland Districts in 1985 and 1986, was based in rented offices, initially at Cleator Moor and later at Workington.

All the participants in the Community Programme had to have been unemployed for at least six months up to the time of their recruitment. This caused some problems in finding suitable personnel, particularly in the later years of the project, when recruitment became a lengthy process and encroached upon the field season. Two other aspects of the CP contract also had repercussions on the survey. First, staff were only entitled to 52 weeks on the scheme (although extensions were granted from time to time) and, secondly, they were encouraged to continue their search for permanent employment and often left early to take up other posts. Thus, while the scheme was successful in the aims of training its participants and placing them in employment, it suffered as a result from loss of staff and from delays in their replacement.

Recruitment delays in 1985 resulted in a late start to the West Cumbria project and left 450 km^2 of Allerdale unsurveyed at the end of the season. The need to extend the survey for a further year provided the opportunity to resurvey all areas previously covered by the NCC Phase 1 Ecological Survey of 1977-80, and both survey teams were retained for this purpose. Unfortunately, continuing problems with recruitment resulted in the loss of a total of 87 surveyor-weeks during the 1986 field season and a further 48 surveyor-weeks during the winter period. In spite of this, the survey programme was almost completed by continuing field survey into November and December, aided by exceptionally fine autumn weather and a good measure of fortitude and determination on the part of the survey team, and the remaining gaps were filled the following

spring. Clearly this could only be done at the expense of the indoor work programme and, although almost all survey maps were measured and analysed, only four of the district reports were produced.

Some relief from the acute shortage of staff was afforded by a contract from Barrow-in-Furness Borough Council which enabled Mrs A Kyle, a former cartographer on the CP scheme, to carry out the survey, analysis and report for this 80 km^2 borough. Further short contracts, funded by the NCC, allowed Mrs A Riddell to complete the measurement of outstanding maps remaining at the end of the CP scheme and K Perry to assist with the compilation, checking and analysis of the habitat data and the production of this report.

In the course of its four years the survey employed a total of five supervisors, 24 surveyors, eight cartographers and 11 clerical assistant/typists. The pattern of staffing during the four separate CP schemes which constituted the survey is shown in Appendix 4.

1.2.4 Survey procedure

Fieldwork was carried out between mid-April and late October by the field teams, each consisting of four surveyors and a supervisor. After an initial period of field training, the surveyors worked in pairs in the field, recording vegetation and land-use from roads and public footpaths wherever possible. Where access to land away from public rights of way was needed, permission was sought at the time of survey and was rarely refused. Much use was made of binoculars in viewing habitat types at moderately short range and, in suitable terrain, the use of vantage points allowed intensively farmed areas to be mapped rapidly and potentially interesting sites to be picked out for closer examination on foot.

Semi-natural habitats were mapped in colour in the field, on photocopies of 1:10,000 scale Ordnance Survey maps, by using the standard Phase 1 habitat codes (NCC 1983) with dominant species indicated by standard letter codes superimposed on the habitat colours.

All units greater than 0.25 ha (i.e. 50 m x 50 m) were mapped and some areas of smaller size where these were ecologically significant. Sites considered to be of wildlife interest were marked on the map with a red 'target' symbol and described in a brief grid-referenced target note, indicating the nature of the site and its wildlife interest, naming the dominant and significant plant species and noting current management and other relevant information, together with the date of survey and surveyors' initials.

Each 5 x 5 km map sheet of the 1:10,000 scale O.S. series was completed by a pair of surveyors, often working separately over quite large areas but maintaining contact for reasons of safety and consistency. Careful route-planning to make the best use of access routes and vantage points was found to be the key to complete and efficient coverage of the map. The surveyors worked systematically over the map, each pair on average completing one 25 km^2 map sheet per week, although in practice this rate varied considerably according to terrain and habitat type. Bad weather frequently hampered fieldwork and slowed down the rate of survey, but, with considerable input from the supervisor, the overall rate was maintained.

In a comprehensive survey of this nature it is not possible to visit every habitat at the best time of year. Although this was the general aim, it was inevitable that some sites were visited too early or too late to make the best assessment

of their conservation interest, although it was usually possible to get some indication of their quality. In these cases the target note would indicate the need for further survey earlier or later in the year. The problem arises most seriously in the case of recently cut hay-meadows. When there was doubt, these were included in the semi-natural category, since all fields in this category merit further survey in the future (see Section 3.2).

Rich and varied habitats require more detailed target notes than simpler ones, but the time spent on visiting such sites was limited, allowing just sufficient time to indicate the nature of the interest at that site. Large woodlands could not be surveyed in detail and target notes for these were generally based on visits to one or two locations within the wood combined with observations from the boundary. Linear habitats such as streams and coastlines were not walked in their entirety; instead these too were sampled at a number of points. Target notes were also used to indicate the need for further survey on large or complex sites, on sites visited at an inopportune time of year and the occasional site to which access was refused.

After a few days in the field, while the information was fresh in the mind, the surveyors would spend a day in the office producing a fair copy from their field maps and writing out target notes from their notebooks. The notes were then typed and the completed fair-copy maps were passed to a cartographic assistant, who produced the final copy on the 1:10,000 scale O.S. base map.

Once the fieldwork was completed, time was spent checking the maps and target notes, particular attention being paid to the agreement between the 6-figure grid references and the target notes and the positions of target symbols on the maps and to agreement between the habitat mapping along the edges of adjacent maps.

Since the period when lowland grassland and woodlands can most easily be classified and evaluated is restricted, areas rich in these habitats were given priority between May and July. Moorland habitats, by contrast, can be most easily assessed later in the year, so these areas were surveyed towards the end of the field season.

During the winter period, information from the files of the NCC and Cumbria Trust for Nature Conservation (CTNC) was added to the target notes and further target symbols were added to the map where necessary. Whenever possible, the information from previous surveys was compiled prior to the field season and target symbols were marked on the surveyors' field maps to indicate areas of interest to be checked in the field.

Where contemporary (1980s) survey already existed, as in the case of the NCC Upland Survey, Phase 2 habitat surveys and Lake District Special Planning Board Surveys (see Section 1.3), the maps were transcribed onto fair-copy maps, using Phase 1 coding, and the survey boundaries marked on the field maps to avoid unnecessary resurvey.

During the winter season following survey, all habitat areas were measured on the completed habitat maps, as described in the following section, and a general description was written for each sheet, summarising its topography, geology, vegetation and conservation interest. This quantitative and qualitative information was then summarised in the form of district reports, which included tabulated and graphical presentation of habitat area data, 5 km habitat distribution maps and descriptive accounts of each habitat in the district (NCC, NW England Region 1986, 1987a, 1987b, 1987c).

1.2.5 Analysis of habitat data

In order to determine the distribution and extent of each habitat category within each district and within the county as a whole, habitat areas were measured on the 1:10,000 scale maps using a Romer dot grid. This is a transparent overlay which divides each 1 km grid square of the maps into 100 squares, each of 1 ha, containing 25 equally-spaced dots. The number of dots lying over a single habitat unit is counted and multiplied by 0.04 to give the area in hectares of that unit on the ground. A digital planimeter was also available, but it was found to be more convenient to use the dot grid for area measurement of the habitat units, which were often rather small. The planimeter was used mainly for measuring large areas of intertidal habitat and for checking the total area of each district on a given map sheet.

The area of each distinct unit of habitat was measured within each 1 km square on the final hand-coloured 1:10,000 scale O.S. maps. Where habitat units crossed into adjacent squares, the area in each square was recorded separately, with a linking grid reference so that the total area of each habitat unit could be calculated at a future date.

The measurements for each 1 km square were recorded on a single form, but where a district boundary or a National Park boundary crossed a grid square the data for each administrative unit were recorded on separate forms. The total area of each habitat category within each 1 km square (or part square) on a 5 x 5 km map sheet was recorded on a second form, summarising the habitat area totals for the map sheet within a given administrative unit. The map sheet totals were then collected on a third form and summed to give the total area of each habitat inside and outside the National Park boundaries in each district. The results, shown in the next section, represent some 150,000 area measurements from 7,000 grid squares on 330 map sheets covering six districts and five National Park units. No computer facilities were available, so all calculations were performed on pocket calculators and double-checked.

The accuracy of area measurement, to 0.04 ha, greatly exceeds the accuracy of mapping, estimated to be from 0.1 to 0.25 ha and is thus more than adequate for the purpose. The greatest potential source of error in a survey of this kind arises from the possibility of assigning a habitat to the wrong category. Such errors can only be estimated quantitatively by systematic replication of the survey, but time and resources did not allow this. Instead, effort was put into reducing these errors by careful training and supervision, by interchanging between pairs of surveyors and by careful comparison of adjacent maps. Areas of doubt were re-examined in the field.

The second largest source of error is likely to be in recording the location of habitat boundaries on the map. No attempt has been made to estimate this error, which will be most significant in the case of small, unbounded habitats. Fortunately the majority of habitat units are well defined, with boundaries already shown on the O.S. map.

The effect of errors in mapping and measuring habitat boundaries is further reduced by the fact that for many habitats the bulk of the final total is made up of relatively large units, where the percentage error is small, so that the accumulated error on the smaller units is not significant. It is unlikely that any of the county or district totals is in error by more than 5%.

1.3 Previous surveys

1.3.1 NCC Phase 1 Survey 1977-80

The Phase 1 survey of Cumbria was initiated in 1977, using a habitat classification developed from a prototype used in SE Scotland (NCC, NW England Region 1977). The survey was one of the first to undertake complete coverage of a county and continued for four years, employing two contract surveyors each year and covering 400 to 450 km^2 per year, except for 1979 when a second pair of surveyors was employed to survey North West Water Authority catchments, raising the total for that year to 650 km^2. When the survey was terminated, owing to lack of funds, it had covered approximately 2,000 km^2 of Cumbria, including the Borough of Barrow-in-Furness, a large part of South Lakeland District, part of southern Copeland and the Solway Plain region of Allerdale and Carlisle Districts, together with the catchments of Haweswater and Thirlmere.

The methodology of the present survey is largely based on that of the 1977-80 survey, and the excellent maps and target notes produced by that survey set a standard for the work of the present survey and provided a sound basis for resurvey in 1986-87.

It is unfortunate that changes in the habitat classification system make it difficult to compare directly the results of the 1977-80 and 1986-87 surveys, but it is clear from the maps and target notes that considerable changes have taken place in the semi-natural vegetation during the short period between the two surveys. The most obvious change is the large number of haymeadows, including many herb-rich examples, recorded by the earlier survey which had been lost through agricultural improvement by the time of the second survey.

1.3.2 NCC Upland Survey 1977

This survey, carried out for the NCC by D Horsfield and J Brodie, produced 1:10,000 scale habitat maps for five large upland SSSIs in Cumbria, covering the Skiddaw Forest massif, the Helvellyn/Fairfield block, Cross Fell, the Appleby Fells and Mallerstang and Swaledale Head. Excluding the bulk of the latter site, which lies in North Yorkshire, the survey mapped some 170 km^2 of the Cumbrian uplands using a habitat classification which accords reasonably well with the current Phase 1 system, although the blanket bog category is broader and certain categories, such as wet heath, are not distinguished. The survey reports, revised by A J Poulter (NCC 1978), are detailed and useful, with full species lists and quadrat data for each habitat type.

Moor House NNR and Bellbeaver SSSI were also surveyed in 1977, by I Brown and B Larkin, and a similar though less detailed survey of the Geltsdale and Tindale Fells was carried out in the same year, bringing the total area of upland survey close to 300 km^2.

1.3.3 NCC Upland Survey 1983-86

A revised upland survey, using the upland vegetation classification of Ratcliffe & Birks (1980), was undertaken on all the major upland SSSIs in Cumbria between 1983 and 1986. The sites covered were Appleby Fells (1983); Armboth Fells, Cross Fell, Mallerstang and Swaledale Head, Shap Fells, Great Gable, Pillar, Scafell and Wasdale Fells (1984); Buttermere Fells, Geltsdale and Glendue Fells, Helvellyn and Fairfield, Martindale, Skiddaw Forest and Troutbeck Head (1985); and Birk Fell, Honister Crag, Orton Fells and Whernside (1986).

The results were presented in the form of overlays to aerial photographs accompanied by descriptive notes. In order to provide complete Phase 1 coverage of Cumbria, these surveys have been converted to standard Phase 1 habitat categories and mapped on 1:10,000 scale O.S. maps by the habitat survey teams.

1.3.4 Other NCC surveys

Habitat maps have been prepared for all notified SSSIs in Cumbria, using the Phase 2 habitat classification (a more detailed system from which the Phase 1 categories were derived). It was not considered to be desirable or useful for Phase 1 surveyors to resurvey these sites, so the existing surveys were transcribed onto Phase 1 maps using Phase 1 habitat categories.

NCC also holds a wealth of information, from site visits by NCC staff and other individuals, in grid-referenced scientific files in the Regional Office. This information was collated and incorporated into the survey as described previously.

1.3.5 Lake District Special Planning Board surveys

A number of large sites, totalling 125 km^2, were surveyed in 1980, 1982 and 1984 by the Lake District Special Planning Board (LDSPB), using the NCC's 1977 habitat classification (NCC, NW England Region 1977). The sites surveyed were Blawith and Torver Commons (1980), Caldbeck and Ulldale Fells (1982) and Kinniside Common, Thornthwaite Forest and Wasdale Head (1984). These surveys were also transcribed by the present survey teams, using the current Phase 1 system.

1.3.6 National Trust surveys

In 1980 the National Trust carried out biological surveys of all its holdings in Cumbria. Although the habitat categories used in the surveys were designed to be compatible with the NCC's 1977 habitat classification, the maps were not found to be suitable for direct incorporation into the present Phase 1 survey. The reports of the National Trust surveys are, nevertheless, very informative and provided the basis for a rapid resurvey of these sites.

1.3.7 National Countryside Monitoring Scheme 1984-86

The National Countryside Monitoring Scheme (NCMS) is a study of habitat change in the countryside, based on the comparison of a sample of aerial photographs from the mid-1940s and the mid-1970s. Cumbria was chosen as a pilot area for this study, and the report Changes in the Cumbrian countryside (NCC 1987) showed dramatic changes and significant losses in semi-natural habitat during that period and indications that these are continuing. The findings of this survey are discussed in the relevant habitat sections of this report.

Unfortunately the nature of the NCMS study does not permit a direct comparison of their findings with those of the present survey. Nevertheless, the scale and direction of the principal changes found in the NCMS study fit well with the results of this survey and with the observations of the surveyors in the field.

TABLE 1 TOTAL AREAS OF HABITAT CLASSES IN CUMBRIA

Habitat	Total area (km^2)	% of county area	% of semi-natural area
Broadleaved woodland	197.5	2.90	7.38
Coniferous woodland	2.9	0.04	0.11
Mixed woodland	8.9	0.13	0.33
Dense/continuous scrub	13.0	0.19	0.49
Acid grassland	1,106.5	16.22	41.35
Neutral grassland	22.9	0.34	0.85
Calcareous grassland	21.9	0.32	0.82
Marshy grassland	120.8	1.77	4.51
Continuous bracken	205.2	3.01	7.67
Tall herb & fern	3.1	0.05	0.12
Dry heath	161.7	2.37	6.04
Wet heath	46.9	0.69	1.75
Dry heath/acid grassland	75.5	1.11	2.82
Wet heath/acid grassland	29.7	0.44	1.11
Blanket bog	313.6	4.60	11.72
Raised bog	29.5	0.43	1.10
Valley bog/basin mire	16.4	0.24	0.61
Flush/soligenous mire	66.4	0.97	2.48
Swamp & fen	2.2	0.03	0.08
Standing water	72.0	1.06	2.69
Running water	19.4	0.29	0.73
Saltmarsh	38.9	0.57	1.45
Coastal rock, shingle, sand	22.1	0.32	0.83
Open dune	5.2	0.08	0.19
Fixed dune	9.4	0.14	0.35
Maritime cliff	0.8	0.01	0.03
Inland rock & scree	55.7	0.82	2.08
Limestone pavement	7.8	0.11	0.29
Total area semi-natural habitat	2,675.9	39.24	100.00
Broadleaved plantation	3.9	0.06	
Coniferous plantation	357.8	5.25	
Mixed plantation	12.0	0.18	
Total plantation area	373.6	5.48	
Quarry, spoil & refuse	19.6	0.29	
Built-up, road & rail	265.1	3.89	
Agricultural	3,486.7	51.12	
Total land area	6,820.2	100.00	
Semi-improved grassland[1]	646.1		
Intertidal[2]	296.1		

[1] Included in agricultural total
[2] Not included in land area

2 RESULTS

The overall results of the survey are presented in Table 1, which shows the total area in square kilometres of each habitat type in the county. The proportions contributed by each of the major habitat groups are shown in Table 2 and Figure 4.

TABLE 2 ANALYSIS OF MAJOR HABITAT CLASSES IN CUMBRIA

	Total area (ha)	% of county area
Semi-natural	267,594.0	39.2
Plantation	37,362.0	5.5
Agricultural (including semi-improved grassland)	348,607.6	51.1
Built-up	17,955.5	2.6
Road and rail	8,547.0	1.3
Quarry, spoil and refuse	1,955.9	0.3
Total	682,022.0	100.0

It will be seen that the semi-natural habitats collectively total 2,676 km^2, accounting for 39% of the land area of the county, with an additional 296 km^2 of intertidal habitats below high water mark. Agricultural land, consisting of arable land, improved and semi-improved grassland, farm tracks and hedges, makes up 3,487 km^2, 51% of the county area. Built-up land, including the surfaces of roads and railways, occupies 286 km^2, almost 4% of the county, while 374 km^2 of plantation woodlands accounts for a further 5.5%.

The semi-natural vegetation of the county is analysed in terms of broad habitat categories in Table 3, while Figure 5 shows diagrammatically their relative proportions and Figure 6 indicates their distribution relative to the National Parks.

It is readily seen that the predominant form of semi-natural habitat is unimproved grassland, which covers 19% of the county area and makes up 47% of the semi-natural vegetation. The majority of this grassland (87%) is acid grassland, so that this single habitat class accounts for over 40% of the semi-natural vegetation cover of the county. Semi-natural woodlands cover only 3.3%, while conifer plantations cover 5.3% of the county and dense bracken covers a further

3.0%. Peatlands, predominantly blanket bog, cover 6.2% of the land and make up 16% of the semi-natural vegetation, while heathlands cover 4.6% of the county and contribute 12% of the semi-natural total. It should be noted that not all of the heathland area is heather-dominated, since this class also includes bilberry-dominated heathland and open heaths which are a mosaic of heathland and grassland. Heather-dominated vegetation is also found in the peatland categories, particularly in blanket bog and raised bog habitats.

TABLE 3 ANALYSIS OF SEMI-NATURAL HABITAT CLASSES IN CUMBRIA

	Total area (ha)	% of total land area	% of total semi-natural area
Grasslands	127,201.6	18.7	47.5
Peatlands	42,815.8	6.2	16.0
Heathlands	31,373.5	4.6	11.7
Woodlands	22,235.1	3.3	8.3
Bracken, tall herb and fern	20,831.2	3.1	7.8
Open and running waters	9,149.3	1.3	3.4
Coastal*	7,636.4	1.1	2.9
Inland rock and scree	5,573.4	0.8	2.1
Limestone pavement	777.4	0.1	0.3
Total	267,593.6	39.2	100.0

* Excluding 29,611 ha of intertidal habitats

Table 4 summarises the results for the Lake District National Park, and these figures are further analysed in Appendix 2, which compares the areas of each habitat type within the Lake District and Yorkshire Dales National Parks and outside the National Parks. The Cumbria habitat areas and National Park habitat areas are broken down by district in Appendices 1 and 3 respectively.

As might be expected, the Lake District National Park has a much higher proportion of semi-natural vegetation than the county as a whole, the proportions being 61% and 39% respectively. The National Park contains approximately half of the semi-natural woodlands and grasslands in Cumbria and 52% of all

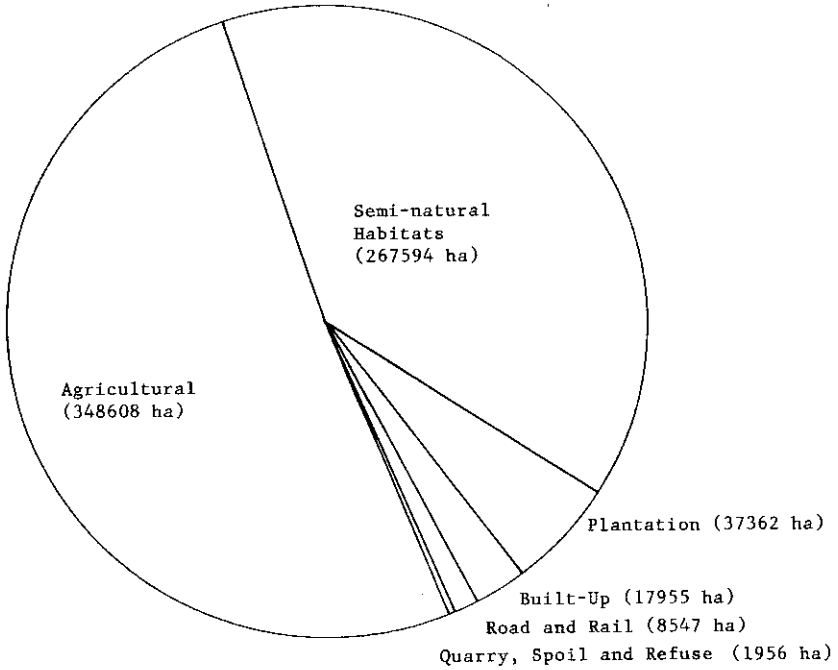


Figure 4 Relative proportions of major habitat classes in Cumbria

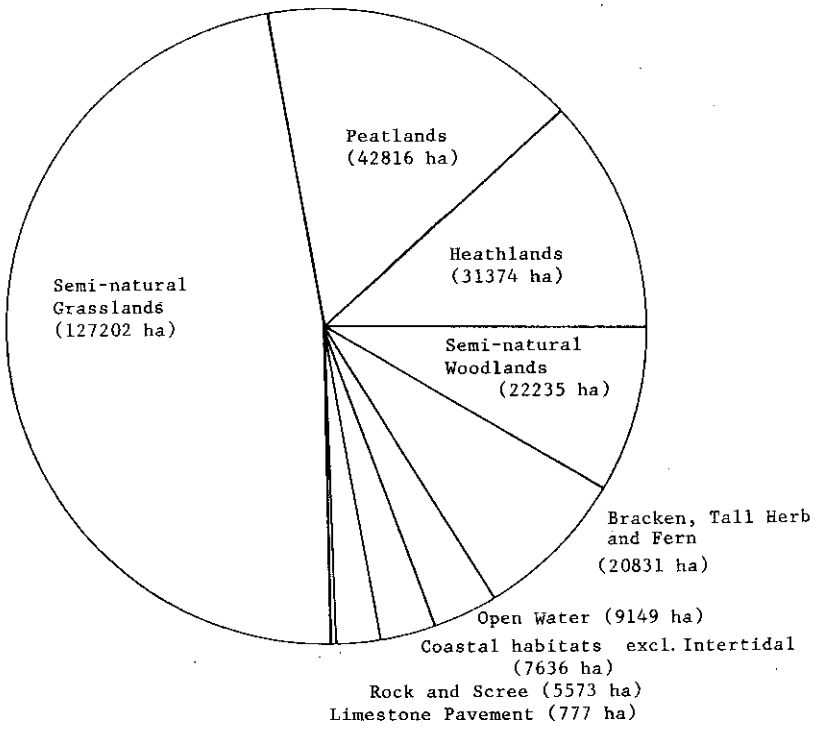


Figure 5 Relative proportions of semi-natural habitat classes in Cumbria

TABLE 4 TOTAL AREAS OF HABITAT CLASSES WITHIN THE LAKE DISTRICT NATIONAL PARK

Habitat	Total area (in ha)	% of Park area	% of semi-natural area
Broadleaved woodland	10,425.3	4.58	7.54
Coniferous woodland	118.4	0.05	0.08
Mixed woodland	503.3	0.02	0.36
Dense/Continuous scrub	576.2	0.25	0.42
Acid grassland	62,039.8	27.26	44.85
Neutral grassland	379.9	0.17	0.27
Calcareous grassland	589.0	0.26	0.43
Marshy grassland	5,052.3	2.22	3.65
Continuous bracken	16,672.4	7.32	12.05
Tall herb & fern	57.5	0.03	0.04
Dry heath	10,952.7	4.81	7.92
Wet heath	1,530.8	0.67	1.11
Dry heath/acid grassland	4,664.3	2.05	3.37
Wet heath/acid grassland	631.3	0.28	0.46
Blanket bog	4,862.1	2.14	3.51
Raised bog	244.4	0.11	0.18
Valley bog/basin mire	1,209.9	0.53	0.87
Flush/soligenous mire	4,916.0	2.16	3.55
Swamp & fen	87.3	0.04	0.66
Standing water	6,300.0	2.76	4.55
Running water	620.1	0.27	0.45
Saltmarsh	254.3	0.11	0.18
Coastal rock, shingle, sand	95.6	0.04	0.07
Open dune	208.9	0.09	0.15
Fixed dune	292.8	0.13	0.21
Maritime cliff	11.6	0.01	0.01
Inland rock & scree	4,966.7	2.18	3.59
Limestone pavement	57.5	0.02	0.04
Total area semi-natural habitat	138,320.4	60.76	100.00
Broadleaved plantation	167.1	0.07	
Coniferous plantation	12,951.6	5.69	
Mixed plantation	314.7	0.14	
Total plantation area	13,433.4	5.90	
Quarry, spoil & refuse	307.7	0.14	
Built-up	2,606.3	1.15	
Agricultural, road & rail	72,845.4	32.00	
Total land area	227,513.2	100.00	
Semi-improved grassland[1]	7,281.0		
Intertidal[2]	1,459.0		

1 Included in agricultural total
2 Not included in land area

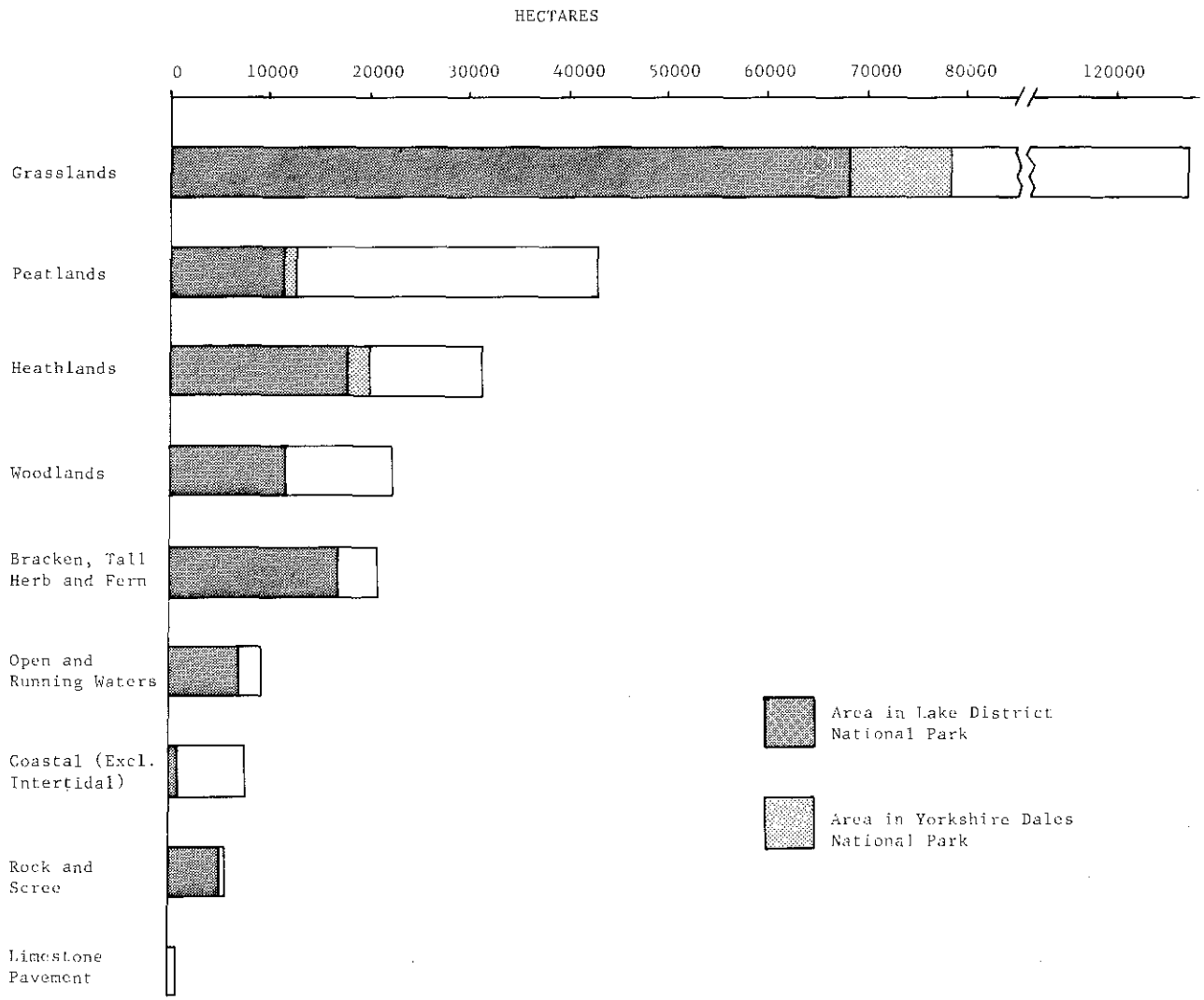


Figure 6 Areas of semi-natural habitat classes in Cumbria and proportions in the National Parks

the semi-natural vegetation in the county. It is not surprising that rock and scree are particularly well represented within the National Park, as are also bracken and the open water of the lakes themselves. Other habitats, however, are strikingly under-represented within the National Park area, notably saltmarsh and beach habitats, limestone pavements, raised bogs, blanket bogs and neutral grassland.

An indication of the geographical distribution of various types of semi-natural habitat can be obtained from Figures 9, 10, 15 - 22 and 27 - 30, while Figure 8 shows the distribution of semi-natural vegetation as a whole. These maps use tone densities to indicate the proportion, by area, of a given habitat category within each 5 km square in the county and summarise the results of the habitat area measurements carried out on the 1:10,000 scale map sheets. A non-linear incremental scale has been used to give more information where habitats are relatively scarce.

The correlation between the distribution of semi-natural vegetation and the topography and relief of the county can be seen clearly in Figure 8, where the highest densities are found in the Lake District, the Pennines and the south-eastern fells. This effect is severely reduced by large-scale afforestation in the north of the county. Elsewhere in the county very low densities of semi-natural vegetation are associated with intensive agriculture.

The composition of each of the broad habitat categories - woodlands, grasslands, heathlands, peatlands and coastlands - is further analysed in Tables 5 - 9 and Figures 11 - 14, 23 - 26, 32 and 33, which are to be found in the relevant parts of Section 3, in which the results for each habitat are discussed.

3 INTERPRETATION AND DISCUSSION

3.1 Woodlands

After the last Ice Age the natural climax vegetation which eventually developed over most of Britain was woodland. With the exception of wetlands and rocky outcrops, much of Cumbria up to an altitude of 500 m was probably covered by forests of oak, ash and birch, with elm, lime and other species locally (Rackham 1980). About 5,000 years ago Neolithic pastoralists and agriculturalists began to clear the woods for farmland and for timber. This process continued up to the Norman Conquest, by which time the main phase of woodland clearance had been completed. It is estimated that the woodland cover of England was reduced from 80% in 500 BC to 15% in 1100 AD and continued to decline to approximately 4.4% in 1900 AD (Rackham 1980).

Although Cumbria still appears to be fairly well-wooded, with 8.75% of the county covered by woodland, 62% of this is plantation woodland, mainly coniferous, and only 3.0% of the county is covered by semi-natural broadleaved woodland. From a study of aerial photographs (NCC 1987) it was estimated that 48% of the semi-natural broadleaved woodland present in Cumbria in the 1940s had been lost by the 1970s. One third of this was lost to coniferisation and most of the remainder was cleared for agriculture. The distribution of woodland throughout the county is influenced by geology, altitude, climate and local history. Much of it occurs as rather small units so that the cover is more scattered and uneven than appears from Figure 9.

The woodlands of greatest conservation interest are the ancient semi-natural woodlands, which are defined as woods which have been in existence since at least 1600 AD and which still bear stands of native trees which have not obviously been planted. These ancient woodlands are often rich in plant and animal species and many of them are believed to be surviving relics of the prehistoric 'wildwood' which covered much of the county 8,000 years ago. Some 10,000 ha of ancient woodland remain in Cumbria (NCC 1985), approximately half of the total area of semi-natural woodland.

3.1.1 Semi-natural woodland

This category includes all woodland, both ancient and recent, which is not obviously planted, although planted trees may be present and may contribute up to 30% of the canopy. Some of this semi-natural woodland is directly descended from ancient primary woodland but it is unlikely that any of it has not been managed at some time by coppicing or replanting. Some of it is secondary woodland developed on previously cleared land, either from plantation woodland or from natural regeneration following invasion by scrub.

The 22,200 ha of semi-natural woodlands in Cumbria (Table 5) have been divided into four categories, namely broadleaved, coniferous and mixed woodland and continuous dense scrub, of which broadleaved woodland is the major category, contributing 89% of the total.

3.1.2 Broadleaved semi-natural woodland

There are over 19,700 ha of broadleaved semi-natural woodland in the county, with the highest densities in the south and west. In many parts of the county, and particularly in the north and east, broadleaved woodlands are found mainly along rivers and streams. Numerous small woodlands also occur, scattered across predominantly agricultural areas, and these are generally well-established

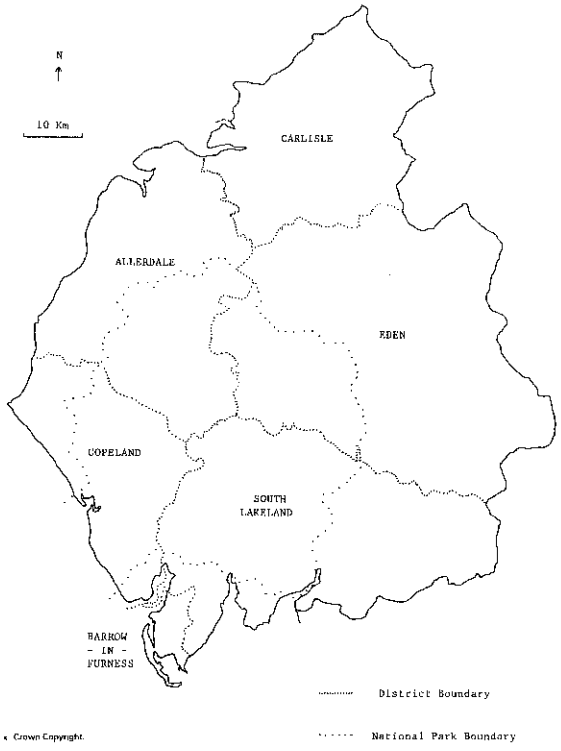


Figure 7 Cumbria : Districts

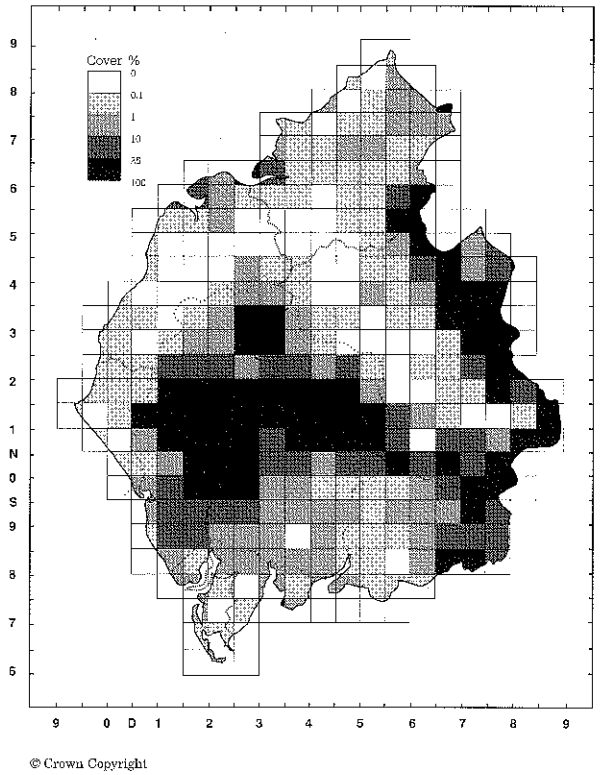


Figure 8 Distribution of semi-natural habitat in Cumbria

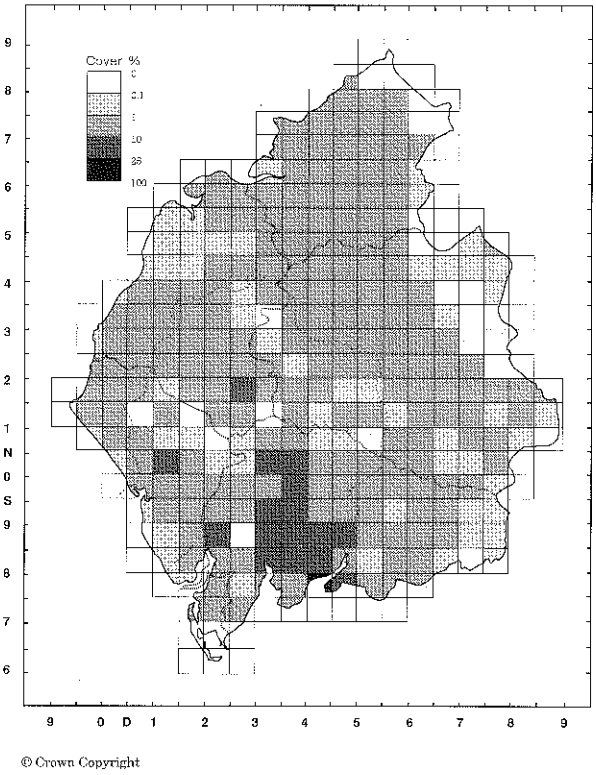


Figure 9 Distribution of semi-natural woodland in Cumbria

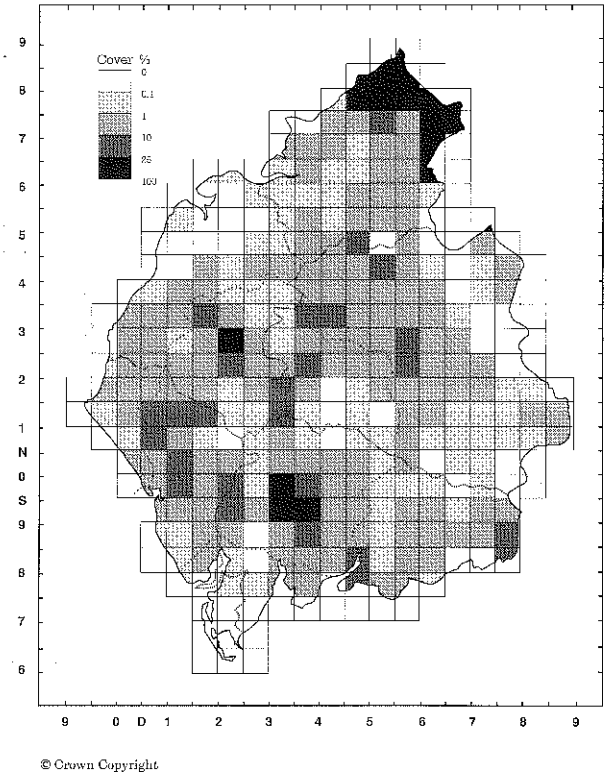


Figure 10 Distribution of plantation woodland in Cumbria

TABLE 5 ANALYSIS OF WOODLAND HABITAT CLASSES IN CUMBRIA

	Total area (ha)	% of county area	% of total semi-natural area	% of total woodland area
Broadleaved semi-natural woodland	19,747.3	2.9	7.4	33.1
Coniferous semi-natural woodland	294.5	0.04	0.1	0.5
Mixed semi-natural woodland	893.9	0.1	0.3	1.5
Continuous/ dense scrub	1,299.4	0.2	0.5	2.2
Broadleaved plantation	386.5	0.1	-	0.7
Coniferous plantation	35,777.0	5.3	-	60.0
Mixed plantation	1,198.0	0.2	-	2.0
Total	59,596.6	8.8	8.3	100.0

plantations, planted for timber or as shelter-belts and coverts. These have been recorded as semi-natural where they consist of native species growing where they might be expected to grow naturally.

The woodland types within the county are closely related to the underlying geology (see Figure 3). In the area of Skiddaw Slates, in the north of the Lake District, the most common woodland type is acidic birch/sessile oak (Betula/Quercus petraea) woodland over a heath or moorland ground flora, poor in flowering plants. Similar oak/birch woodland occurs on the Borrowdale Volcanics, but here the acidity of the soil is more variable, with local enrichment, resulting in a more variable flora and the appearance of other trees such as ash (Fraxinus excelsior) and wych elm (Ulmus glabra). The Borrowdale Woods are good examples of this type and are particularly interesting for the rich flora of lichens, mosses and liverworts which they support and which reflect the high rainfall of this area. This group of woodlands is regarded as being internationally important for its oceanic bryophytes (mosses and liverworts) and lichens and has a rich fern flora including oak fern (Gymnocarpium dryopteris), beech fern (Phegopteris connectilis) and filmy-ferns (Hymenophyllum spp.).

The most heavily-wooded part of Cumbria is the area of Silurian slates and grits extending from the Windermere area westwards towards Barrow-in-Furness. Most of its woodlands survive because of their past industrial importance, when they were managed by coppicing to supply charcoal for the local iron industry, and because of the rocky nature of their sites, which are unsuitable for mechanical cultivation. The woods of this area are largely of the acidic type and resemble the Borrowdale oakwoods to some extent, but the Silurian rocks weather to give a richer soil than the slates and volcanics to the north and this is reflected in the more diverse composition of the woodland, though they are relatively poor in bryophytes as a result of their past management. Sessile oak is abundant, but birch, alder (Alnus glutinosa), hazel (Corylus avellana), bird cherry (Prunus padus), wild cherry (P. avium), wych elm, ash and rowan (Sorbus aucuparia) are also common, and small-leaved lime (Tilia cordata) occurs locally, being here at the northern limit of its range.

On the Carboniferous Limestone areas to the south and east of the Lake District the woodlands are dominated by ash and hazel with birch, oak, wych elm, small-leaved lime and yew (Taxus baccata) all common. (Where yew occurs at high concentrations the woodland is considered as mixed woodland: see Section 3.1.4.) These woods often have a rich shrub layer, which may include wild service-tree (Sorbus torminalis), spindle (Euonymus europaeus), privet (Ligustrum vulgare) and buckthorn (Rhamnus catharticus), four species at the northern limit of their range. The ground flora is generally rich in vascular plants, compared with the oakwoods, and includes some nationally and locally rare species such as herb-Paris (Paris quadrifolia), lily-of-the-valley (Convallaria majalis) and mezereon (Daphne mezereum). Good examples of limestone woodlands occur near Arnside and on Whitbarrow. In the east of the county, Helbeck and Swindale woods represent the northern end of a chain of internationally significant ashwoods on the Carboniferous Limestone of the Pennines.

Other woodlands of interest in east and north Cumbria include Lyne Woods, the river-gorge woodlands at Gelt Woods and Eden Gorge, and Mollen Wood, one of only a few remaining upland alder woodlands.

On certain types of mire and wet fen, willow and alder carr woodland develops, and examples of this can be found scattered throughout the county around the edges of ponds, tarns and lakes as well as on some valley and basin mires.

The ground flora of woodlands varies with local soil type and drainage. In the more acidic oak/birch woodlands, wavy hair-grass (Deschampsia flexuosa), bilberry (Vaccinium myrtillus) and bracken (Pteridium aquilinum) tend to predominate. Bluebell (Hyacinthoides non-scripta), pignut (Conopodium majus), foxglove (Digitalis purpurea) and broad buckler-fern (Dryopteris dilatata) are common to all the oakwoods, while red campion (Silene dioica), ramsons (Allium ursinum), herb-Robert (Geranium robertianum), primrose (Primula vulgaris) and dog's mercury (Mercurialis perennis) are commoner in the less acid oak/wych elm and oak/hazel/ash woodlands. Wild daffodils (Narcissus pseudonarcissus), for which the Lake District is famous, are a feature of the ground flora of some old-established oakwoods on less acid soils. Primrose, bluebell and dog's mercury are often also abundant in the ground layer of the limestone ash woodlands.

Woodlands throughout the county provide shelter, food and breeding sites for many different animals, including badgers, foxes, bats and roe deer, and for a wide range of bird species, including redstart, wood warbler, pied flycatcher, buzzard and tawny owl.

3.1.3 Coniferous semi-natural woodland

Coniferous semi-natural woodland in Cumbria generally consists of mature stands of planted Scots pine (Pinus sylvestris) and European larch (Larix decidua) and their self-sown progeny. Most of these stands are less than 1 ha in size but they frequently provide opportunities for shelter, feeding and breeding sites for a number of birds and animals in areas where these may be otherwise scarce. The stands are typically open with well-spaced trees, allowing the development of a good ground flora, similar to that of the acid oakwoods, including bilberry, foxglove, bluebell, wavy hair-grass and broad buckler-fern. Creeping lady's-tresses (Goodyera repens), an uncommon species of coniferous woodland, occurs in a few of these sites in Cumbria.

3.1.4 Mixed semi-natural woodland

Mixed semi-natural woodland, consisting of a mixture of coniferous and broadleaved trees with at least 10% of each, covers approximately 890 ha in Cumbria. A few of the woods have originated from the planting of Scots pine or larch in existing broadleaved woodlands before this century, so that these now contribute to the canopy. The flora and fauna of such woods are very similar to those of the original broadleaved woodland. Localised areas of mixed ash yew woodland occur on the Carboniferous Limestone of south Cumbria. Here too the flora and fauna are those of the adjacent broadleaved woodland.

Mixed semi-natural woodlands of self-sown Scots pine and birch have developed on the edges of raised bogs in both the north and the south of the county and tend to spread rapidly into the central areas of these bogs as they dry out. Examples can be seen at Nichols Moss and Arnaby Moss in the south and Cumwhitton Moss and Finglandrigg Woods in the north. The ground flora often includes a good cover of Sphagnum mosses together with heather (Calluna vulgaris) and other heath and bog species. Notable species of this habitat include creeping lady's-tresses, lesser twayblade (Listera cordata) and common wintergreen (Pyrola minor), and there is usually a characteristic range of associated insect species.

3.1.5 Scrub

Scrub tends to develop on heathland and grassland that is not cut, grazed or burnt regularly and also on areas of felled woodland which have not been replanted and unenclosed edges of woods. The dominant vegetation consists of shrub species such as hawthorn (Crataegus monogyna), blackthorn (Prunus spinosa) and gorse (Ulex europaeus), but tree species tend to invade eventually and more or less gradual succession to woodland takes place, depending on the proximity of the seed source.

The survey recorded 1,300 ha of dense scrub, in addition to which a considerable amount of scattered scrub occurs in various other habitats such as acidic and semi-improved grasslands. In lowland areas the scrub usually consists of mixed or single-species stands of hawthorn, blackthorn, gorse and broom (Cytisus scoparius), but common sallow or rusty willow (Salix cinerea subsp. oleifolia) also forms scrub in marshy areas around lakes and tarns and locally on mires. Juniper (Juniperus communis), an uncommon species which forms patches of scrub in the central fells, is susceptible to grazing and regenerates poorly with the result that it now survives mainly on steep slopes and crags, in stands which appear to be very old.

In urban areas the scrub which develops on abandoned railway lines and industrial sites can be an important part of the local wildlife habitat resource.

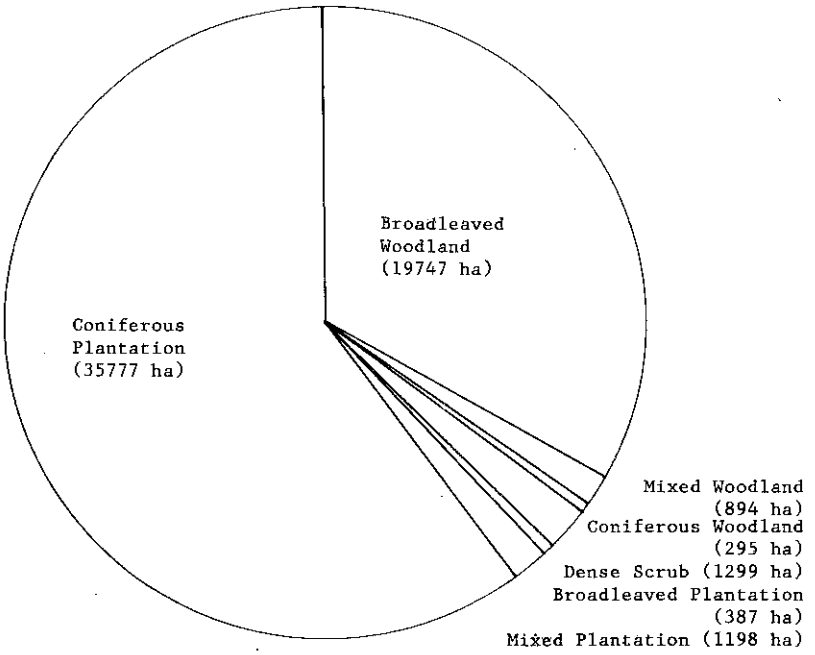


Figure 11 Relative proportions of woodland habitat classes in Cumbria

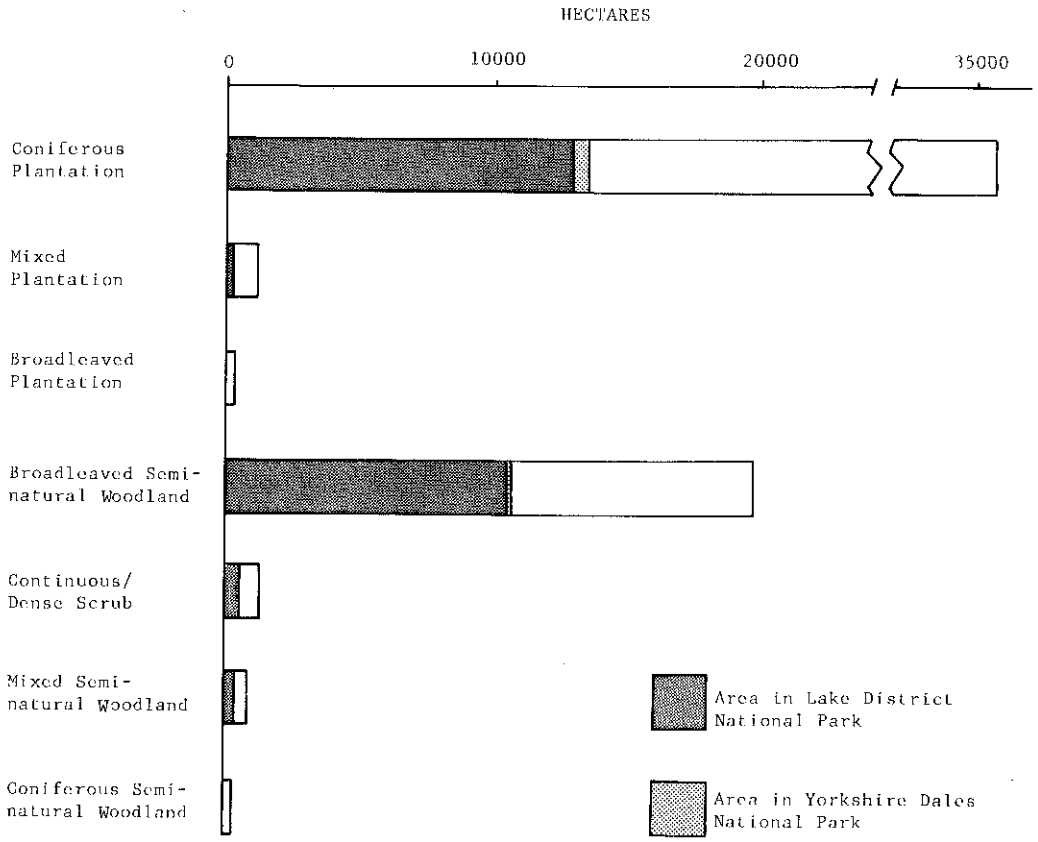


Figure 12 Areas of woodland habitat classes and proportions in the National Parks

The mosaic of habitats provided by a mixture of grassland, scrub and woodland provides ideal sheltered habitat for a variety of birds, butterflies and other wildlife. The hedgerow is essentially a linear scrub habitat, and some ancient hedges may represent the survival of the original woodland-edge scrub community which was left when the woods were cleared for agriculture. The area of hedgerows has not been measured separately but is included in the areas of the habitats bounded by them.

3.1.6 Coniferous plantation

Coniferous plantations make up 60% of all woodland in Cumbria, covering 35,700 ha, approximately 5% of the total land area. Most of this afforestation has taken place in upland areas and on some lowland fells and hills, with the greatest concentrations in the extreme north of the county and in parts of the Lake District.

The large expanses of Spadeadam and Kershope forests in the north of the county occupy ground which was once upland bog and moorland and they thus represent considerable losses of semi-natural habitat. This habitat loss has continued up to the present, with extensive plantings in the past 20 years. In the past, conifer-planting was also carried out on a large scale in the Lake District around Thirlmere, Thornthwaite, Skiddaw, Ennerdale and Grizedale, and one third of the total area of conifer plantation lies within the Lake District National Park. Much of this planting took place on previously unwooded sites which were relatively poor grazings, but some semi-natural woodlands were partially or wholly replaced by conifer plantations.

The main species planted are Sitka spruce (Picea sitchensis), Norway spruce (P. abies), European larch (Larix decidua), Japanese larch (L. kaempferi), hybrid larch (L. x eurolepis), Corsican pine (Pinus nigra subsp. laricio) and Scots pine (P. sylvestris). These have generally been planted in uniform, close-ranked single-species blocks, which are clear-felled and replaced with a similar monoculture of conifers of very little value to wildlife. The recent trend towards more varied planting and felling patterns, together with the effects of windthrow and frost damage, is producing a mosaic of smaller stands of different ages and species which is both more visually pleasing and of greater value to wildlife.

Young plantations generally have a more abundant and diverse fauna than the upland grazings which they replace. They are fenced to exclude grazing animals, and this allows a dense growth of ground vegetation, which is accompanied by a rapid increase in small mammal populations; these in turn attract birds of prey such as the kestrel and the short-eared owl. Whinchat and meadow pipit are common in this early stage, and as the plantation develops to the thicket stage they are replaced by willow warbler, whitethroat and linnet, and subsequently by blackbird, thrush and chaffinch, whose fledglings are preyed upon by the sparrowhawk. The mature forest tends to have a dense canopy, low light levels and a bare floor densely carpeted with needles, and it supports very few birds and mammals, though it may still support a few predators, such as fox, sparrowhawk, buzzard and even goshawk, which feed in the neighbouring farmland and moorland.

3.1.7 Broadleaved plantation

There are few recent broadleaved plantations in the county, and these are generally small in extent, their total area amounting to 390 ha. Many of them have been planted as shelter-belts or screening around conifer plantations

and other developments. Although native species are generally used, in some cases the species chosen are not native to the county or appropriate to the site. Plantings of sycamore (Acer pseudoplatanus), beech (Fagus sylvatica) and poplars (Populus spp.) are likely to have considerably less wildlife value than species such as oak, ash, alder and birch, which are native to Cumbrian woodlands.

Although broadleaved plantations have more potential for wildlife than coniferous plantations, their habitat diversity is limited by uniformity of age structure and species composition and by the close spacing of their trees. Furthermore, unless planted on previous woodland sites, they are unlikely to develop a typical woodland ground flora, since the species characteristic of this habitat are generally slow to invade and may take centuries to become established. Mature plantations, if thinned and appropriately managed, may take on many of the attributes of semi-natural woodland, and indeed many 19th century planted woodlands have been included in the semi-natural category of the present survey, but their flora and fauna are always less diverse than those of ancient woodlands, for which they are no substitute.

3.1.8 Mixed plantation

Mixed plantations, consisting of a mixture of broadleaved and coniferous trees, cover almost 1,200 ha and occur mainly as small stands. Their conservation value depends upon the species mixture and the density of planting. A fairly even mix of conifers and broadleaved trees, not too closely spaced, will give good light penetration and allow the development of a varied ground flora and its associated animal life, but often this is not the case and the over-dense plantations support a very limited flora and fauna.

3.1.9 Threats to semi-natural woodlands

Forestry poses a threat to semi-natural woodlands where it involves felling of native broadleaved trees and replacement of these with alien species. Even-aged plantations of closely-ranked conifers support a very limited range of wildlife compared with broadleaved woodlands. Their dense, evergreen canopy allows very little light to reach the forest floor, whereas the floor of a mixed-age deciduous woodland receives a patchy, diffuse light in summer and full light from autumn to spring. Without light the woodland ground flora, which may have existed at the site for many centuries, disappears, leaving only occasional ferns, mosses and fungi.

Underplanting of broadleaved woodlands with conifers has much the same effect in the long term, as the rapidly-growing conifers overtop the broadleaved trees and shade out both them and the ground flora. One of the first effects of underplanting is on the insect life of such woods, and many woodland butterflies soon disappear from the over-shaded rides of coniferised woods. Considerable mechanical damage is likely to be caused during the removal of the conifers when these are harvested, and the broadleaved woodland which remains will have lost much of its original conservation value.

Native broadleaved woodlands can also be damaged by severe management in the form of draining, weeding and the clearing of understorey and dead timber, with consequent loss of woodland flora and fauna. In contrast to this, more traditional and sympathetic woodland management, by coppicing, coppice-with-standards, small coupe felling with natural regeneration, or thinning and underplanting with appropriate native broadleaves, is likely to maintain or increase the diversity of physical structure and of the flora and fauna in the wood.

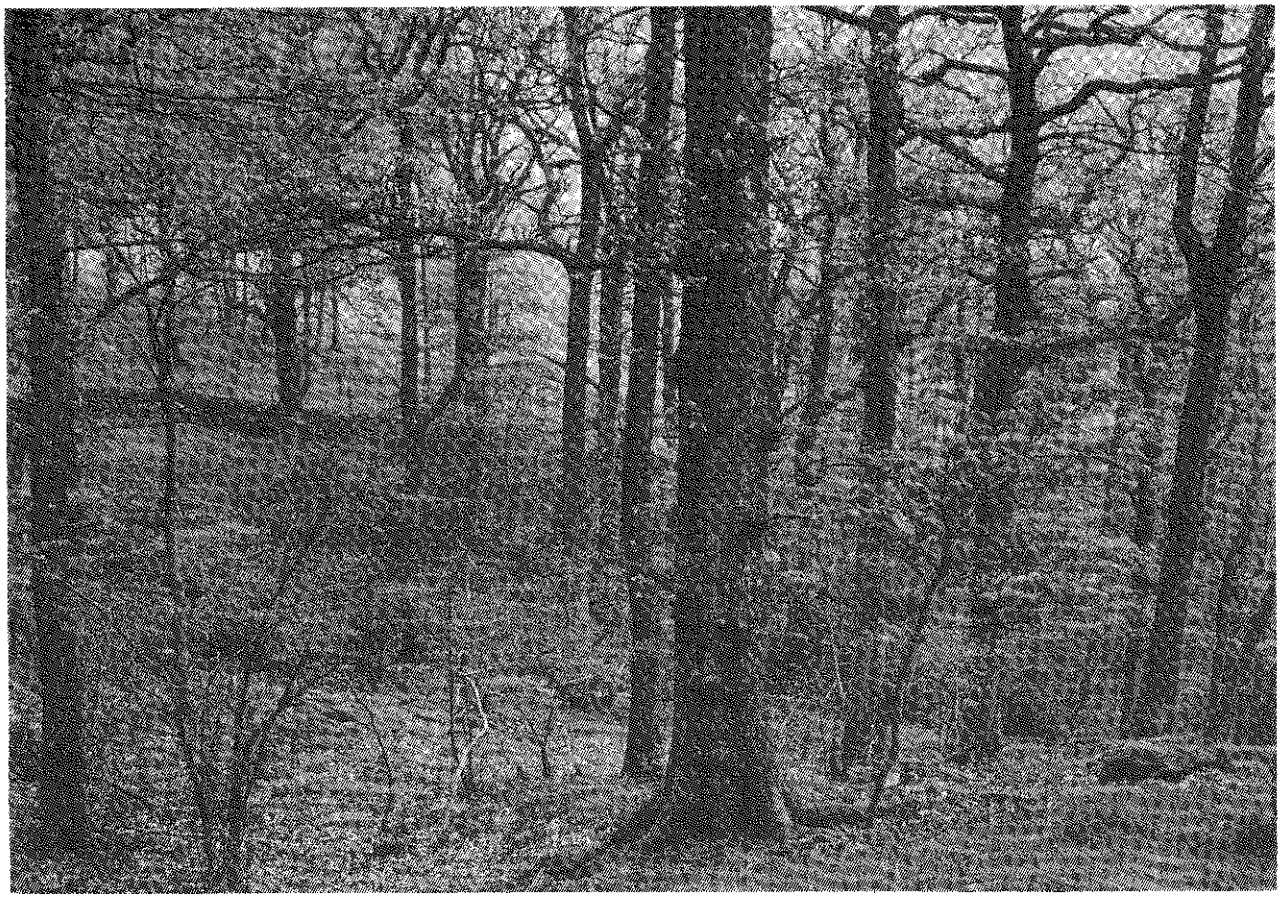


Photo 1 Broadleaved semi-natural woodland, Great Wood, Borrowdale. Mixed-age woodland, mainly of oak, ungrazed with an understorey of shrubs and saplings and a bluebell-rich ground layer. P Wakely 1985

Photo 2 Broadleaved semi-natural woodland, Gait Barrows NNR, Lancashire. Ash/hazel coppice on limestone. Wood anemones, primroses, bluebells, dog-violets and dog's mercury carpet the ground in spring before the trees are in leaf.

R Wallen 1977

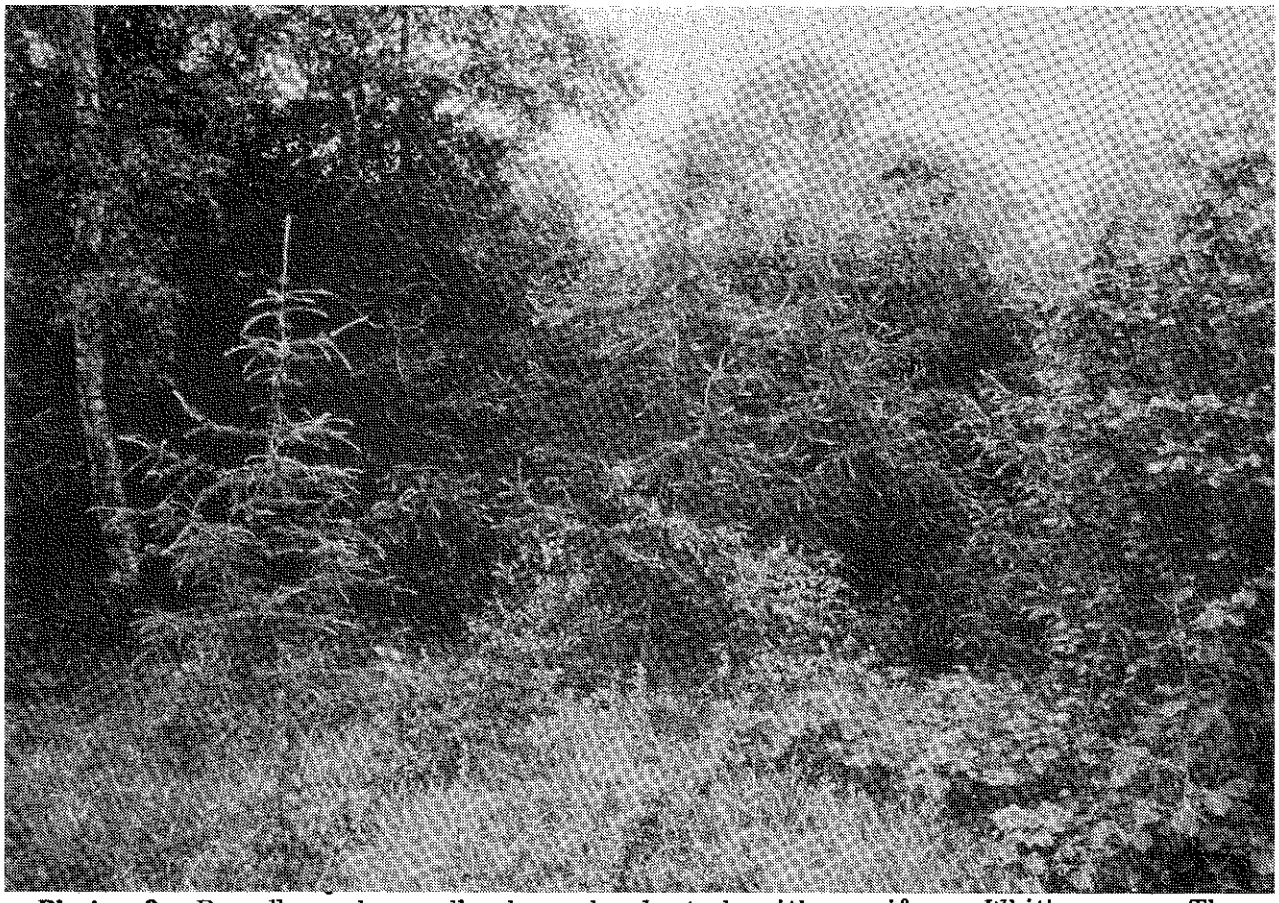


Photo 3 Broadleaved woodland, underplanted with conifers, Whitbarrow. The conifers will eventually overtop the broadleaved trees and will shade out the trees, shrubs and ground flora, destroying this rich habitat. P Welsh 1981

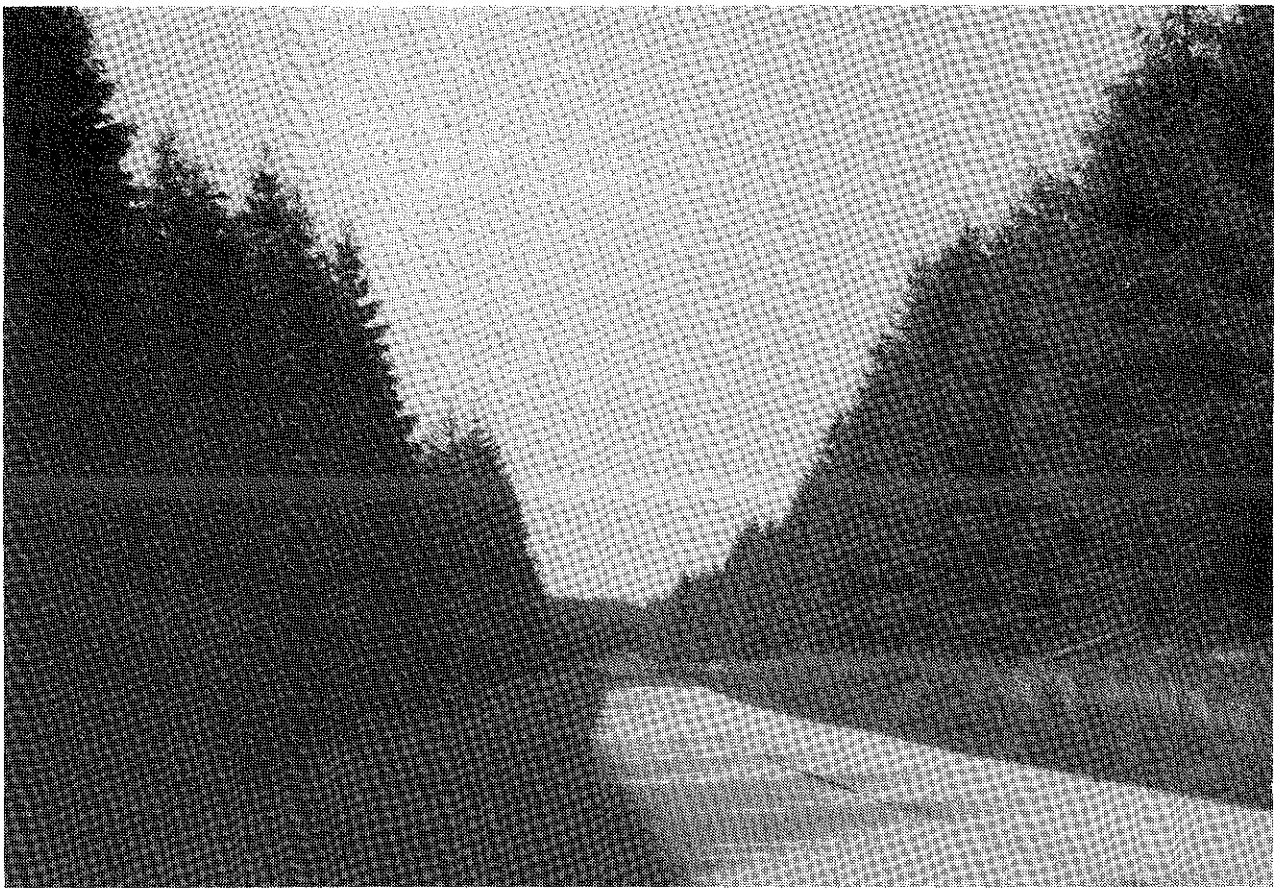


Photo 4 Coniferous plantation, Glen Trool, Galloway. The dense stands of Sitka spruce afford little light or space to other species and the ground vegetation dies except along forest rides and roadsides. D A Ratcliffe 1980

Heavy grazing, particularly by sheep, reduces the diversity of the ground flora and destroys tree and shrub seedlings, thus preventing regeneration of the woodland. This is particularly a problem in the unfenced woodlands of upland areas, which provide shelter for grazing stock but which often completely lack the understorey of shrubs and saplings present in ungrazed woodlands. Consequently there are no young saplings available to replenish the ageing population of trees and the woods become increasingly sparse with time until only a few scattered ancient trees remain and the woodland habitat has been completely lost. Excessive browsing, grazing and trampling by cattle and horses have similar damaging effects, and many traditional pasture woods in the lowlands have a much reduced understorey and an ageing tree population as a result, while others persist only as scattered trees in improved pasture land.

Clearance of woodland for agriculture still continues, and woodlands below about 5 ha in size are particularly vulnerable, with the smallest examples being the most likely to be felled and grubbed out. The wildlife value of these pockets of woodland habitat can be considerable in agricultural areas, where they act as refuges and as 'stepping stones' between the larger woods, which may be very far apart.

Intensive recreational use can be damaging in woodlands. Woodland ferns and flowering plants are susceptible to trampling and picking, and woods adjacent to car parks and picnic sites often have a much reduced ground flora. Many caravan sites in and around the Lake District National Park are situated in woodlands, giving privacy to their occupants and screening the caravans from public view. Whilst this is often done in such a way as to preserve the visual integrity of the wood from a distance, on closer inspection it can be seen to be very damaging. The concentrated human presence causes increased disturbance to wildlife and intensive pressure on the ground flora, which rapidly deteriorates and may be totally destroyed. Since the ground layer includes tree seedlings, its loss will lead eventually to the loss of the woodland, which can no longer regenerate itself.

The development and regeneration of scrub are affected by heavy grazing, cutting and burning, which have been responsible for the loss of this habitat in some cases and for its failure to develop in many areas where ageing scattered scrub still remains. In the uplands, gorse and juniper scrub are particularly vulnerable to moor-burning and accidental fires. Redevelopment of waste ground and abandoned fields for urban and agricultural use removes the opportunities for their colonisation by scrub, whilst in other cases the developing scrub is likely to be cleared by those seeking to improve the environment for amenity purposes, unaware that it is often an important local resource of wildlife habitat.

3.2 **Grasslands**

The habitats in this section include all areas dominated by grasses except those associated with coastal habitats and areas of swamp, fen and emergent vegetation in standing and running waters. Grasslands are divided into improved, semi-improved and unimproved categories. Unimproved grasslands are further subdivided into acid, neutral, calcareous and marshy grassland. The total area of each category in Cumbria is given in Table 6 and shown graphically in Figures 13 and 14.

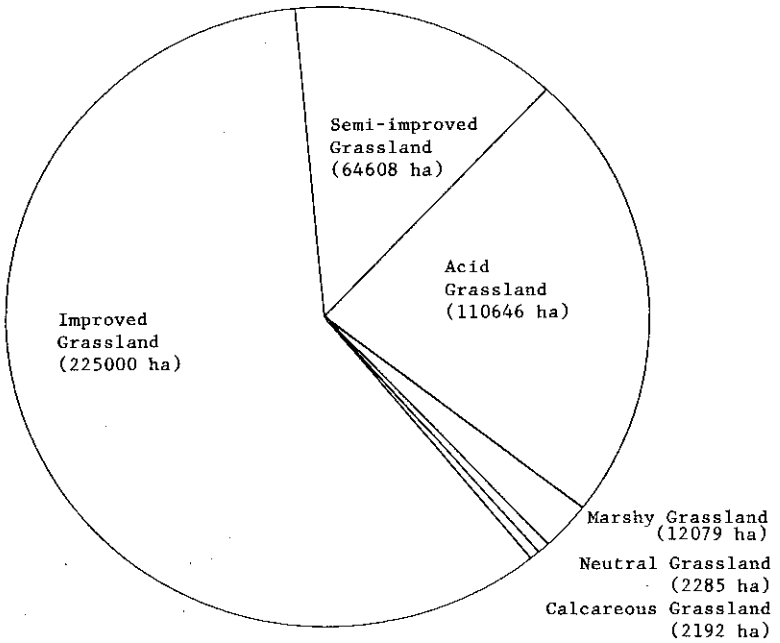


Figure 13 Relative proportions of grassland habitat classes in Cumbria

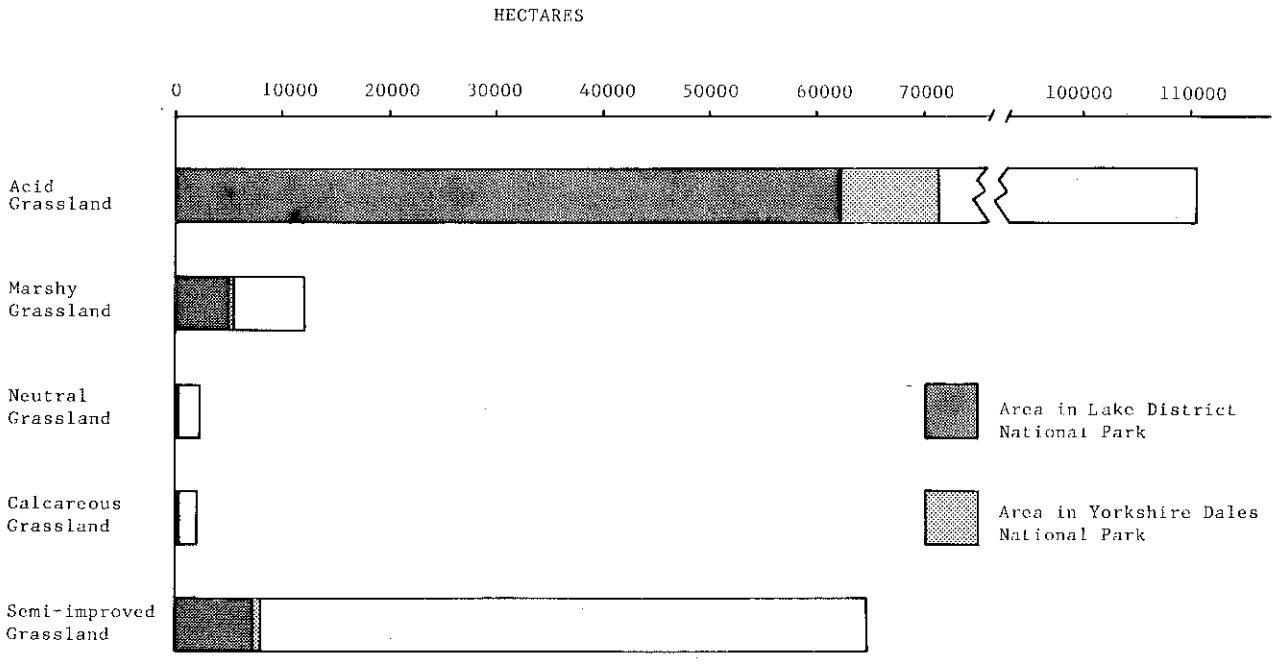


Figure 14 Areas of grassland habitat classes and proportions in the National Parks

TABLE 6 ANALYSIS OF GRASSLAND HABITAT CLASSES IN CUMBRIA

	Total area (ha)	% of county area	% of total semi-natural area	% of total grassland area
Acid grassland	110,645.9	16.2	41.4	26.6
Neutral grassland	2,285.0	0.3	0.8	0.5
Calcareous grassland	2,191.7	0.3	0.8	0.5
Marshy grassland	12,079.0	1.8	4.5	2.9
Semi-improved grassland	64,608.0	9.5	-	15.5
Improved grassland*	225,000.0	33.0	-	54.0
Total	475,809.6	61.1	47.5	100.0

*Estimated

Unimproved grasslands are the most extensive semi-natural habitat group in Cumbria, covering 127,000 ha and accounting for almost half the semi-natural habitat in the county. It should be noted, however, that there is very little unimproved neutral grassland and that 87% of the unimproved grassland is acid grassland, a relatively species-poor habitat. The NCMS study of aerial photographs from the 1940s and 1970s (NCC 1987) estimated a 26% loss of unimproved grassland over the whole county during that period, whilst in the lowlands 65% of the unimproved grassland was lost. The study indicated that this loss was mainly to improved and semi-improved grassland, though some was also lost to bracken and scrub and to conifer plantation.

3.2.1 Improved grassland

Improved grasslands are those meadows and pastures which have been so affected by heavy grazing, drainage and the application of fertilisers and herbicides that they have lost most of the species that one could expect to find in an unimproved sward. They have a limited range of grasses and few flowering plants, mainly those that are demanding of nutrients and resistant to grazing. Plantains (Plantago spp.), buttercups (Ranunculus spp.) and dandelions (Taraxacum spp.) are typical of highly improved grassland, while stands of docks (Rumex spp.), common nettle (Urtica dioica) and thistles (Cirsium spp.) indicate local enrichment of the soil by grazing animals.

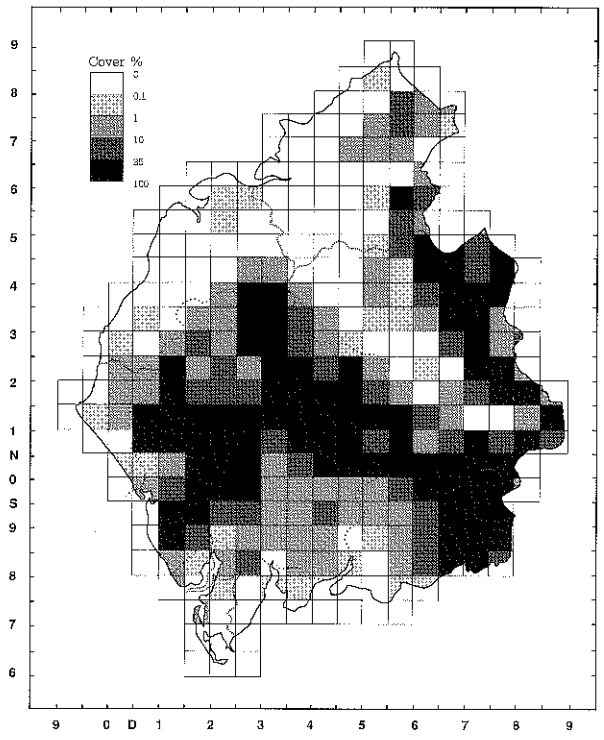


Figure 15 Distribution of acid grassland in Cumbria

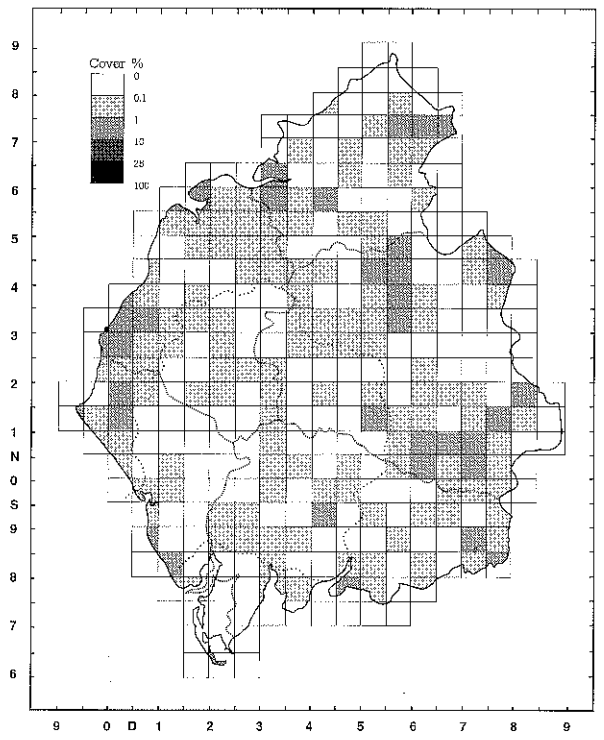


Figure 16 Distribution of neutral grassland in Cumbria

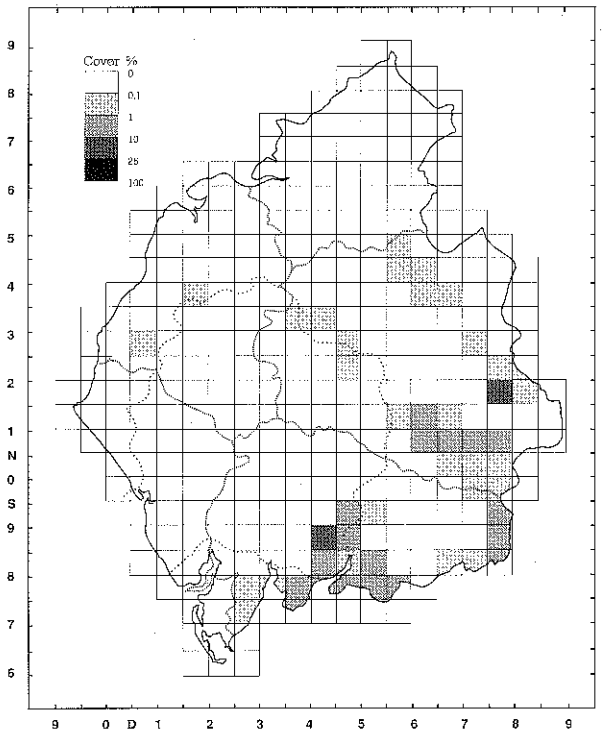


Figure 17 Distribution of calcareous grassland in Cumbria

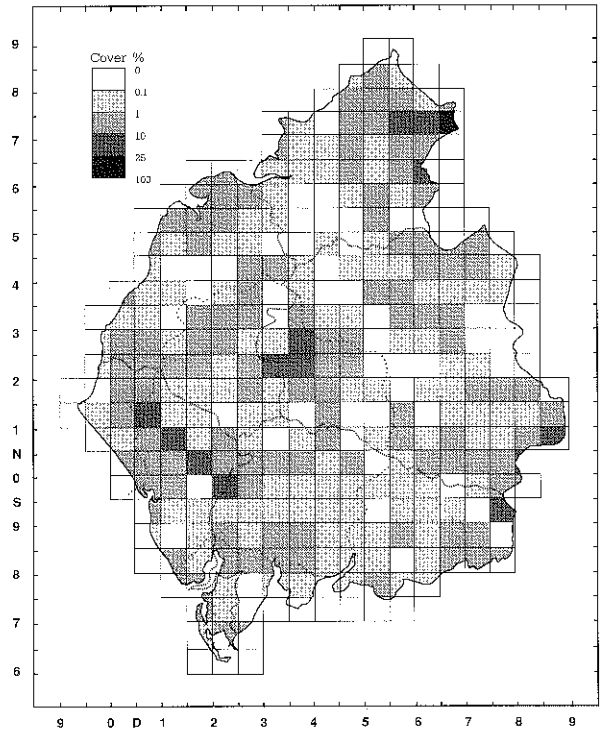


Figure 18 Distribution of marshy grassland in Cumbria

Fields which have been reseeded in the past and have since become more diverse are included in this category, but recently reseeded grasslands were recorded separately and temporary grass leys were considered as arable land. For the purpose of area measurement, improved grassland, reseeded grassland and arable land were treated as a single category - agricultural land - which includes the intervening hedges, ditches and farm tracks. The agricultural habitat thus defined covers some 284,000 ha, just over 40% of Cumbria, of which an estimated 225,000 ha is improved grassland.

3.2.2 Semi-improved grassland

Semi-improved grassland is a transition category made up of grasslands which have been modified by inorganic fertilisers, grazing or drainage; they consequently have a range of species which is less diverse and natural than that of unimproved grasslands but they are still of some conservation interest and value. Semi-improved grassland may originate from partial improvement of acidic, neutral or calcareous grassland, but these three sub-types have not been differentiated in the present survey. Indeed, because improvement reduces the acidic or calcareous character of the grassland, they are not always easy to distinguish in the field.

It should also be noted that much of the improved and semi-improved neutral grassland in Cumbria has been derived from acidic, calcareous or marshy grasslands by past agricultural management as pasture and meadowland.

Some 64,600 ha of semi-improved grassland were recorded in Cumbria during the survey. It is widely distributed throughout the county but is most commonly found on the flanks of hills, where it forms an intermediate zone between the unimproved acid grassland, heath and bog of the uplands and the improved agricultural land below. It is most abundant in the south-east of the county, around Dentdale and Garsdale and between Tebay and Kirkby Stephen, where between 10 and 25% of the land is semi-improved grassland. It is also common in the areas around Alston and Bewcastle in the north-east, where there is little intensive farming.

In view of the scarcity of unimproved neutral grasslands (see below), semi-improved grasslands are an increasingly important habitat. Although not equivalent in quality to the unimproved grasslands, they nevertheless have the capacity to support a wide variety of plant and animal species, given appropriate management. In some cases they form a buffer zone between improved and unimproved land and, although they are particularly vulnerable to further improvement, they also have some potential to revert towards unimproved grassland if conditions change.

3.2.3 Acid grassland

Acid grassland is by far the most abundant habitat type in the county, covering 16% of the land area and accounting for 41% of the semi-natural habitat. Approximately 110,600 ha of acid grassland were identified, distributed widely throughout the upland fells of the central Lake District, the Yorkshire Dales and the Pennines (see Figure 15).

The glacial history and the geology of the Lake District have resulted in a series of rocky fells and steep-sided valleys, with thin soils overlying weather-resistant rocks over much of the area, particularly on the valley sides

and the upland ridges and plateaux between. Because of the high rainfall, which in places exceeds 400 cm per year (see Figure 2), the soils tend to be heavily leached and base-poor and support only acid-tolerant plant communities such as acid grasslands, heathlands and bogs. Acid grassland is the dominant vegetation on most of the Lakeland Fells, whilst on the Pennines large areas formerly covered with blanket bog now support species-poor acid grassland after a long history of drainage, burning and grazing. Several types of acid grassland can be distinguished, according to the dominant species. Mat-grass (Nardus stricta) and sheep's-fescue (Festuca ovina) are the dominant species on the leached, acid soils over many of the fells, together with heath rush (Juncus squarrosus) on poorly-drained thin peats and wavy hair-grass (Deschampsia flexuosa) in drier situations. Where the soils are slightly less acidic and a little richer in minerals, mat-grass is less abundant and common bent (Agrostis capillaris) is usually co-dominant with sheep's-fescue.

It is likely that much of the acid grassland on the Howgill and Lakeland Fells has been derived from dwarf shrub heath as a result of burning and grazing over many centuries (see Section 3.4).

Acid grasslands tend to be poor in flowering plants, but heath bedstraw (Galium saxatile), tormentil (Potentilla erecta), common milkwort (Polygala vulgaris) and sheep's sorrel (Rumex acetosella) are often plentiful. Their fauna is likewise rather limited but they support large numbers of craneflies (Tipulidae) and other insect species, which provide food for moorland birds such as curlew and golden plover, ring ouzel, skylark and meadow pipits, while the rare mountain ringlet butterfly (Erebia epiphron), found on the grassy slopes of the Central Fells, is restricted to this habitat.

Species-poor acid grasslands frequently contain small areas of richer habitat in the form of rock and scree, wet flushes, springs, mires and tarns. When these are greater than 0.25 ha in size they have been treated as separate habitats, but innumerable smaller examples are present within the acid grassland category.

Although acid grasslands are typically poor in plant and animal species, some herb-rich acid grasslands occur locally on dry banks and rocky levels. The sward of red fescue (Festuca rubra), sheep's-fescue, common bent, wavy hair-grass and field woodrush (Luzula campestris) is usually rather open and may contain heath bedstraw, tormentil, harebell (Campanula rotundifolia), pignut (Conopodium majus), cat's-ear (Hypochoeris radicata) and betony (Stachys officinalis). Some unusual plants such as adder's-tongue fern (Ophioglossum vulgatum), moonwort (Botrychium lunaria) and dyer's greenweed (Genista tinctoria) can occur in this habitat.

Relatively herb-rich acid grasslands were probably once fairly widespread and common in Cumbria in the form of meadows and pastures but have been lost as a result of agricultural improvement by liming etc., so that this habitat now survives mainly on banks and knolls in otherwise improved fields and, in an impoverished form, as semi-improved pastures on marginal land.

3.2.4 Threats to acid grasslands

Considerable areas of acid grassland have been reclaimed for agriculture in the past by drainage and the application of lime and fertilisers to produce semi-improved and improved grasslands. Most of the semi-improved grassland recorded by the survey is semi-improved acid grassland. Large areas of acid

grassland have been ploughed and planted for forestry in the past, but more recently the tendency has been to drain and plant the deeper peats, which are less valuable for grazing. Large areas of acid grassland are used as sheep-walk, which has helped to maintain the grass sward, but overgrazing in many areas has increased the dominance of unpalatable species such as mat-grass and heath rush at the expense of other species and of the habitat diversity. In some places, as a result of changes in agricultural practices, bracken (Pteridium aquilinum) is invading the lower slopes and shading out herb species.

Acid grasslands on peat and thin soils are vulnerable to recreational pressure, and considerable erosion has taken place on footpaths in the Lake District fells, particularly where the paths are on steep or wet ground. Less immediately apparent but more widespread is the effect of trampling on the vegetation, which often affects a considerable area around footpaths and on fell tops, reducing the diversity and cover of the vegetation as the more vulnerable species are eliminated and leading eventually to obvious erosion scars.

3.2.5 Neutral grassland

Neutral grassland can occur on a variety of soils and in different conditions wherever the soil has a pH between 5.5 and 7.0 and is free from calcium carbonate. In spite of this, unimproved neutral grassland is a scarce habitat in Cumbria; only 300 ha were recorded, the reason being that most neutral grasslands have been improved for agriculture. The remaining unimproved neutral grassland occurs in small amounts, widely distributed throughout the county. Local concentrations occur on the west coast, associated with the railway line and the urban area around Workington, and also around Bewcastle, in the north-east, and between Tebay and Kirkby Stephen. A few isolated examples of unimproved meadows still exist in west Cumbria and in the Yorkshire Dales National Park in south-east Cumbria. There are three broad groups of neutral grasslands, which differ in their origin and management. These are the traditionally managed haymeadows, the upper saltmarsh grasslands and the more recently developed grasslands which occur on previously disturbed ground, as in urban areas, around the edges of quarries and along the sides of railways and motorways. There is a great deal of variation within each of these groups in terms of the species present and their overall diversity.

Traditionally managed haymeadows typically have a rich variety of wild flowers and a diverse sward of grasses. Their richness is maintained by the fact that many of the plants are able to flower and set seed before mowing so that their seeds are scattered during haymaking. It is diminished by earlier mowing for silage and by the use of fertilisers and herbicides. Farmyard manure is used traditionally to replace the nutrients removed in the annual hay crop, but excessive manuring or the addition of artificial fertilisers favours the growth of fast-growing, nutrient-demanding grasses at the expense of other species and the overall diversity then falls rapidly. Repeated mowing for silage accentuates this process.

Because agricultural improvement has been most extensive on the better soils, many of the neutral haymeadows of the past are now arable fields, temporary grass leys or intensively grazed pasture, and most types of unimproved meadow are now very scarce. Even the small haymeadows of the Lake District valleys have been improved to provide a greater quantity of winter feed to support increased numbers of sheep on the fells.

The most common remaining meadow type is characterised by the presence of sweet vernal-grass (Anthoxanthum odoratum) and wood crane's-bill (Geranium

sylvaticum), often with rough hawkbit (Leontodon hispidus), yellow-rattle (Rhinanthus minor) and oxeye daisy (Leucanthemum vulgare) and, occasionally, melancholy thistle (Cirsium helenioides). Examples of this type of meadow can be seen between Orton and Tebay and nearby in Swindale and Wet Sleddale and also at Gowk Bank.

Flood meadow grasslands must once have been common in the dale bottoms and along riversides, but they are now very scarce as a result of improved agricultural use of thin fertile soils. They are characterised by an abundance of meadow foxtail (Alopecurus pratensis) and great burnet (Sanguisorba officinalis) in a species-rich sward. A good example of the type occurs near Wigton, where a large commonly-held meadow, farmed in a number of separate stints, has more than 70 plant species including heath spotted-orchid (Dactylorhiza maculata subsp. ericetorum) and northern marsh-orchid (D. purpurella).

Meadows of the crested dog's-tail (Cynosurus cristatus)/common knapweed (Centaurea nigra) type are widespread and can still be found in many places in the form of improved and semi-improved pastures. Unimproved examples are now rare, and one at High Leys, near Frizington, has been purchased by the NCC to be managed as a National Nature Reserve.

Examples of wet meadows with meadowsweet (Filipendula ulmaria), ragged-robin (Lychnis flos-cuculi) and marsh-marigold (Caltha palustris) can still be found, particularly in the upland areas, but these too are becoming scarce and often survive only in unimproved hollows and corners in otherwise improved fields.

With the demise of the haymeadows, roadside verges have become increasingly important as the last remnants of unimproved grassland. They are frequently much more species-rich than adjacent fields and preserve much of the meadow flora which was widespread at the time when they were fenced off from the surrounding land. Many former herb-rich meadows in Cumbria can be identified only by the rich verges and field edges which now remain. Cumbria is fortunate in the richness, variety and extent of unspoilt roadside verges which it possesses, and several of these have now been notified as Sites of Special Scientific Interest, far exceeding the neighbouring fields in the diversity of their flora and fauna and providing a reservoir of natural species from which colonisation of grasslands may be possible in the future.

Railway embankments and disused railway lines similarly provide semi-natural grassland habitats, often in areas of intensive agricultural land-use. Unlike roadside verges, they are seldom mown and may develop scrub and woodland. Where they are suitably managed, these sites can support a wide variety of plant communities with a diversity of insects, birds and small mammals. Many butterflies and other insects take advantage of the warm, sunny slopes of railway embankments and cuttings, and an important colony of the rare Scotch argus butterfly (Erebia aethiops) has recently been found on such a site. Disused railway lines in the Kirkby Stephen area provide good examples of this habitat, with calcareous and neutral grassland, flush, tall herb, scrub and woodland communities and with a corresponding range of rare and interesting plant species, including blue moor-grass (Sesleria albicans), fly orchid (Ophrys insectifera) and bird's-eye primrose (Primula farinosa).

The verges of motorways and other dual carriageways, being more recent in origin, tend to support species-poor grassland communities dominated by agricultural grasses, but in suitable areas they are being colonised by a steadily increasing range of wild plants including oxeye daisy and cowslip (Primula veris).

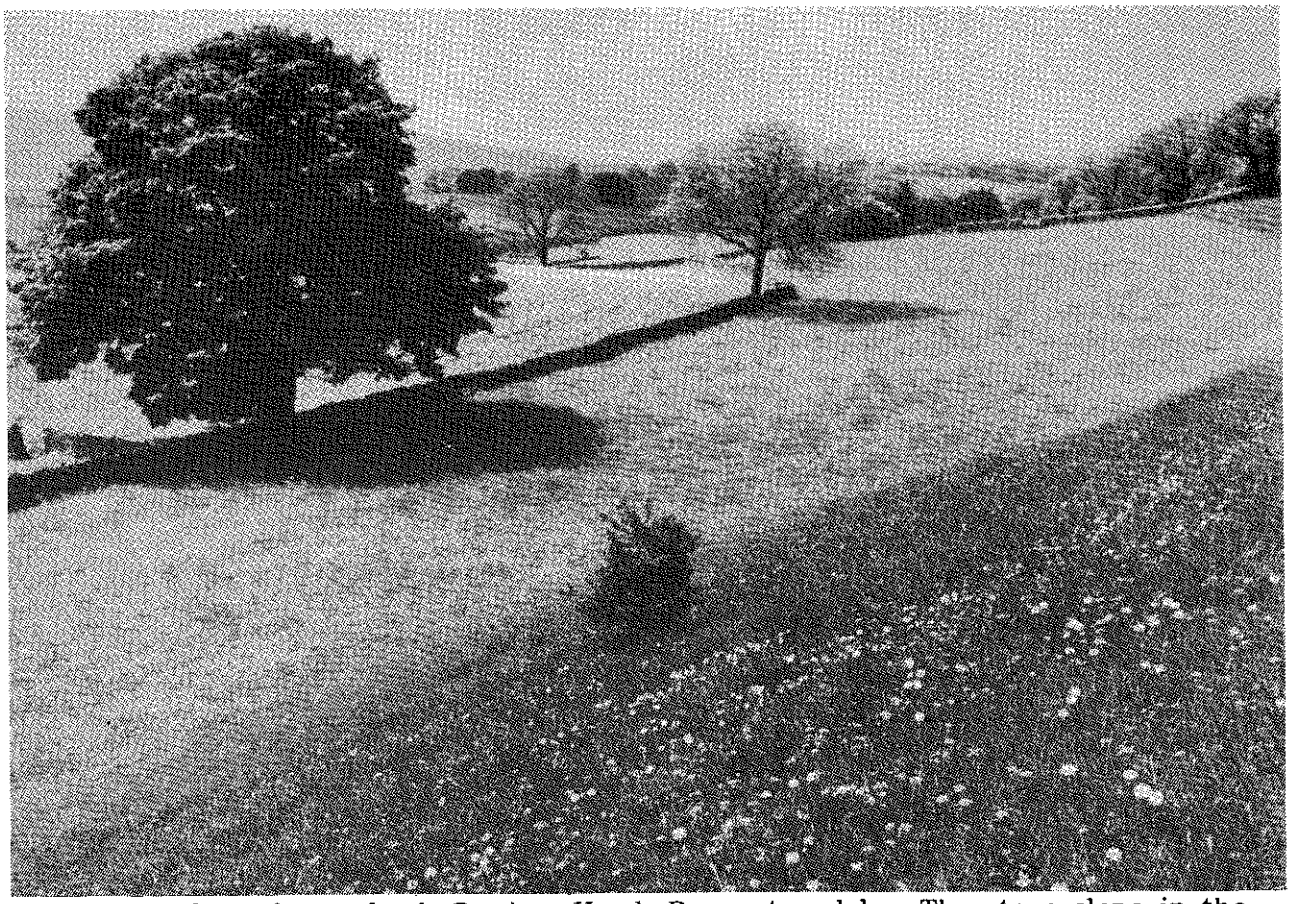


Photo 5 Neutral grassland, Bowber Head, Ravenstonedale. The steep slope in the foreground is unimproved, but the lower part of the meadow, rich in cow parsley and buttercups, is semi-improved. P Wakely 1989

Photo 6 Neutral grassland, Raisbeck, Orton. A herb-rich haymeadow with great burnet, wood crane's-bill and rough hawkbit abundant in the sward. P Welsh 1984

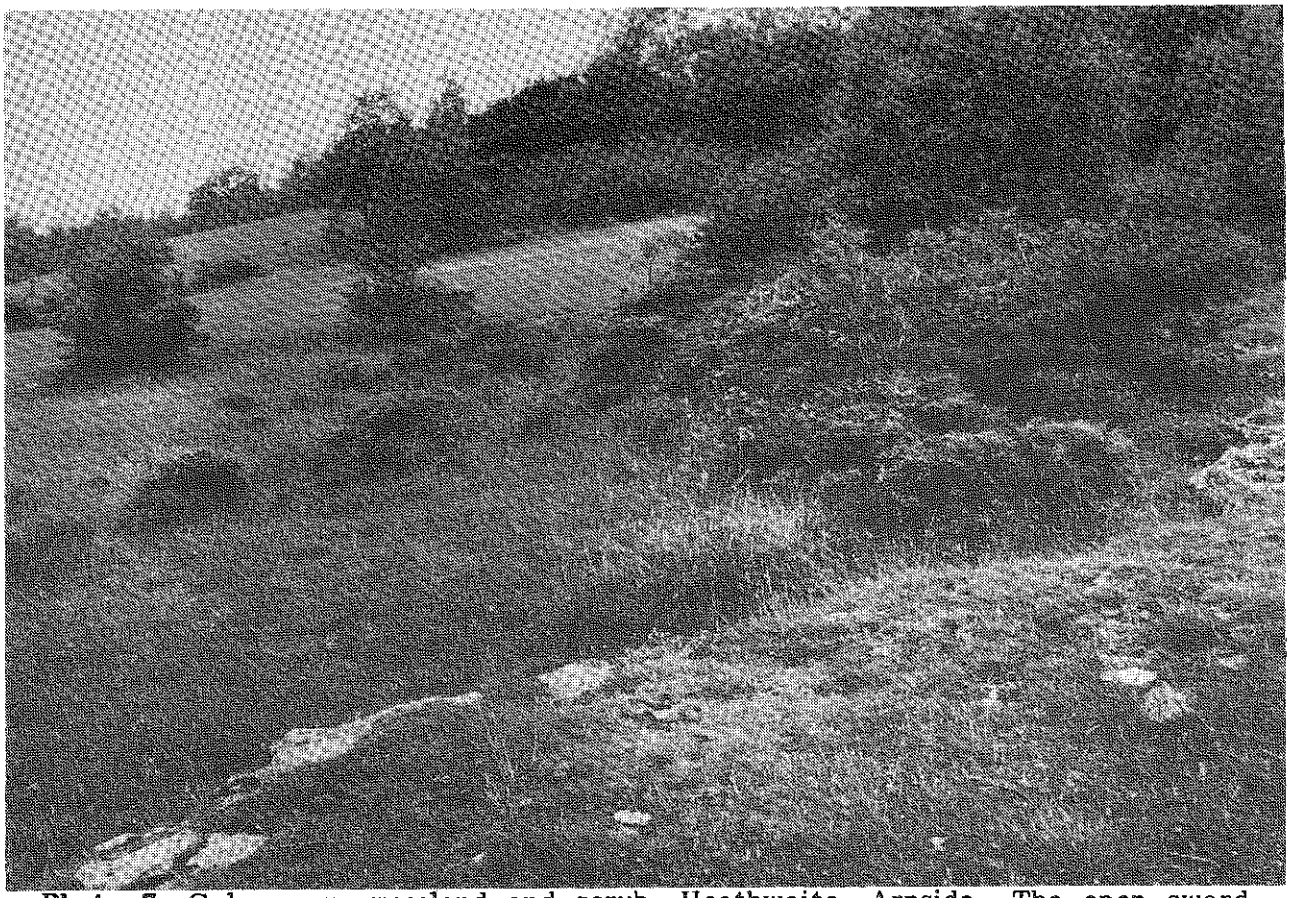


Photo 7 Calcareous grassland and scrub, Heathwaite, Arnside. The open sward is rich in wild flowers and is frequented by butterflies and other insects. Encroaching juniper scrub is kept in check by grazing. P Wakely 1989

Photo 8 Calcareous grassland and scrub with scattered trees, Whitbarrow. Blue moor-grass dominates the open, stony ground and juniper/hawthorn scrub with ash and yew trees grows on the deeper soil in the hollows. P Wakely 1983

Being undisturbed and often unmown, they may support large populations of small mammals and attract kestrels and other predators.

The linear nature of railways and roadside verges makes them of considerable importance as wildlife corridors, connecting one isolated habitat block with another. Together with their roles as relict habitats and species reservoirs, this makes them of great importance for nature conservation.

The upper fringes of the saltmarsh at Burgh Marsh and other marshes on the Solway grade into large areas of neutral grassland which, although relatively species-poor in comparison with inland sites, have a distinct assemblage of species, including red fescue, fern-grasses (Desmazeria spp.) and crested hair-grass (Koeleria macrantha). This grassland represents the final phase in the saltmarsh sequence from open mudflats to dry land, and its ecology and management should be considered together with that of the saltmarsh (see Section 3.7.2).

3.2.6 Threats to neutral grasslands

Undoubtedly the main threat to grassland habitats comes from agricultural improvement by the application of fertilisers and herbicides and reseeding with highly productive grasses, such as perennial rye-grass (Lolium perenne). Ploughing and reseeding have been the sad fate of many herb-rich meadows in Cumbria, and many more have lost their more interesting species as a result of the application of fertilisers and herbicides. The recent change from haymaking to silage-making has accelerated this process, with a combination of heavy fertiliser use and early mowing, both of which reduce the diversity of the sward.

Herb-rich meadows are best maintained by traditional haymaking in late summer, which allows seed to be set and spread and maintains soil fertility at a fairly low level by not returning more nutrients than have been removed in the hay crop.

Overstocking is also damaging to grasslands, resulting in excessive trampling, poaching and overgrazing. This tends to impoverish the vegetation whilst enriching the soil and leads to the invasion of nutrient-demanding weed species such as nettles, docks and thistles and coarser grasses such as cock's-foot (Dactylis glomerata).

Roadside verges, an increasingly important conservation resource, can be seriously damaged by herbicide spraying or by cutting too often or too early in the year. The modern practice of only cutting part of the verge is most beneficial, as it provides a diversity of habitat for the grassland fauna and allows seed to be set by the uncut plants. It is perhaps the nearest that can be achieved by mechanical means to the patchy grazing which must once have been usual in the extensive grasslands of the past.

If not grazed or mown, most grasslands will become invaded by scrub and ultimately progress towards the formation of woodland. The presence of a growing point close to the ground allows grasses to withstand grazing while other plants suffer from having their apical growing point grazed off, and indeed the whole plant may be grazed down in winter when food is scarce. Many grassland plants are either annuals, which pass the winter as seeds, or else have ground-hugging winter leaf rosettes or food-storing tap roots. When grazing pressure is removed, the survival of taller perennial plants is favoured at the expense of the grassland species. It is important, therefore, to maintain grazing pressure at appropriate levels or, if grazing is stopped, to replace it with a suitable mowing regime.

3.2.7 Calcareous grassland

Some 2,200 ha of calcareous grassland were recorded, mainly in the south and east of the county where Carboniferous Limestone strata occur. Thus 57% of the calcareous grassland in the county occurs in South Lakeland District and 42% in Eden District. The total area represents approximately 2% of the unimproved grassland in Cumbria, an indication of the rarity of this habitat.

Calcareous grassland communities develop on well-drained base-rich soils and are almost confined to areas where the underlying Carboniferous Limestone is at or near the surface. They are found in association with outcropping limestone at Scout and Cunswick Scars, Whitbarrow, Arnside Knott, Hutton Roof and Farleton Knott in South Lakeland and with the scars and pavements of the Asby Plain and the western flanks of the Pennines in Eden District. Small areas also occur in Allerdale and Copeland Districts, where they are of considerable local importance because of their scarcity.

Calcareous grasslands are characterised by the wide range of plant species which they support, including many nationally rare and scarce species, which in turn support a rich diversity of insects including two rare butterflies, the Scotch argus and the northern brown argus (Aricia artaxerxes). The calcareous grasslands of Cumbria are often dominated by blue moor-grass, an attractive and nationally uncommon species, and may support a variety of orchids, including early-purple orchid (Orchis mascula), green-winged orchid (O. morio), lesser butterfly-orchid (Platanthera bifolia) and frog orchid (Coeloglossum viride). The short-grazed turf near the limestone outcrops is often rich in attractive flowering plants such as common rock-rose, (Helianthemum nummularium), salad burnet (Sanguisorba minor), limestone bedstraw (Galium sterneri), squinancywort (Asperula cynanchica), hoary plantain (Plantago media) and wild thyme (Thymus praecox).

On slightly deeper and damper calcareous soils blue moor-grass is replaced by a mixture of species including crested hair-grass and meadow and downy oat-grasses (Avenula pratensis and A. pubescens), and the sward may include small scabious (Scabiosa columbaria) and dropwort (Filipendula vulgaris).

3.2.8 Threats to calcareous grasslands

Most, if not all, the limestone grassland sites in Cumbria are used for grazing sheep and cattle, and it is important that this should continue in order to prevent invasion by scrub. Calcareous grasslands provide a valuable early 'spring bite' for grazing stock, but, where the land is heavily grazed, as tends to occur on common land in particular, species may be lost owing to prevention of flowering and to the effects of repeated cropping and trampling, and their interest and diversity can fall quite rapidly.

Conversely, the removal of grazing pressure on some sites of high conservation value has led to invasion by scrub and woodland, which have had to be cleared by hand in order to maintain the grassland habitat. Ideally, what is required is to maintain grazing at the appropriate level. The effect of myxomatosis in removing grazing rabbit populations has made this more difficult to achieve.

Some of the more readily accessible areas have been agriculturally improved by the application of herbicides and inorganic fertilisers and have consequently lost their interest and value for conservation purposes.

3.2.9 Marshy grassland

Marshy grasslands cover a total of 12,000 ha in Cumbria, 1.8 per cent of the county area. They are scattered throughout the county but are scarce in areas of intense agricultural activity, as on the coastal plains of the west and the flood plains of the Rivers Kent and Eden (Figure 18). The most significant concentrations occur in the north-eastern part of Carlisle District, in the Yorkshire Dales and in the north and west of the Lake District National Park.

This habitat category includes all poorly-drained land where the cover of rushes (Juncus spp.), purple moor-grass (Molinia caerulea) or meadowsweet exceeds 25%. It can be divided into two broad groups based on the dominance of either rushes or purple moor-grass, and the rush-dominated group may be further divided into species-rich and species-poor types. Marshy grassland occurs on a wide range of soil types from rich alluvial deposits to acidic soils and thin peats.

The richer types of marshy grassland are generally dominated by a mixture of soft rush (Juncus effusus), jointed rush (J. articulatus), sharp-flowered rush (J. acutiflorus) and meadowsweet, with some tufted hair-grass (Deschampsia cespitosa) and Yorkshire-fog (Holcus lanatus). These are accompanied by a wide variety of herbs including marsh-marigold (Caltha palustris), cuckooflower or lady's smock (Cardamine pratensis), ragged-Robin (Lychnis flos-cuculi), devil's-bit scabious (Succisa pratensis), wild angelica (Angelica sylvestris) and common spotted-orchid (Dactylorhiza fuchsii). This type occurs in situations ranging from isolated wet fields and corners of pastures and meadows to poorly-drained roadside verges and the edges of streams and rivers. Where it occurs around the edges of lakes and tarns, it may grade into fen vegetation. It is often rich in invertebrates, including several species of butterfly and a wide variety of flies and other insects, as well as the frogs, toads and lizards which feed on them. It is also the feeding and breeding ground of birds such as curlew and snipe.

Species-poor acidic marshy grassland is found mainly on poorly-drained pastures on the lower fells and tends to be dominated by soft rush and sharp-flowered rush, together with species such as heath rush and tormentil which are usually associated with acid grasslands. This type often occurs in close association with, and grades into, areas of acidic flush dominated by a similar range of species together with heath spotted-orchid, lesser spearwort (Ranunculus flammula) and bog-mosses (Sphagnum spp.). Typical examples of this type can be found on areas over Skiddaw Slates as at Matterdale Common, where there are some of the largest expanses of this habitat type in the county. This habitat can often develop on poorly-drained pastures on the lower fells when they have been neglected.

Acidic marshy grasslands dominated by purple moor-grass develop over thin peats and tend to occur in close association with areas of wet heath and blanket mire vegetation. Other species usually found here include bog-mosses and small quantities of bilberry (Vaccinium myrtillus), cross-leaved heath (Erica tetralix), heath bedstraw and heath rush. This type of habitat occurs widely throughout the county, with good examples to be found on the lower fells of Eskdale, on Caudbeck Flow north of Carlisle and in the area north of Sleddale Forest near Skeggles Water. This vegetation type is also associated with areas of degraded raised bog in lowland situations, occurring around the edges of these sites on shallow peat.

3.2.10 Threats to marshy grasslands

The chief threat to this habitat is undoubtedly drainage. In some upland areas this has been undertaken to improve the grazing value for sheep; in other places deep drainage has facilitated the planting of large areas with conifers, as in the north-east of Carlisle District and around Spadeadam.

In the lowlands, marshy grasslands were once common, but most have been drained and improved for agriculture, so that this habitat often survives only in isolated patches in hollows and corners of improved fields. It is important that the remaining undamaged sites are recognised as an important part of Cumbria's natural heritage which needs to be managed positively to maintain its wildlife interest and conservation value.

The Molinia grasslands, which are associated with wet heath and blanket bog, can be seriously damaged by burning, and this results in the loss of associated species. Overgrazing and excessive trampling by cattle can also reduce the species diversity. In west Cumbria a number of rich and diverse marshy grassland sites have been completely destroyed by opencast coal-working. At Potato Pot, near Workington, part of an area of marshy grassland threatened with destruction by opencast mining has been transplanted to a nearby site in an attempt to preserve some of its flora, which includes a sizeable population of lesser butterfly-orchid.

3.3 **Tall herb and fern communities**

This is a rather diverse group of habitats which includes communities characteristic of disturbed ground, with opportunist species such as common nettle (Urtica dioica) and rosebay willowherb (Chamerion angustifolium), together with communities associated with rock-ledges on mountains and dense stands of bracken (Pteridium aquilinum) and other ferns. Collectively this habitat group covers 20,800 ha in Cumbria, of which 98% is bracken, the remainder being mainly tall herb vegetation.

3.3.1 Bracken

Continuous dense stands of bracken cover more than 20,000 ha in Cumbria, in addition to which scattered bracken (mapped but not measured in the present survey) is common in a number of other habitats such as acid grassland and heathland. Dense bracken is most abundant in southern and central Cumbria on the Furness and Coniston Fells and the lower slopes of the Central Fells. It is widespread throughout the Lake District National Park up to an altitude of 300 m and occurs locally on the lower slopes of the Howgills and the Pennines.

Bracken forms extensive stands on well-drained brown-earth soils and glacial drift, spreading by means of underground rhizomes and suppressing other plants by the dense shade of its tall fronds in summer and its dense, slowly-decaying litter in winter. A few shade-tolerant species are able to survive under bracken, including bluebell (Hyacinthoides non-scripta) and wood anemone (Anemone nemorosa), but the flora is generally very restricted. The fauna is likewise limited, though bracken stands do provide shelter for ground birds and small mammals and for predators such as foxes in upland areas where there is little or no tree cover.

In lowland areas bracken tends to occur as smaller, isolated stands, as on railway embankments, old mine sites and maritime banks. Here too bracken adds to the diversity of the habitat mosaic and is often a valuable source of shelter for small animals.

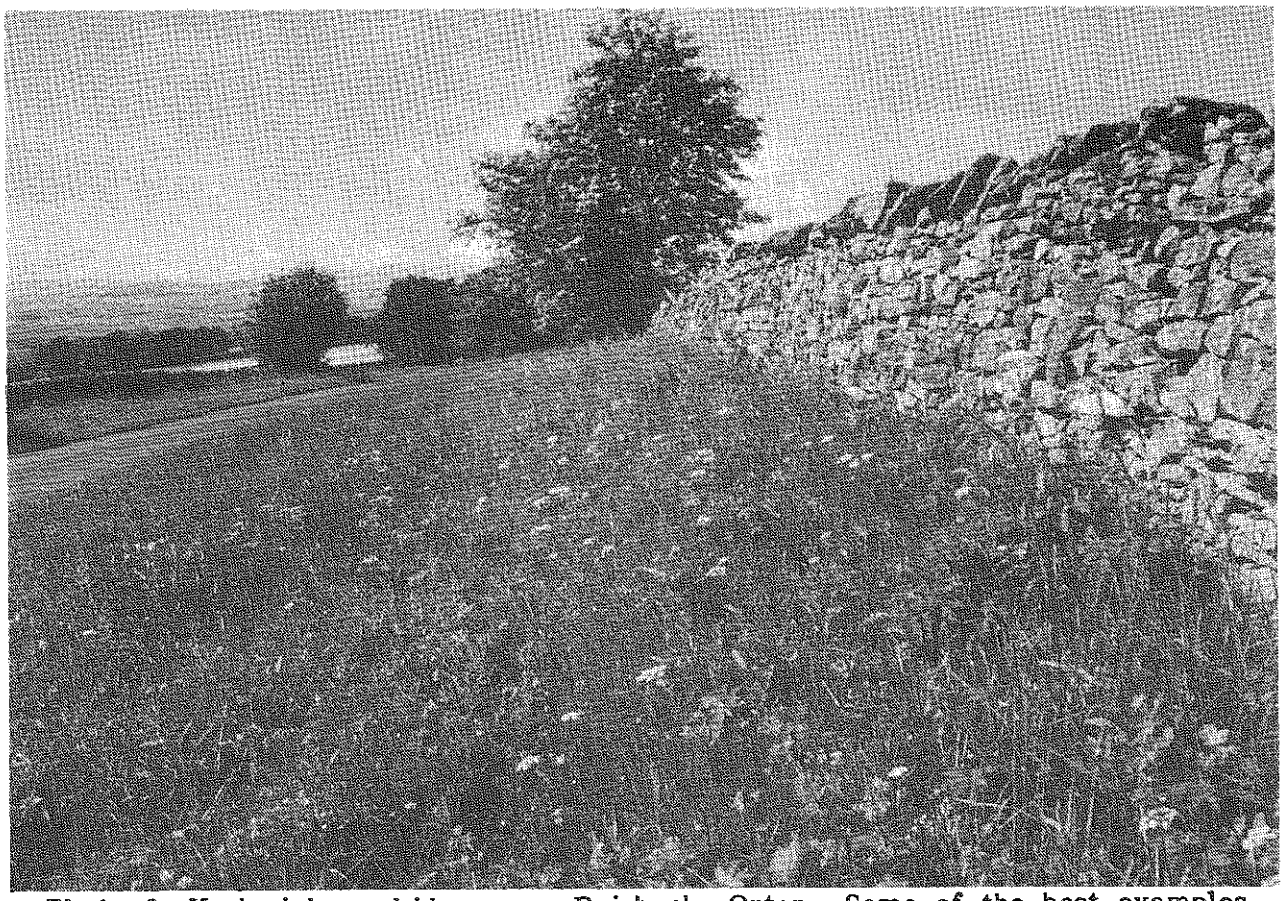


Photo 9 Herb-rich roadside verge, Raisbeck, Orton. Some of the best examples of unimproved grassland in the county, rich in orchids, crane's-bills and many other wild flowers which are to be found on these broad roadside verges. P Wakely 1989

Photo 10 Streamside flush, with sedges and bird's-eye primrose, in semi-improved pasture, Orton. P Wakely 1984

Photo 11 Marshy grassland, Halsenna Moor, Gosforth. Ungrazed marsh, dominated by rushes and sedges with wild angelica, hogweed, sneezewort, devil's-bit scabious and other marsh-loving herbs. A habitat rich in insects. P Wakely 1984

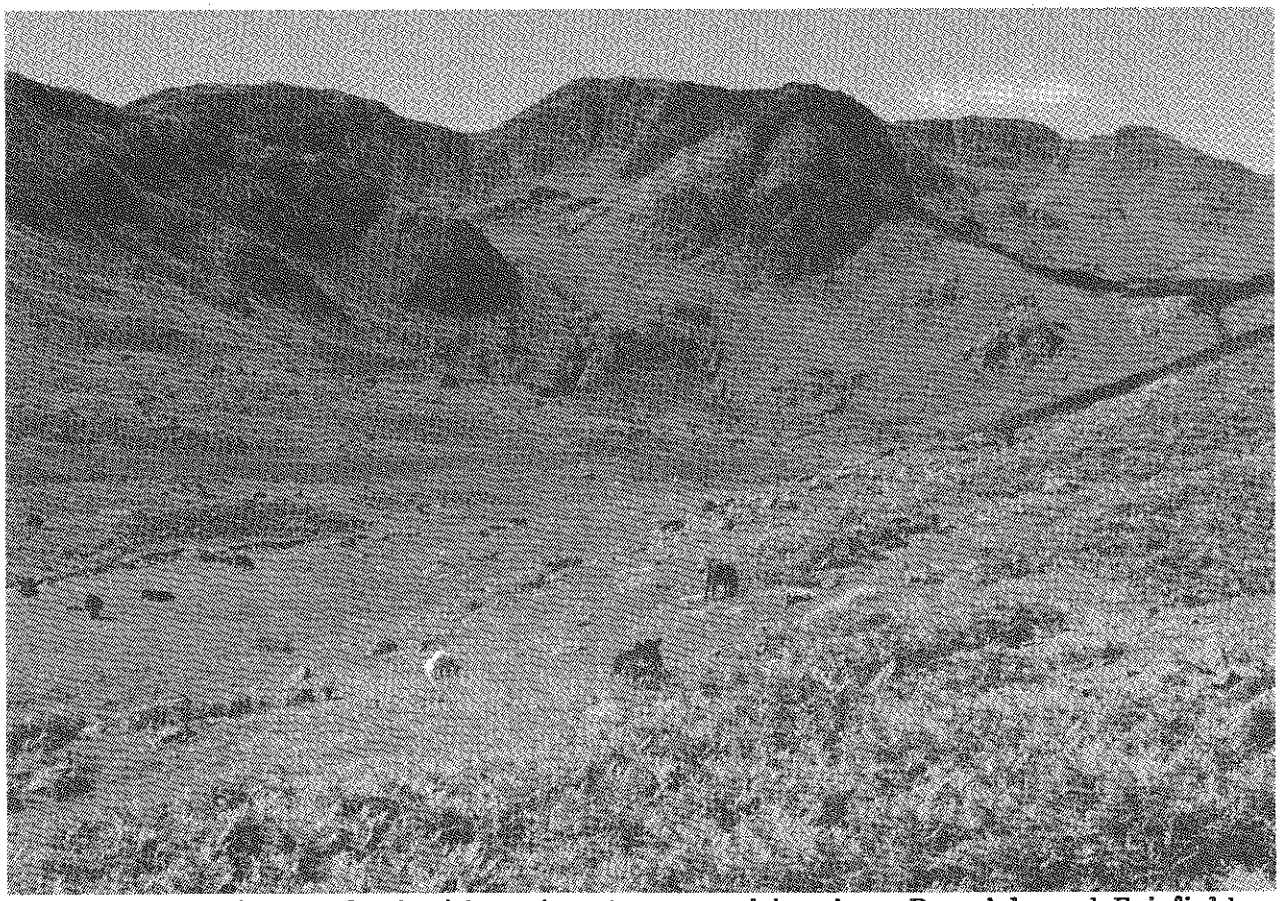


Photo 12 Acid grassland with rock outcrops and bracken, Deepdale and Fairfield. Acid grassland predominates in this upland valley, with bracken on the deeper soils. The cliffs and crags in the background are notable for their alpine plants.
D A Ratcliffe 1977

Bracken is a normal component of the woodland ground flora in Cumbria, and the invasion of open grassland and heathland by bracken probably represents the first stage in the natural succession of changes which would progress through scrub to woodland in the absence of other controlling factors. In practice, this succession is usually prevented by the lack of a local seed source, the uplands having long been deforested, and by the preferential removal of seedlings by grazing animals.

There has been a marked spread of bracken in Cumbria in this century, associated with changes in hill-farming practices. Formerly the spread of bracken was controlled by the trampling and grazing of cattle and by regular cutting for animal bedding and burning for potash. The abandonment of small hill-farms, lack of agricultural labour and the change from cattle to sheepgrazing on the fells have all contributed to the spread of bracken by removing its means of control. From a study of aerial photographs (NCC 1987) it has been estimated that the area of bracken cover in Cumbria increased by 66% over the 30-year period from the 1940s to the 1970s. The continued spread of bracken can now be controlled only by repeated mechanical cutting and spraying with herbicides.

3.3.2 Other tall herb and fern communities

Altogether, just over 300 ha of tall herb vegetation were recorded during the survey. This figure is likely to be an underestimate since tall ruderal species frequently occur in isolated stands that are too small to map on urban, industrial and other sites. The tall herb vegetation of mountain ledges is likewise of too small extent to be mapped, but this is discussed under rock and scree habitats (see Section 3.8). Dense stands of ferns other than bracken occur in woodlands and very locally on banks and gulleys on steep hillsides. These latter occurrences are almost always too small to be mapped in the present survey, whilst the former have been included under woodland.

Tall herb vegetation is characterised by quick-growing plants with easily dispersed seeds which germinate rapidly, allowing these species to establish themselves quickly on open, disturbed ground. The initial lack of competition on such sites may allow alien species to become established and some, such as Japanese knotweed (Reynoutria japonica), may become a serious problem.

Areas of waste land associated with urban development and industrial decay tend to be ideal sites for the development of these habitats. Such sites are particularly common around the larger towns on the west coast of Cumbria. Old building sites, railways and slag banks have become colonised by a wide variety of native and introduced species, including rosebay willowherb, mugwort (Artemisia vulgaris), colt's-foot (Tussilago farfara), docks (Rumex spp.), evening-primrose (Oenothera spp.) and Oxford ragwort (Senecio squalidus), the last of which has spread rapidly in areas such as Sellafield and Workington.

Railway embankments, new road cuttings, coastal cliffs and river banks also provide suitable areas for stands of species such as butterbur (Petasites hybridus), creeping thistle (Cirsium arvense) and common ragwort (Senecio jacobaea).

Some tall herb species, particularly nettles, thistles, docks and common ragwort, occur as weeds on agricultural land. Although common and widespread, these seldom occur in extensive, dense stands and have generally been included in the agricultural land category.

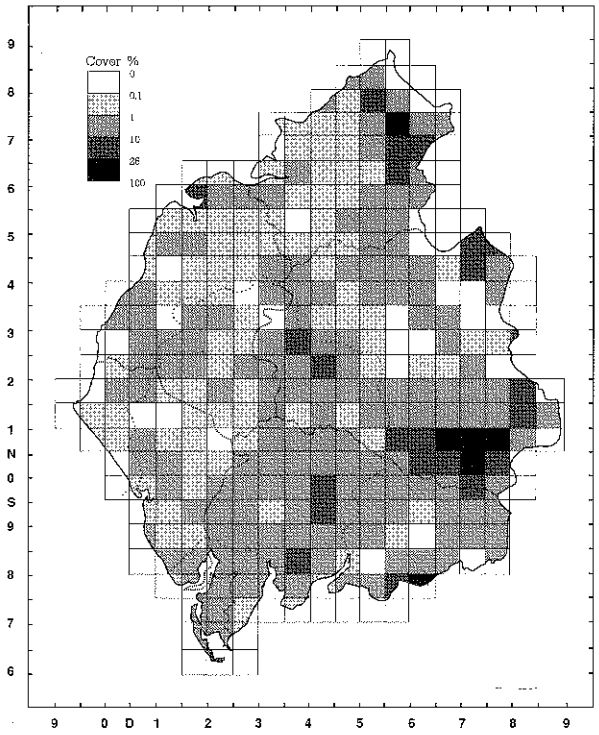


Figure 19 Distribution of semi-improved grassland in Cumbria

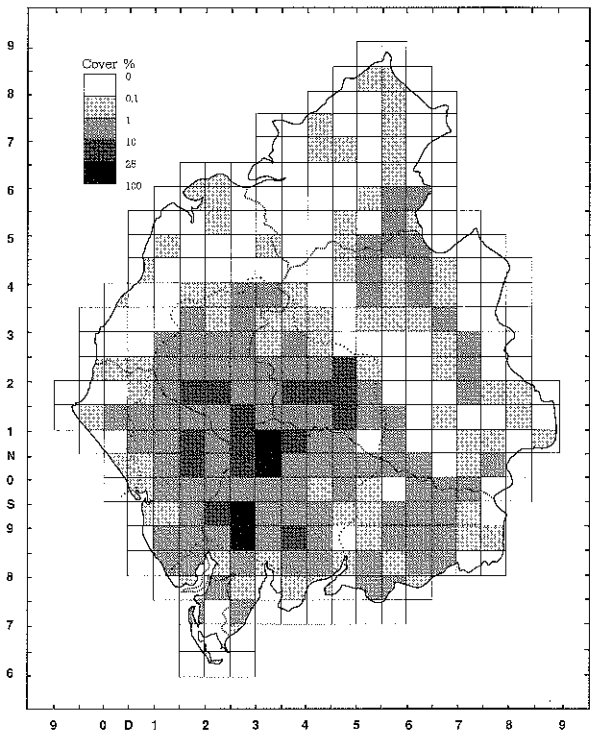


Figure 20 Distribution of dense bracken in Cumbria

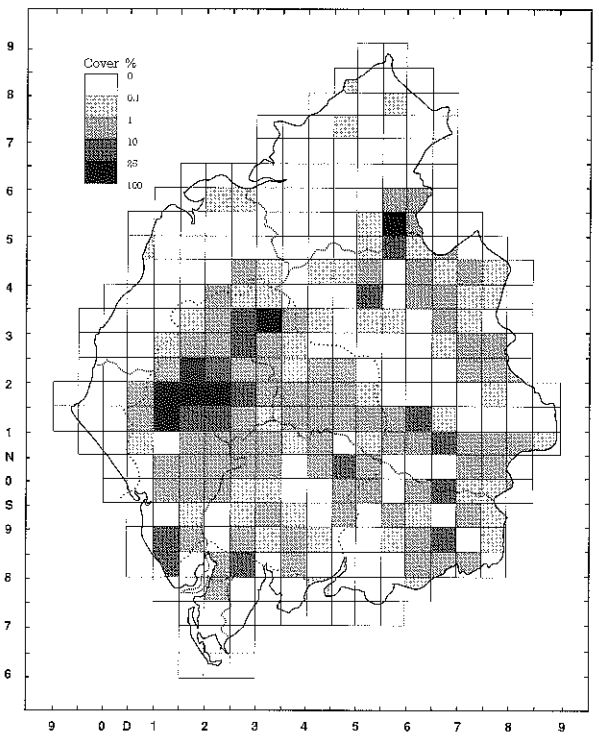


Figure 21 Distribution of dry heath in Cumbria

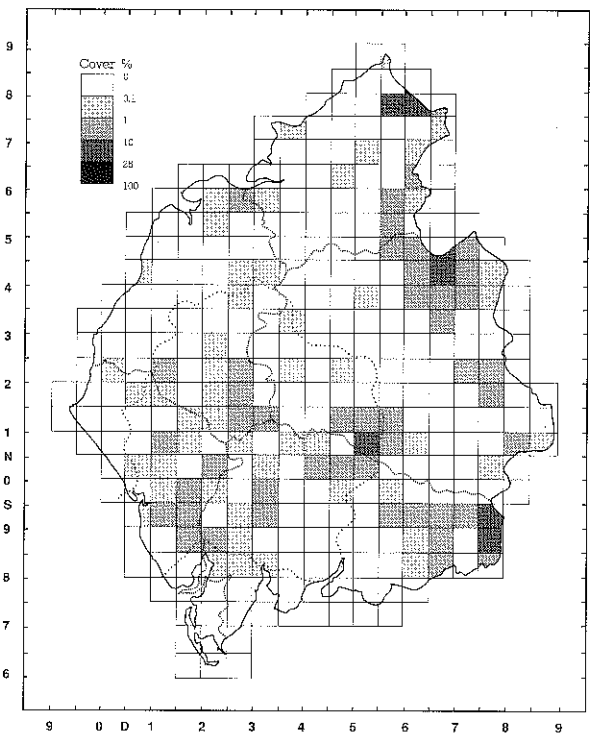


Figure 22 Distribution of wet heath in Cumbria

Although the total area covered by this habitat is small, it supports a wide variety of plants and animals of conservation interest. Tall herb stands often provide isolated refuges in urban and other man-made environments where insects, birds and small mammals can find food and shelter. Many caterpillars feed on tall herbs, for example the elephant hawkmoth (Deilephila elpenor) on rosebay willowherb, cinnabar moth (Tyria jacobaeae) on ragwort and small tortoiseshell and peacock butterflies (Aglais urticae and Inachis io) on common nettle, while many other butterflies and moths, bees, hoverflies and other insects are attracted to their nectar. The abundance of invertebrates attracts insect-feeding birds, and the seed-heads of thistles and other plants provide food for a variety of finches.

Tall herb communities form an important stage in the colonisation of waste land, leading eventually to its invasion by scrub and tree species which may add considerably to its aesthetic appearance and conservation value. In non-urban areas, tall herb stands tend to occur in association with other habitats such as neutral grassland or woodlands and help to increase their diversity.

3.3.3 Threats to tall herb and fern communities

Left unmanaged, these habitats would generally follow a succession to scrub and eventually to woodland, but periodic cutting or burning will prevent this. The main threats to these habitats, particularly in urban areas, come from urban redevelopment and from unsympathetic management by those who see these sites as untidy wastelands in need of improvement. Inappropriate management can destroy the conservation value of a site as surely as redevelopment.

Untimely mowing of tall herb vegetation along forest rides, roadside verges and railway banks or spraying with herbicides can result in widespread loss of this valuable wildlife habitat, whereas carefully planned mowing or burning can increase its conservation value.

3.4 **Heathlands**

The analysis of sub-fossil pollen and plant remains in peat deposits suggests that heathland communities were once widespread in the upland areas of Cumbria after the clearance of primeval forest in Neolithic times (Pennington 1974). More recently the extent of heathland has been reduced by cultivation, afforestation and changes in grazing and burning practices. The NCMS study of aerial photography estimated a 70% loss in dwarf-shrub heath between the 1940s and the 1970s, mainly to grassland but in some areas to afforestation (NCC 1987).

3.4.1 Dry heath

31,400 ha of heathland habitat still survive on well-drained soils, steep, rocky slopes and shallow peats, mainly on the flanks of the fells of the Lake District, Howgills and Pennines, along with a few isolated areas of lowland heath. Three quarters of the heathland in Cumbria consists of dry dwarf-shrub heath, dominated by heather (Calluna vulgaris) and bilberry (Vaccinium myrtillus), the latter becoming more dominant at higher altitudes, often in association with crowberry (Empetrum nigrum). Bell heather (Erica cinerea) is present locally in the driest situations such as on crags and steep stony slopes.

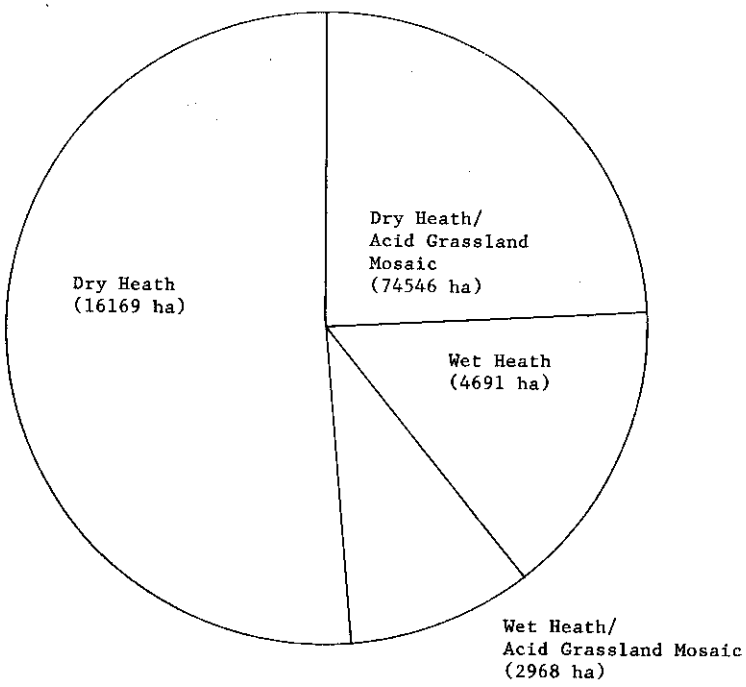


Figure 23 Relative proportions of heathland habitat classes in Cumbria

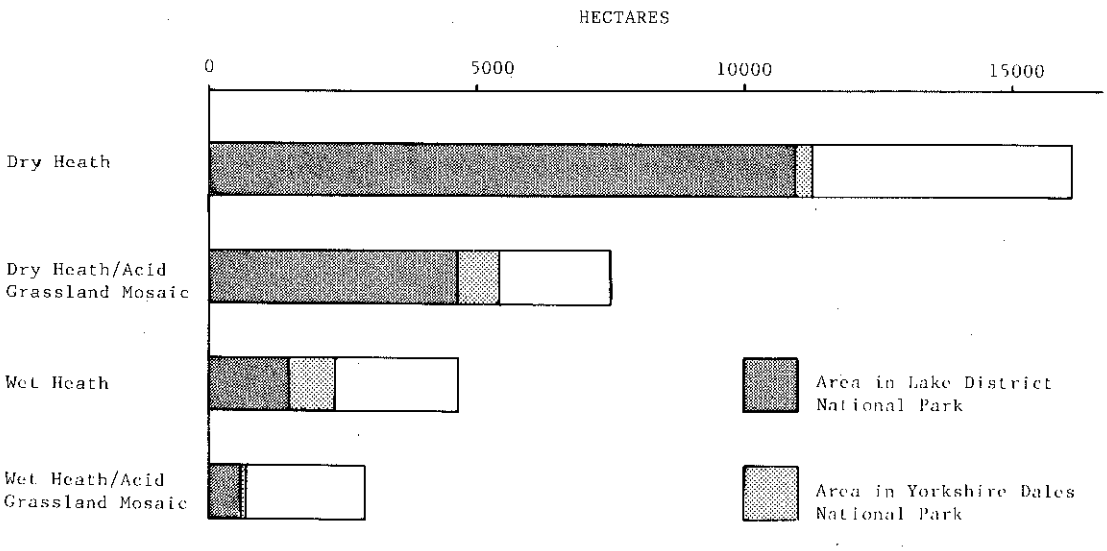


Figure 24 Areas of heathland habitat classes and proportions in the National Parks

TABLE 7 ANALYSIS OF HEATHLAND HABITAT CLASSES IN CUMBRIA

	Total area (ha)	% of county area	% of total semi-natural area	% of total heathland area
Dry heath	16,168.5	2.4	6.0	51.5
Wet heath	4,690.9	0.7	1.8	15.0
Dry heath/acid grassland mosaic	7,546.3	1.1	2.8	24.0
Wet heath/acid grassland mosaic	2,967.8	0.4	1.1	9.5
Total	31,373.5	4.6	11.7	100.0

Most of the dry heaths are acidic and are found on fairly deep podsols developed on well-drained base-deficient soils. They are often found in association with acid grassland habitats, and the two types sometimes form an intimate mosaic, which has been mapped as a separate category. The present survey recorded 7,500 ha of dry heath/acid grassland mosaic, approximately one quarter of the total heathland area. Basic or calcareous heaths also occur and are found on gently sloping dry limestone hillsides in close association with calcareous grassland.

Montane heaths of various kinds are found at high altitudes on the Lake District fells and on Cross Fell in the Pennines. They occur on rather open, stony ground where frost and snow persist for long periods. Cross Fell shows almost the full range of these communities from a prostrate Calluna/Empetrum heath mixed with a unique Vaccinium/lichen heath, through Festuca/Vaccinium heath with woolly hair-moss (Racomitrium lanuginosum) to the largest area of Racomitrium/Carex bigelowii summit heath in the north of England. This community is also found on the summit of Scafell, Skiddaw, Helvellyn and the Buttermere Fells, but on all sites it has declined greatly as a result of human trampling and sheep-grazing.

On the lower western slopes of Black Combe, close to the coast, small areas of heath are dominated by the low-growing western gorse (Ulex gallii), while further up the coast, at Eskmeals and Ravenglass, are some fragments of dune heath. Dune heath must once have been a fairly extensive habitat along the west coast of Cumbria and elsewhere on the British coast, but agricultural, industrial and recreational pressures have eliminated it from many of its former sites, and the small fragments that remain need careful conservation.

Heathlands, and especially lowland heaths, have a rich and characteristic invertebrate fauna of spiders, flies, bees, wasps, beetles and other insects, and this in turn supports reptiles, such as the common lizard and the adder, and a

wide variety of breeding birds. Upland heaths also have a rich invertebrate fauna, including the northern eggar and emperor moths (Lasiocampa quercus callunae and Saturnia pavonia), and a characteristic assemblage of moorland birds - red grouse, whinchat, stonechat, wheatear, ring ouzel, merlin, peregrine, buzzard and raven. Red deer and brown hare are locally common in this habitat.

3.4.2 Wet heath

The heathlands of Cumbria include some 7,700 ha of wet dwarf-shrub heath and a further 3,000 ha of wet heath/acid grassland mosaic. Wet heath vegetation develops on relatively shallow peat and is dominated by varying proportions of purple moor-grass (Molinia caerulea) and cross-leaved heath (Erica tetralix), together with heather and deer-sedge (Trichophorum cespitosum). Macrolichens (Cladonia spp.) may be locally abundant and some bog-mosses may be present, but they are much less abundant than in bog habitats and the species present (mainly Sphagnum compactum and S. tenellum) are distinctive. As the peat depth increases beyond 0.5 m, wet heath grades into blanket bog and other mire communities. Molinia-dominated vegetation, resembling wet heath but having less than 25% cover of dwarf shrubs, has been classified in this survey as marshy grassland.

In Cumbria, wet heath is found mainly in the uplands, on moderately steep slopes on hillsides and around flushes and mires. In the Geltsdale and Bewcastle Fells, wet heath vegetation often forms a transition zone between the acid grassland of the lower slopes and the blanket bog which covers the higher fells. In lowland situations, wet heath communities tend to occur on shallow peats around lowland raised bogs.

3.4.3 Threats to heathlands

Heathlands have been traditionally managed for sheep-grazing by periodic burning to encourage the regrowth of young heather shoots. Where they are managed for grouse they are burned in smaller patches, or preferably strips, on a rotation so as to provide a patchwork habitat of heather at different stages of regrowth, providing both food and cover for the birds. This results in diverse heathland with a good range of plant and animal species.

Where the burning regime has not been maintained, tall, leggy stands of heather develop which are of little value to grazing sheep or grouse. On fells where the density of sheep-stocking is high, the regeneration of heather cannot keep pace with the consumption of young shoots by sheep and the heather dies back. Consequently the areas of heather on the fell progressively diminish and are replaced by species-poor acid grassland. Bilberry and other dwarf shrubs are similarly affected. The loss of heather through overgrazing can be seen clearly on many fells with common grazing rights, where it is not in the interest of any one commoner to reduce his sheep numbers unless all agree to do so.

Lowland heaths are threatened by agricultural improvement and by forestry, whilst forestry appears to be the main threat to wet heath habitats. Large areas of wet heath in the uplands have been drained and planted with conifers, particularly on the fells of north-eastern Cumbria and increasingly in the south-east, near Sedbergh, where wet heaths are frequent.

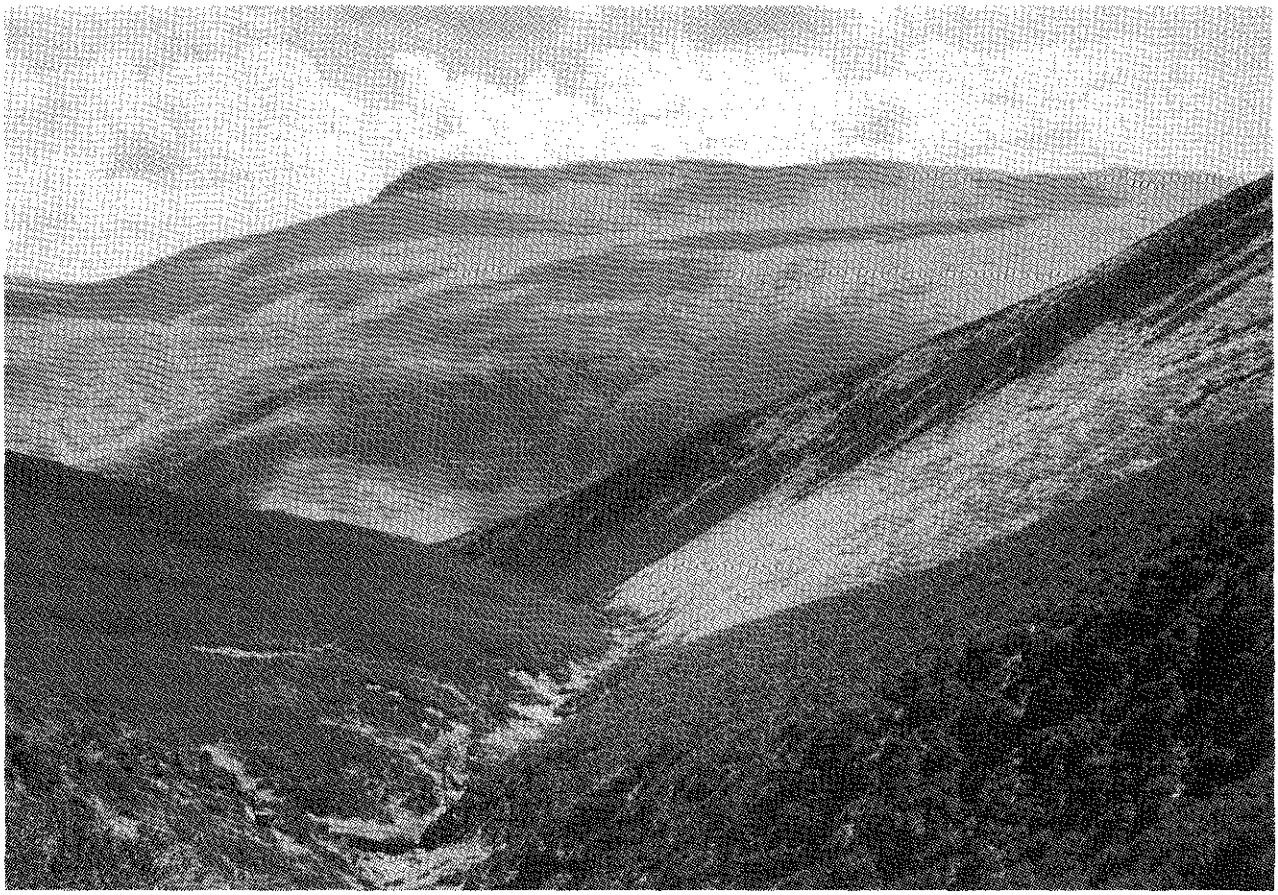


Photo 13 Dry dwarf-shrub heath and acid grassland, Skiddaw Forest. Heather and bilberry heath with mat-grass/sheep's-fescue grassland on the slopes beyond. D A Ratcliffe 1980

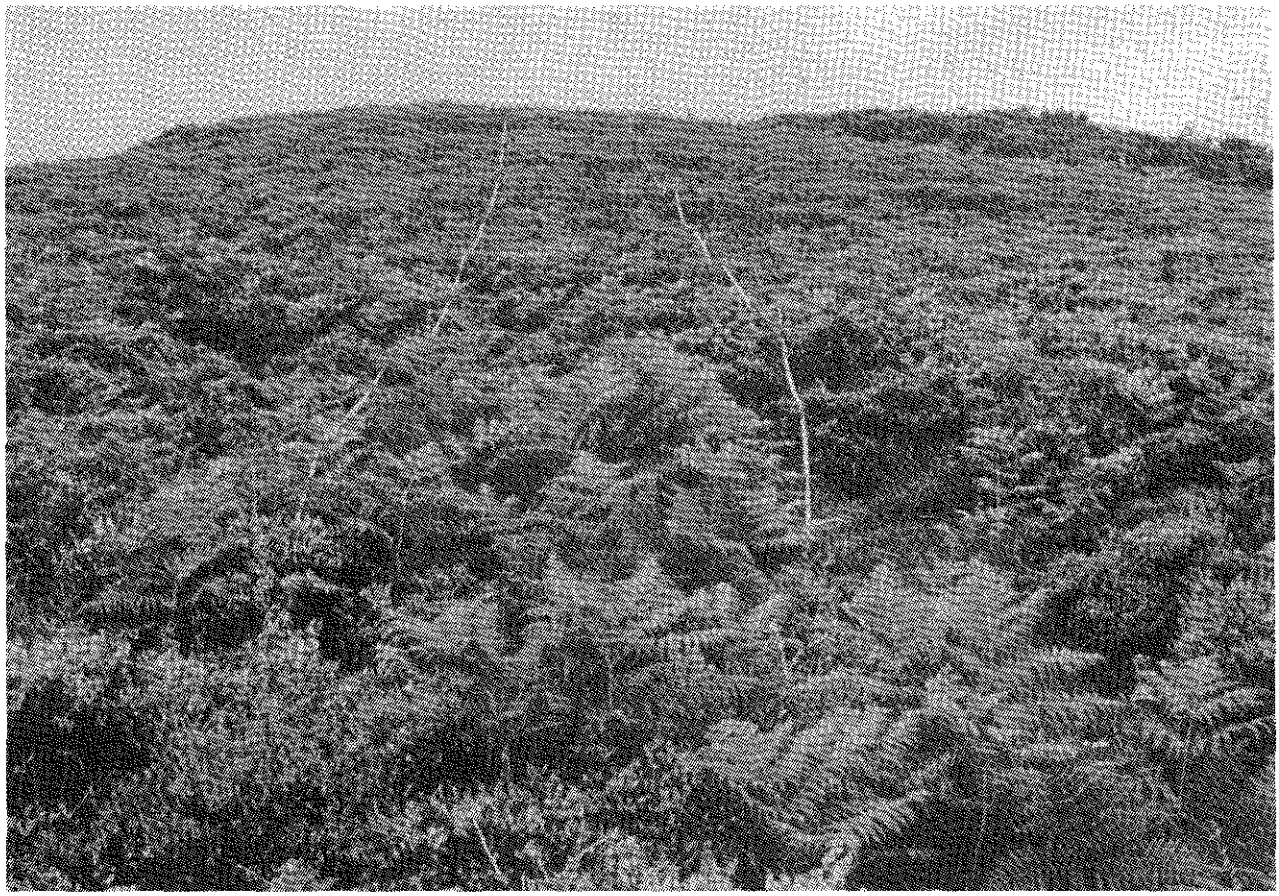


Photo 14 Dry dwarf-shrub heath, Yewbarrow, Finsthwaite. Mature heather, with invading bracken. The bracken fronds along the transect between the two tapes are counted periodically to monitor this change in the vegetation. D Shaw 1984

Photo 15 Undisturbed blanket bog, Roan Fell, Dumfries. A hummock and pool complex in heather/cottongrass bog with abundant bog-mosses (Sphagnum spp.).
D A Ratcliffe 1981

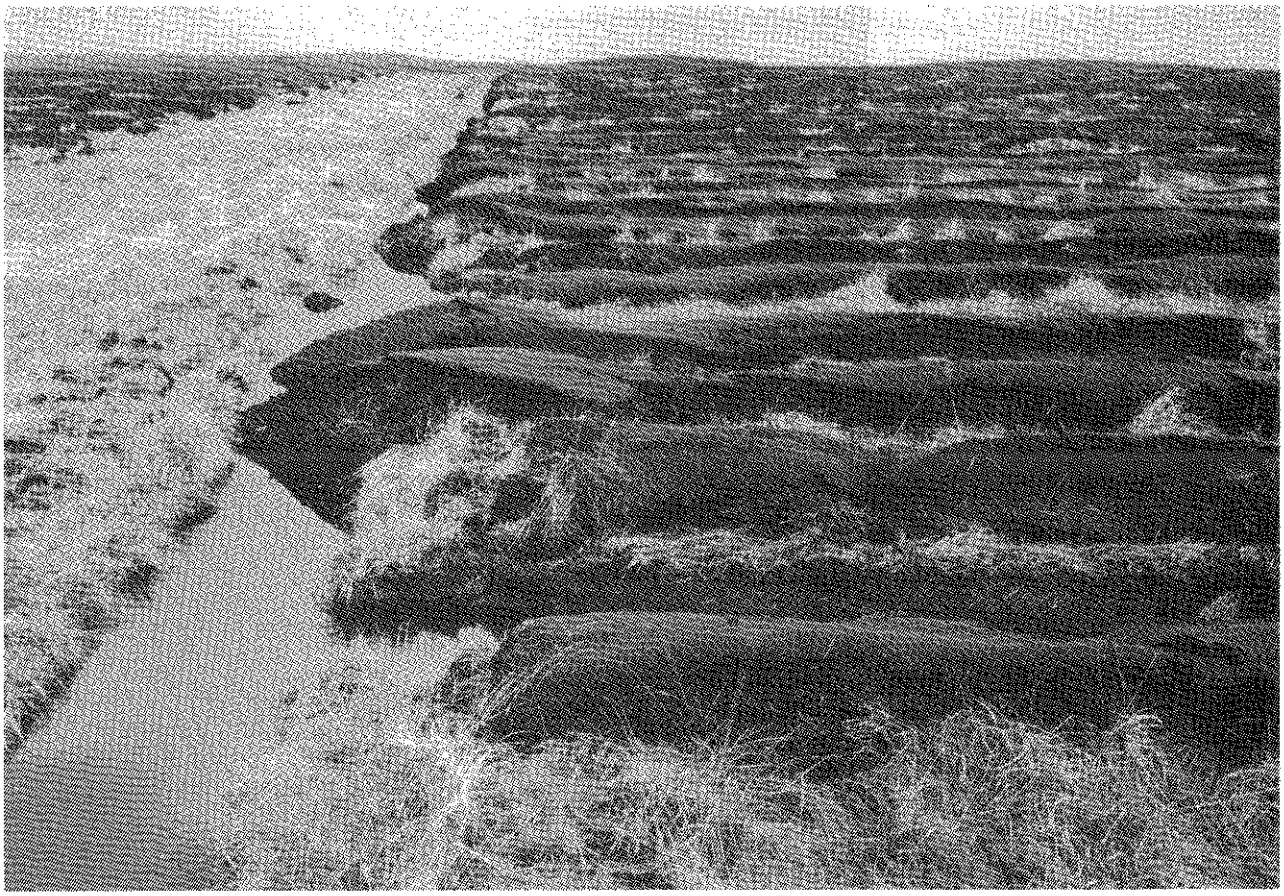


Photo 16 Blanket bog ploughed for afforestation, Spadeadam, Gilsland.
D A Ratcliffe 1983

3.5 Peatlands

The peatlands of Cumbria total 42,800 ha, 16% of the total semi-natural habitat in the county, and are of national importance for the extent and quality of their sites.

Peat is formed on ground with impeded drainage where permanently waterlogged conditions prevent plant material from decomposing. The undecomposed material accumulated to considerable depths, forming peat. In situations where silting or flushing with minerals takes place, the peat tends to be somewhat base-rich and supports fen vegetation, characterised by the presence of tall sedges (Carex spp.), common reed (Phragmites australis) and reed canary-grass (Phalaris arundinacea). Under the base-poor conditions which are much more usual in a county with acidic rocks and a heavy rainfall, acidic bogs and mires develop, dominated by bog-mosses (Sphagnum spp.) together with cottongrasses (Eriophorum spp.) and dwarf shrubs of the heather family (Ericaceae) which thrive under these conditions.

In the present survey eight different types of peatland habitat were distinguished but, for convenience, these were grouped into five broad categories, - blanket bog, raised bog, valley bog (valley mire), basin bog (basin mire), flush and soligenous mire, and swamp and fen (see Note 1).

With the exception of swamp and fen, these habitats are best separated on the basis of their hydrological and topographic features rather than their vegetation. Bogs are predominantly ombrotrophic, that is to say they receive their water and nutrient supply directly as rainfall, whereas soligenous mires are predominantly groundwater-fed (minerotrophic). The bog (or mire) class as a whole is defined as vegetation which is dominated by ericoids, cottongrass and bog-moss (often with sedges, rushes and/or purple moor-grass) occurring on peat greater than 0.5 m in depth. Similar vegetation on shallower peat would be recorded as heathland or marshy grassland, but it is not always easy to distinguish between some wet heath and bog communities, particularly where the peat depth is variable. Areas of scrub or woodland on deep peat are recorded as scrub or woodland.

3.5.1 Blanket bog

Blanket bog develops on flat and sloping ground in the uplands where the combination of high rainfall, low temperatures, poor drainage and acid substrates leads to the accumulation of peat over extensive areas. Three quarters of the peatland in Cumbria is blanket bog and over 31,000 ha of this habitat were recorded in the present survey. It blankets large areas above 600 m on the Pennine Fells in the east of Cumbria and is also found on the Shap Fells, Armboth Fells and Skiddaw Forest and on the flatter tops of the south-western fells.

The vegetation is typically dominated by hare's-tail cottongrass (Eriophorum vaginatum), heather (Calluna vulgaris), cross-leaved heath (Erica tetralix) and bog-mosses. Other frequently occurring species are bilberry (Vaccinium myrtillus),

Note 1. The classification of peatlands has recently been revised to bring it into line with continental practice, so that it is now usual to refer to ombrotrophic bogs as blanket mire and raised mire respectively, while minerotrophic mires are more correctly known as valley fen and basin fen and are classified with lake and river fens. In this report the terminology current at the time of the survey has been retained.

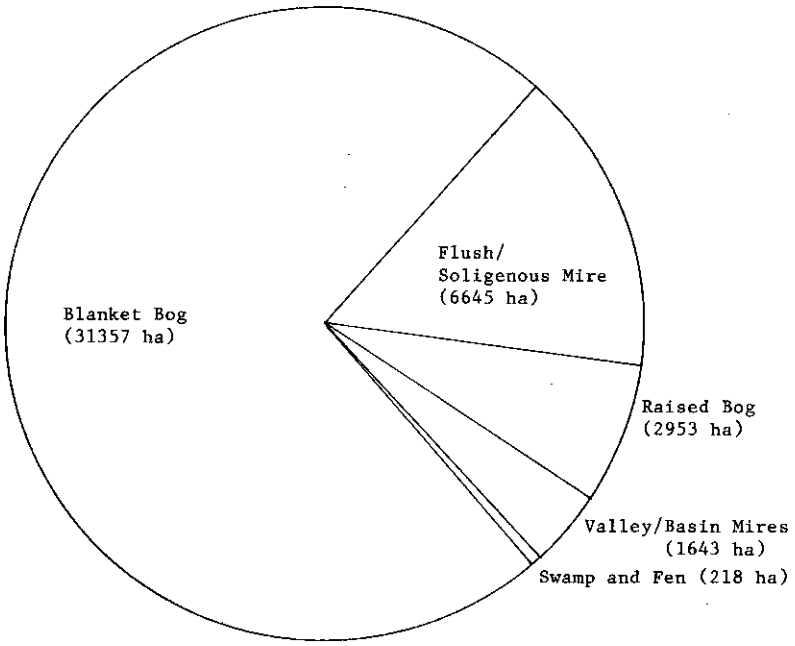


Figure 25 Relative proportions of peatland habitat classes in Cumbria

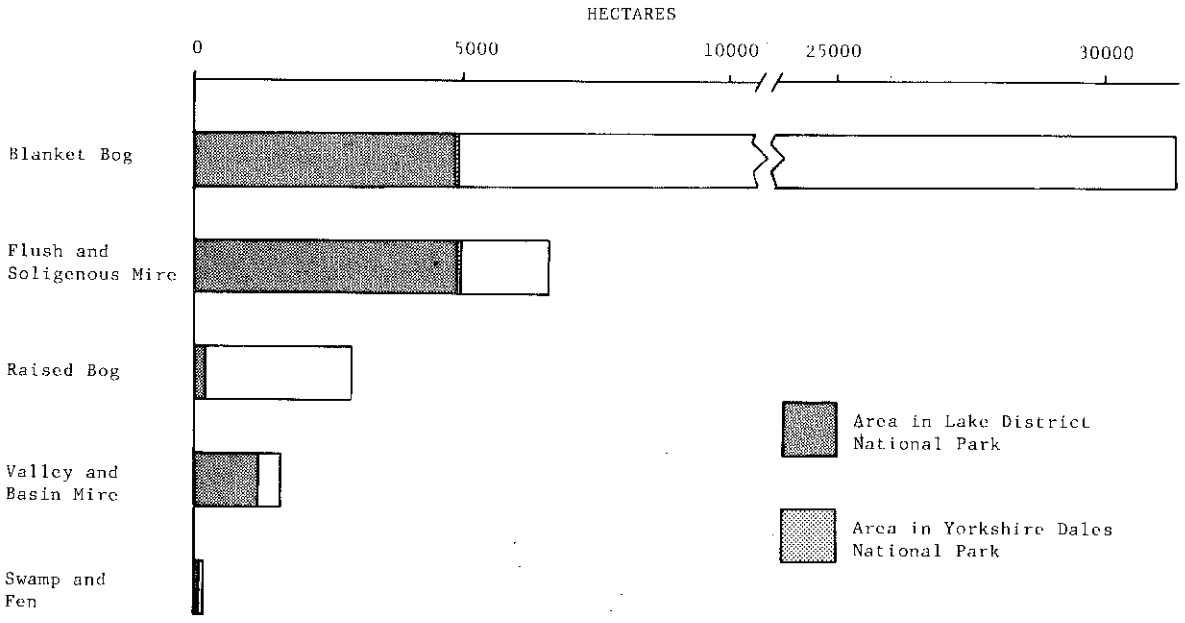


Figure 26 Areas of peatland habitat classes and proportions in the National Parks

TABLE 8 ANALYSIS OF PEATLAND HABITAT CLASSES IN CUMBRIA

	Total area (ha)	% of county area	% of total semi-natural area	% of total peatland area
Blanket bog	31,356.9	4.6	11.7	73.2
Raised bog	2,952.6	0.4	1.1	6.9
Valley and basin mires	1,643.4	0.2	0.6	3.8
Flush and soligenous mire	6,644.5	1.0	2.5	15.5
Swamp and fen	218.4	0.03	0.1	0.5
Total	42,815.8	6.2	16.0	100.0

crowberry (Empetrum nigrum), cranberry (Vaccinium oxycoccos) and cowberry (V. vitis-idaea). Undisturbed blanket bogs tend to develop a series of Sphagnum-dominated hollows and heather-dominated hummocks, and many have well-developed pools with bogbean (Menyanthes trifoliata) and bottle sedge (Carex rostrata). Less common plants of blanket bogs are cloudberry (Rubus chamaemorus), locally common only on the Pennines, and bog-rosemary (Andromeda polifolia). Blanket bogs are also important for their breeding moorland birds such as red grouse, redshank, curlew, golden plover and merlin.

Blanket bogs are generally less species-rich than the other bog categories, and many areas have become impoverished through burning, grazing and drainage.

On the other hand they are usually very extensive and often include small areas of raised bog, valley and basin mires and flushes, all of which add to their diversity and interest. Internationally, blanket bog is a scarce habitat type and Britain's resources are of world importance. Consequently most of the sites in Cumbria are of considerable importance to nature conservation.

Butterburn Flow, at an altitude of 270 m on the border with Northumberland, is one of the most important areas of blanket mire in England. It has an interesting form of surface patterning, transitional between hummock-and-hollow and ridge-and-pool patterns, and has large intact areas dominated by bog-mosses (mainly Sphagnum magellanicum and S. papillosum) and a number of rare plant species, notably tall bog-sedge (Carex magellanica), few-flowered sedge (C. pauciflora) and the bog-mosses Sphagnum pulchrum and S. imbricatum, while bog-rosemary and cloudberry are plentiful.

Another notable area of undisturbed blanket bog is Caudbeck Flow on the Bewcastle/Irthinghead Fells, where much of the surrounding area has been afforested. Caudbeck Flow has a particularly rich assemblage of bog-mosses

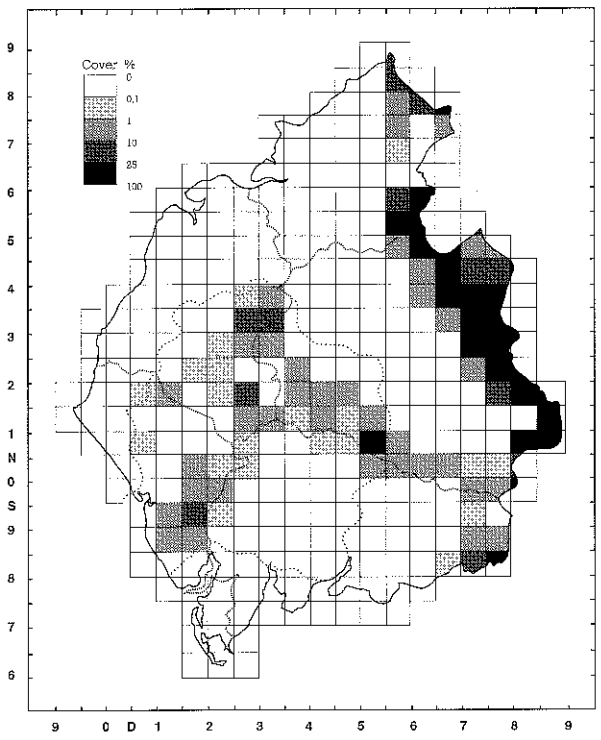


Figure 27 Distribution of blanket bog in Cumbria

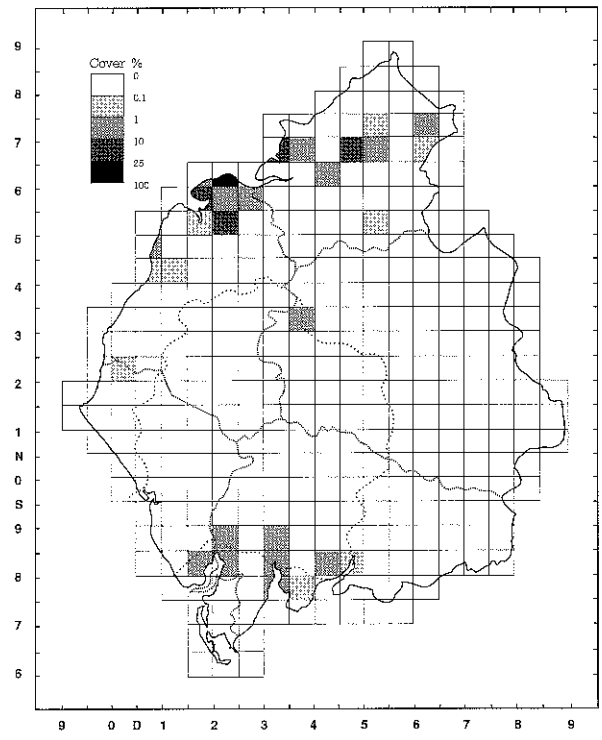


Figure 28 Distribution of raised bog in Cumbria

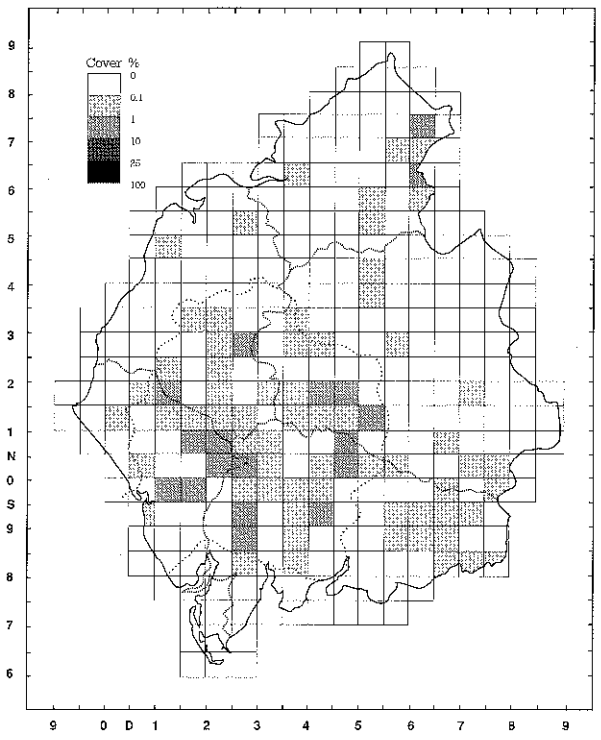


Figure 29 Distribution of valley and basin mires in Cumbria

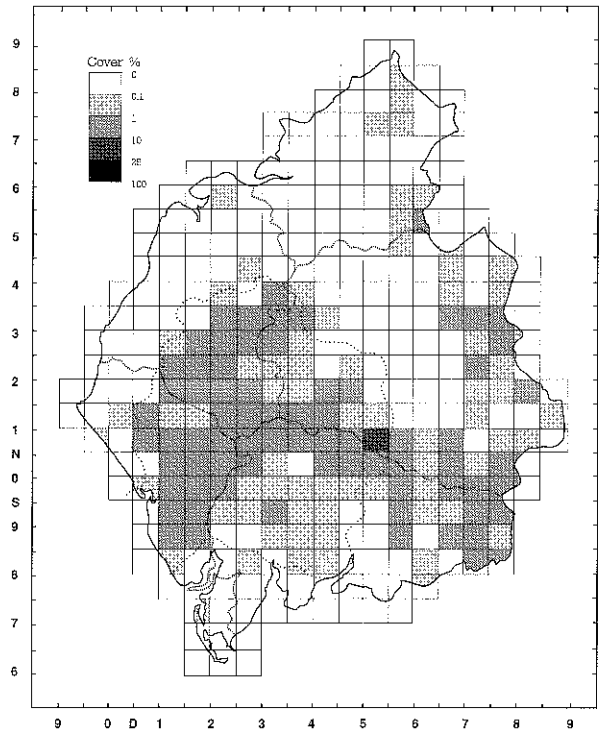


Figure 30 Distribution of flushes in Cumbria

together with cranberry, round-leaved sundew (Drosera rotundifolia), common butterwort (Pinguicula vulgaris) and cloudberry. It is also notable for its acidic and calcareous flushes, with their widely differing vegetation, which contribute to the overall diversity of the site.

Large areas of blanket bog are found on the Pennines, from Christianbury Crags and Bewcastle Fells south to the Tynehead and Appleby Fells. Much of the northern area has been drained and planted with conifers. It is estimated that 65% of the conifer plantations in Carlisle District are on blanket peat. Further south, extensive 'moor-gripping' with regularly spaced drains has been undertaken to improve the value of the land for sheep-grazing.

3.5.2 Threats to blanket bogs

Drainage, together with burning which often follows it, leads to the loss of Sphagnum and other bog species and the development of mixed moorland of heather, bilberry and hare's-tail cottongrass. Heavy grazing leads to the further loss of dwarf shrubs, leaving a uniform cottongrass moor with few other plant species, which is of little value as wildlife habitat. On drier areas affected by drainage and grazing, particularly at the edges of blanket bogs, heath rush (Juncus squarrosus) and grasses may become prominent, so that the vegetation comes to resemble species-poor acid grassland. Such impoverishment has been the fate of large areas of blanket bog on the Pennines and also of the smaller remnants of blanket bog on the ridges of the Lake District Fells.

The loss of plant cover resulting from excessive burning and grazing leads to the exposure of bare peat, which erodes rapidly to form deep gulleys between collapsing peat hags. This effect can be seen here and there along the edge of existing blanket bogs on the Pennines.

Many species of Sphagnum have disappeared from Pennine blanket bogs during the past century, probably as a result of their sensitivity to acid rain. Bog-mosses obtain their mineral nutrients from the minute amounts present in rainfall, extracting them by ion-exchange on the surface of their leaves. Acidified rain reverses this process, leaching minerals from the plants and thereby endangering their survival.

Commercial peat-winning is not currently a threat to blanket bogs in England, but peat digging on a smaller scale over many centuries has modified the surface and drainage of considerable areas at the margins of bogs, often reducing the peat depth to such an extent that bog vegetation has been replaced by heath and acid grassland.

3.5.3 Raised bog

The raised bogs of Cumbria are a wildlife habitat of national importance. They occur on the level areas of glacial till which flank the Solway Firth in the north and Morecambe Bay in the south. Like many other semi-natural habitats they were once more numerous and more extensive but have been depleted by the activities of man. The vast tracts of lowland 'peat moss' which enriched the coastal plains of Lancashire and Yorkshire have now almost disappeared, mainly as a result of reclamation for agriculture and horticulture over the past 100 years. Cumbria is fortunate in still retaining many of its lowland raised bogs, though all are damaged to some extent.

The survey recorded approximately 3,000 ha of raised bog (see Note 2) in Cumbria on some two dozen separate sites. This makes up only 7% of the county's peatland but it accounts for 60% of the lowland raised bog in Britain. Since most of the remaining 40% is accounted for by three sites, Flanders Moss in Scotland and Thorne and Hatfield Moors in Yorkshire, it will be appreciated that the Cumbrian sites are important for their number and variety as well as for their total extent.

The series of raised bogs which is found along the Solway coastal plain from Solway Moss, near Carlisle, through Drumburgh and Glasson Mosses to Wedholme Flow and Bowness Common collectively forms the most extensive area of lowland raised bog in Britain. The extent of intact peat surface varies from site to site. None of the sites is undamaged, and Solway Moss and Wedholme Flow are worked extensively for commercial peat-extraction. On the fringes of Morecambe Bay in south Cumbria a further series occurs, with important groups of raised bogs in the Duddon Valley and Rusland Valley, the Roudsea and Holker Mosses beside the Leven estuary, and Nichols, Meathop and Foulshaw Mosses beside the Kent estuary. The Duddon Mosses form the best remaining example of an estuarine raised bog system in England and the other south Cumbrian mosses are of considerable interest, but Foulshaw Moss is almost entirely given over to forestry.

Walton Moss and Bolton Fell Moss, in Carlisle District, are two large and important examples of raised bog occurring at intermediate elevations (approximately 90 m). Bolton Fell has been heavily worked for peat in the past 30 years but still has some ecological interest. Walton Moss, in contrast, is relatively undamaged and has the largest area of intact raised bog in Cumbria. Black Moss, near Egremont in west Cumbria, is a small but relatively intact bog, also at 90 m, which is notable as the only raised bog in this part of the county.

Raised bogs originate in shallow basins on fairly level ground, but the accumulating peat raises the surface level above the surrounding area. As peat growth continues, over a period of thousands of years, fed only by direct rainfall, a domed structure is produced which holds its own water table close to the peat surface some 5 to 10 metres above the surrounding land.

The vegetation of raised bogs, which is responsible for peat formation, is similar to that of blanket bogs, consisting primarily of various species of bog-moss together with heather, bilberry, cross-leaved heath and hare's-tail cottongrass. On undisturbed surfaces a mosaic of hummocks and hollows, ridges and pools develops, with different species of Sphagnum occupying different positions in the mosaic, producing a varied and colourful habitat. Thus the dark green Sphagnum cuspidatum occurs in the open pools, and the grass-green and orange S. recurvum in channels and at the edges of pools, where it may form lawns with the ochreous S. papillosum and orange-gold S. pulchrum. Sphagnum papillosum also contributes to the hummocks, together with the red-tinged S. capillifolium and wine-red S. magellanicum. The golden-brown S. imbricatum, once common on the drier hummocks, is now found only rarely, its loss apparently being the result of both the drying-out and the burning of bogs. Cladonia lichens, particularly C. uncialis, C. abuscula and C. portentosa, are common on the drier tops of the hummocks.

Among the vascular plants, white beak-sedge (Rhynchospora alba), cranberry, round-leaved sundew and bog asphodel (Narthecium ossifragum) are often abundant,

Note 2. Woodland and grassland on deep peat were not classified as bog in the present survey. The total area of raised bogs if defined as hydrological units is over 5,000 ha.

while the rarer great sundew (Drosera anglica), oblong-leaved sundew (D. intermedia) and bog-rosemary also occur and may be locally common.

Water run-off from a raised bog is collected by peripheral 'lagg' streams, which may completely circumscribe the bog. Lagg woodland, of birch, alder and, frequently, Scots pine, is typically found on the edge of the bog which slopes down to the lagg stream. As raised bogs dry out, mainly through the activities of man, they are often invaded by birch and Scots pine, which may be followed by sycamore, oak and hazel, and smaller sites may become almost completely wooded, as at Orton Moss and Rockcliffe Moss in Carlisle District. Although they may have lost much of their value as raised bog habitat, wooded bogs often make an important contribution to the woodland habitat of the relatively unwooded areas in which they occur.

Raised bogs have a characteristic invertebrate fauna, which includes the bog bush-cricket (Metrioptera brachyptera), large heath butterfly (Coenonympha tullia) and some rare spiders, and many sites are highly valued by entomologists for the rich variety of their insect life. Several bird species are known to breed on raised bog sites, including curlew, snipe, redshank, reed bunting and, occasionally, nightjar, while sparrowhawk and kestrel nest in lagg woodlands.

3.5.4 Threats to raised bogs

The operations which are most damaging to raised bogs are draining, burning and peat-cutting. Draining and peat-cutting in the past have modified the hydrology and structure of most of the raised bogs in the county and have resulted in the drying-out of much of the raised surface as the water table is lowered. In such cases active Sphagnum growth can take place only at 'recurrence surfaces', where peat-cutting has lowered the peat surface down to the new water level. The rejuvenated bog which develops at these surfaces has a limited species diversity and habitat diversity compared with the mature bog which it replaces, and it might take several thousand years to build up to the original level. As it dries out, the dome of the bog tends to lose most of its Sphagnum species and it ends up with a heath-like vegetation, usually dominated by heather and sometimes also with hare's-tail cottongrass and purple moor-grass (Molinia caerulea). These 'dry bog' communities are particularly vulnerable to fire, which can further reduce their species diversity.

Drying-out of the bog surface is often accompanied by the invasion of birch and Scots pine. Unless this is halted by fire or by deliberate eradication, it leads to further drying-out of the bog, by evapotranspiration through the trees themselves, and eventually to the establishment of woodland on the moist, aerated peat which remains. The problem of rehabilitating dried-out raised bogs is almost as great as that of cut-over bogs, since the process of raising the water levels and re-creating the domed water-body within the peat is usually frustrated by the presence of numerous drains, cracks and channels in the peat.

It is estimated that only 750 ha of active raised bog still remain, the largest single area being at Walton Moss, where 75% of the bog is believed to be active. Substantial amounts of active bog are also found at Wedholme, Bowness, Glasson and Drumburgh Mosses, but the South Lakeland mosses generally have little active Sphagnum accumulation except on low recurrence surfaces resulting from local peat-working.

Drainage followed by commercial afforestation has been the fate of Foulshaw Moss, once the largest of the South Lakeland raised bogs. A century ago it exceeded 300 ha, but now only 6 ha of bog vegetation remain. Many other raised

bogs have been partially planted, some with conifers and some with broadleaves, and these trees, together with their self-sown seedlings, are continuing to speed up the drying-out of the bogs and their conversion to woodland.

Commercial peat-extraction using modern mechanised methods is far more devastating than the old traditional method of peat-cutting. It usually results in the total removal of peat from vast areas of the bog, leaving only a minimal layer of peat above the underlying clay. Commercial working currently takes place on three of the largest raised bogs in Cumbria, Bolton Fell, Solway Moss and Wedholme Flow, and the area laid bare by these workings, 850 ha, is greater than the total area of surviving active bog in Cumbria. Removal of peat on this scale also threatens adjacent areas of unworked bog through its effect on their hydrology.

The outer margins of lowland raised bogs, lowered by peat-cutting in the past, may also be reclaimed for agriculture. Over-deepening of the drains on this agricultural land can lead to further drying-out of the remainder of the moss and hasten its decline. Many of the South Lakeland mosses have suffered from drainage of the surrounding agricultural land, and extensive drainage schemes, as in the Lyth Valley, have resulted in the progressive drying-out of the mosses and their reclamation for agriculture. A number of smaller mosses have been totally lost to agriculture in this way and large parts of the Rusland Valley mosses have also suffered this fate. A study of changes in lowland raised mires in Cumbria between 1948 and 1978 found a 32% loss of area in the Solway mosses and 68% loss in the South Cumbria mosses during this period (NCC 1984).

3.5.5 Valley and basin mires

Valley mires and basin mires (formerly known as valley bogs and basin bogs) differ from raised bogs and blanket bogs in that they are dependent on groundwater rather than direct precipitation for their nutrient supply.

Their development, like that of raised and blanket bogs, is topographically controlled and they occur where drainage is impeded in valleys and basins respectively. The two habitats show similarities in their vegetation and structure, but valley mires are found on sloping sites and often have a central drainage stream, while basin mires form in closed depressions and may have a central floating mat of bryophytes and sedges.

In practice some sites are transitional between basin and valley mires, while others consist of a mire-complex containing one or more areas of each type together with areas of bog, flush, wet heath and marshy grassland. Although valley and basin mires were usually distinguished during habitat mapping, the two types were combined for the purpose of habitat measurement.

Valley and basin mires cover some 1,650 ha in Cumbria and are an important, though minor, component of the county's peatlands. They are almost confined to the southern and central parts of Cumbria, occurring in shallow depressions and gently sloping valleys. Valley mires occur, together with flushes, in many of the valleys of the Central Fells, while basin mires are more limited in their distribution.

In upland situations, basin and valley mires are frequently associated with flushes which feed into them, forming quite extensive systems, while in the lowlands they tend to be more discrete and widely scattered, probably as a consequence of improvement of the surrounding land.

Photo 17 Ungrazed blanket bog, Christianbury Crags, Bewcastle Fells. A rich mosaic of vegetation with cowberry, crowberry, cloudberry, heather, cottongrass and bog-mosses. P Welsh 1984

Photo 18 Eroding blanket bog, Geltsdale. Bare peat is exposed between the tussocks of cottongrass. Burning patterns can be seen on the hillside beyond. Acid rain, draining, burning and overgrazing all contribute to the peat erosion. P Welsh 1984

Photo 19 Raised bog, Glasson Moss. A Sphagnum-rich heather and cottongrass bog, with cross-leaved heath and white beak-sedge, here seen flowering abundantly.
P Wakely 1981

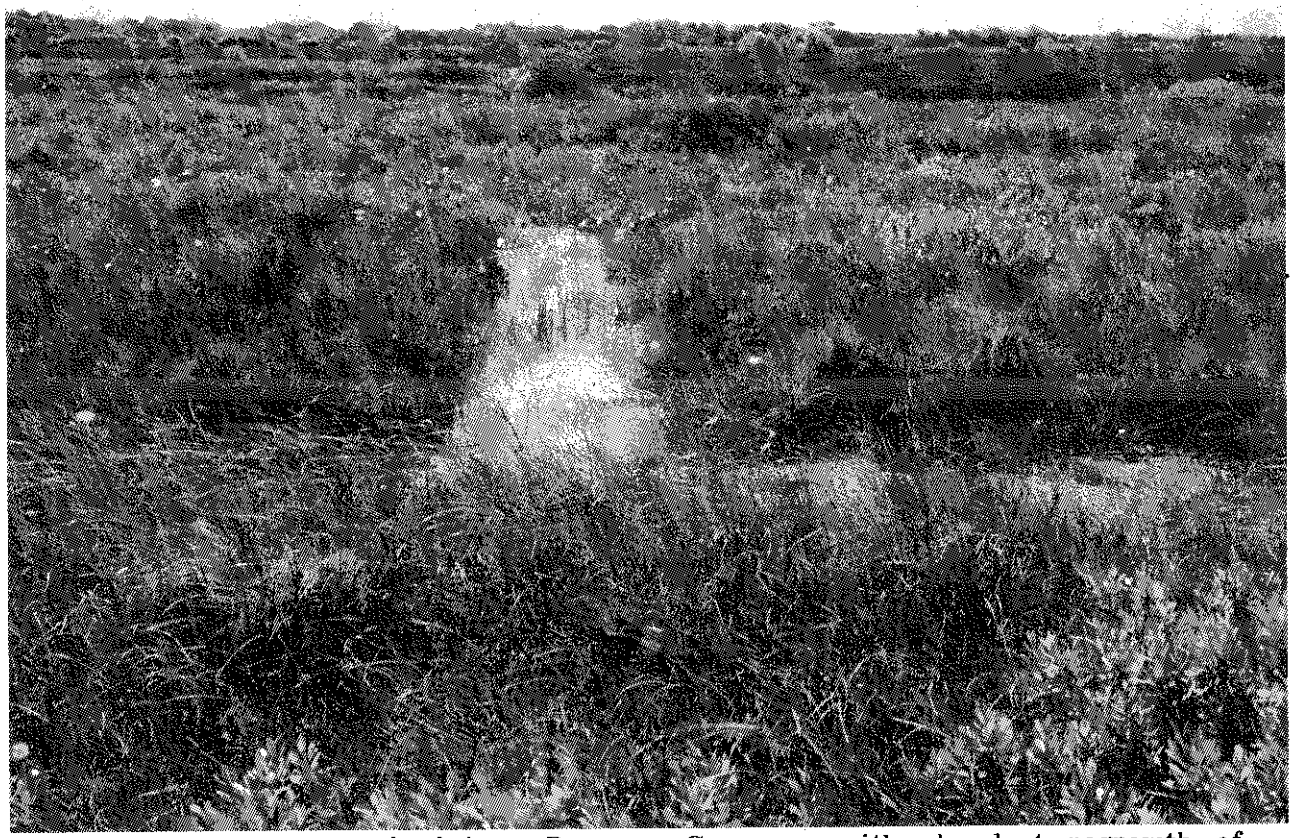


Photo 20 Cut-over raised bog, Bowness Common, with abundant regrowth of bog-myrtle and cottongrass. In the background birch is colonising the drier areas towards the edge of the bog. D A Ratcliffe 1981

Photo 21 Drying raised bog, Rusland Moss. Self-sown Scots pines encroach onto the crown of the bog, which is dominated by cottongrass and bog-mosses with heather, cross-leaved heath and white beak-sedge. P Wakely 1986

Photo 22 Commercial peat-working on raised bog, Solway Moss. Large areas of lowland raised mire in Cumbria have been stripped of their vegetation in the course of commercial peat extraction. M Rawes 1974

Photo 23 Fen with carr woodland, Bassenthwaite. Willow and alder carr with rich fen vegetation near the lake margin. P Wakely 1985

Photo 24 Swamp and fen, North Fen, Esthwaite Water. Common reed forms extensive stands in standing water at the edge of the lake, backed by herb-rich fen and carr woodland. P Wakely 1986

The vegetation of valley mires and basin mires can be similar to that of blanket and raised bogs, usually being dominated by bog-mosses and ericoid species, but ericoids are generally less abundant, occurring where the surface is raised above the water table and dries out periodically. The wetter surface conditions on the mires favour sedges and common cottongrass, and semi-aquatic species such as bog pondweed (Potamogeton polygonifolius) and bladderworts (Utricularia spp.) are often present. The movement of water through these mire systems tends to result in a higher nutrient status and a greater diversity of plant and animal species than in the more acid ombotrophic bogs.

Good examples of valley mire and basin mire habitat can be found on the southern side of Denton Fell in the north of the county and around Devoke Water in the south-west, at Burnsbeck Moss near Kendal and among the small tarns on Claife Heights near Windermere. Many more examples have been found in south and west Cumbria and these are currently being studied in greater detail. A number of rare plants such as few-flowered spike-rush (Eleocharis quinqueflora) and marsh St John's-wort (Hypericum elodes) are found in these habitats, which are also rich in invertebrates such as damselflies and dragonflies. Several sites for the keeled skimmer and white-faced dragonflies (Orthetrum coerulescens and Leucorrhinia dubia), at the northern limit of their ranges, have been found among these mires in Cumbria. On the coastal plains of west Cumbria some mires have developed over kettle-holes formed in the last Ice Age, as at Harnsey Moss and Silver Tarn, and their peat deposits have been studied for their record of vegetational change since the Ice Age. Some mires such as Orton Moss and Biglands Bog have been colonised by woodland and have been included under that habitat in the present survey.

3.5.6 Threats to valley and basin mires

Drainage is a great threat to valley and basin mires and often results in the loss of these sites to agriculture. Because of their relatively small size, moderately good nutrient status and favourable drainage pattern, they are readily reclaimed and make good farmland or woodland, though they are not large enough to attract large-scale commercial forestry. Heavy grazing and trampling can also be a problem on partly drained sites, exposing the underlying peat to erosion.

Being fed by the flow of groundwater from the surrounding land, both valley mires and basin mires are vulnerable to eutrophication by agricultural fertilisers applied to neighbouring fields and to pollution from agricultural, domestic and industrial effluents. The mineral nutrients in these effluents are picked up by the peat and released over a long period, resulting in drastic changes in the vegetation which are difficult to reverse.

3.5.7 Flush and soligenous mire

For the purpose of the survey this habitat was defined as encompassing areas of wet, boggy vegetation which develop along seepage lines on sloping ground, which may be quite steep or almost level. They are distinguished from wet grasslands, which may occur in similar situations, by the lack of dominant grasses and by the importance of Sphagnum or other mosses in the ground-layer. They vary considerably in size from small fan-like features on valley sides to extensive networks following the complex drainage pattern of a large area of gently sloping ground or running along the flanks of a moderately steep hillside.

Although individual sites are quite small, collectively they represent an important segment of Cumbrian peatlands, covering a total area of over 6,600 ha scattered throughout most of the county. They are most abundant in the western Lake District and along the flanks of the Pennines and the Howgills.

Many flushes are small in size (often less than 1 ha) but they may be rich in plant species and they occur as a variety of different types, depending on the chemistry of both the water supply and the underlying substrate.

The commonest type of flush in Cumbria is the species-poor acidic flush which is found on base-poor sites and is widespread in the Pennines, the Howgills and the Northern Fells of the Lake District where the underlying rocks are acidic. These flushes are usually dominated by rushes, particularly soft-rush (Juncus effusus), with bog-mosses, particularly Sphagnum recurvum and S. palustre, and may have few other species, though where there is some enrichment from the surrounding area there will often be star sedge (Carex echinata), marsh willowherb (Epilobium palustre), marsh violet (Viola palustris), marsh pennywort (Hydrocotyle vulgaris) and marsh thistle (Cirsium palustre).

Where mineral flushing occurs on less acid substrates, as on the Borrowdale Volcanics of south and west Cumbria, sharp-flowered rush (Juncus acutiflorus) is the dominant species and there is usually a much richer assemblage of plants including, in addition to those above, common spotted-orchid (Dactylorhiza fuchsii) and a number of sedges.

Many flushes have a diverse and characteristic insect fauna, and in Cumbria flushes with sharp-flowered rush, marsh thistle and marsh violet often support colonies of the small pearl-bordered fritillary butterfly (Clossiana selene), known elsewhere in England as a declining woodland species.

Where the groundwater is influenced by Carboniferous Limestone, it is rich in calcium and can give rise to calcareous flushes which typically have a carpet of brown feathery mosses and sedges such as long-stalked yellow-sedge (Carex lepidocarpa) and glaucous sedge (C. flacca). Bird's-eye primrose (Primula farinosa) is found in such situations, as is also grass-of-Parnassus (Parnassia palustris). Some of the calcareous flushes at Sunbiggin Tarn, Crosby Gill and Caudbeck Flow contain actively growing deposits of tufa, a soft, porous form of limestone produced from the calcareous water by microscopic organisms. In addition to being an unusual phenomenon, tufa provides a habitat for a number of rare and interesting invertebrates.

Local base-enrichment may also take place on quite acid substrates when the groundwater arises in limestones or on some of the more base-rich Borrowdale Volcanic rocks. These circumstances can give rise to a wide variety of different flush communities, some acidic, some basic and some intermediate, each with its own distinct assemblage of species. In upland areas, particularly in south-western Cumbria, flushes dominated by purple moor-grass and bog-myrtle (Myrica gale) are often found draining into mire systems.

Springs and upwellings have been included with flushes in the present survey. These commonly have a dense mat of mosses and liverworts together with blinks (Montia fontana) and opposite-leaved golden-saxifrage (Chrysosplenium oppositifolium). The rare marsh saxifrage (Saxifraga hirculus) is found in springs on limestone in one or two places on the Pennines, whilst the yellow saxifrage (S. aizoides) is found more abundantly in stony flushes on steep mountainsides in the Lake District.

3.5.8 Threats to flushes and soligenous mires

Because of their small size and their dependence on groundwater flow, most flush habitats are vulnerable to changes taking place in the surrounding area. Indeed, any activity undertaken on the land immediately surrounding these habitats may have an effect on them. Drainage and improvement of the surrounding

farmland have led to the loss of many lowland flushes and the impoverishment of others. On the fells, overgrazing and trampling by stock are damaging to flush vegetation, and the afforestation of large areas has resulted in the draining of many flushes and the shading-out of others to the detriment of their conservation value.

3.5.9 Swamp and fen

Swamp and fen communities often develop at the edges of pools, tarns and lakes, where these slope gently and allow the accumulation of silt and peat. They are also found in large ditches and slow streams and beside slow-flowing rivers. They form a transitional stage between open water and dry land and differ in that the water table of swamp is above the ground level for much of the year, whereas in fen it is at or below the surface for most of the year.

Swamp vegetation is typically dominated by tall monocotyledonous species, such as bulrush or reedmace (Typha latifolia) and common reed, in stands consisting of a single species. Fen vegetation is usually more varied, with reeds and other grasses and large sedges mixed with rushes and other flowering plants. In nutrient-poor fens, bottle sedge and bladder-sedge (Carex vesicaria) may predominate, but nutrient-rich fen has a wide variety of flowering plants including purple-loosestrife (Lythrum salicaria), gipsywort (Lycopus europaeus), water mint (Mentha aquatica) and meadowsweet (Filipendula ulmaria) among the reeds and tall sedges. Mature fen habitats may be colonised by scrub or by goat willow (Salix caprea), bay willow (S. pentandra), rusty willow (S. cinerea subsp. oleifolia) and alder (Alnus glutinosa), forming carr woodland. Where this has happened, the habitats are recorded as scrub or woodland rather than fen.

The above description is greatly simplified, as swamp and fen vegetation may vary greatly, depending on the conditions under which it has developed and particularly on the nutrient status of the water. Cumbria as a whole possesses a wide range of sites within this habitat category in both upland and lowland situations, but none is very extensive and the total area of this habitat recorded was only about 220 ha. Moderately large areas of swamp and fen occur on the west coastal plan and on the shores of mesotrophic lakes and tarns in the Lake District, but elsewhere the sites are small and scattered and thus are rather vulnerable.

Rich fen has developed on infilled kettle-hole tarns on the west Cumbrian coastal plain, as at Gibb Tarn and Lantern Moss Tarn, and elsewhere, as at Biglands Bog, Dubbs Moss and the North Fen of Esthwaite Water. Where local conditions are more acidic, poor fen may develop, with carpets of bog-mosses among the reeds and sedges, as at Church Moss and Tarneybank and Lan Tarn. Tall swamp and fen vegetation is found in sheltered bays and at the silted ends of many of the larger lakes and tarns of the county, as at the Ings on Derwent Water, Fellfoot on Windermere, White Moss on Rydal Water, and in Thurstonfield Lough near Carlisle. An extensive area of swamp and fen has developed on alluvial silts at the southern end of Bassenthwaite Lake together with marshy grassland and willow scrub communities.

Despite their small extent, swamp and fen communities are an important part of the lake and tarn ecosystem. The abundance and variety of vegetation, both dead and alive, above and below the water level provides a great variety of microhabitats for invertebrate life, which in turn provides food for vertebrates such as birds, fishes, reptiles and amphibians. Coot, moorhen, little grebe, great crested grebe and various ducks breed in this habitat, which provides them with food, cover and nest sites. Reedbeds also provide food and breeding facilities for reed bunting and reed, sedge and grasshopper warblers. Insects such as

dragonflies and damselflies, which are aquatic in the early stages of their lives, make use of emergent vegetation during their metamorphosis into flying adults. Reedbeds are also important roosting sites for other birds, including migrants. Where carr woodland has developed at the edges of the fen, this adds still more to the variety of the insect life and provides cover, food and nest sites for a further range of insectivorous birds.

3.5.10 Threats to swamps and fens

These habitats are particularly vulnerable to the effects of any drainage work in their vicinity, which may permanently raise or lower their water level. The dredging and clearing of ditches and streams to improve land drainage and water flow have not only resulted in the loss of much of swamp and fen vegetation from these waterways but have also contributed greatly to the drying-out of the areas which they drain. In lowland areas, eutrophication from fertilisers and slurry from surrounding farmland and pollution from pesticides, sewage and industrial effluents can cause irreversible changes in swamp and fen vegetation and the loss of most of their wildlife. Recreational activities on lakes and tarns can cause disturbance to the wildlife of fringing swamp and fen habitats, seriously reducing its breeding success. Excessive trampling may result in damage to or loss of both the vegetation and its substrate, and the wash from power boats can be equally damaging.

3.6 **Open waters**

Open water covers 9,150 ha, or 1.3% of the county. This figure includes both standing and running waters, with standing water predominating in most parts of the county. Although constituting a relatively small fraction of the county area, open water is an important habitat which supports many species not found elsewhere, as well as providing a focus for other more widely distributed species.

3.6.1 Standing water

As much as 79% of the open water area in Cumbria is standing water, a category which includes lakes, tarns, reservoirs, pools and ponds over 0.25 ha in size. A large proportion of the total is accounted for by the lakes of the Lake District, which are of considerable ecological importance, but the importance to wildlife of the large number of smaller tarns, pools and ponds scattered throughout the county should not be overlooked.

Many of the Cumbrian Lakes lie in deep glaciated valleys among the Central Fells. The fells consist mainly of base-poor Borrowdale Volcanic rocks, and the lakes which are fed by their streams are likewise rather acidic and nutrient-poor. Wast Water, Ennerdale Water and Buttermere are good examples of nutrient-poor (oligotrophic) lakes and have a restricted but characteristic range of invertebrate species, including mayflies, caddis flies and water beetles, and rare crustaceans known only from relict glacial lakes. They also support a number of fish species including the nationally rare char (Salvelinus alpinus) and brown trout, salmon, eel, three-spined stickleback and minnow.

The tarns of the Central Fells are similarly oligotrophic and often have stony bottoms and sparse vegetation. The characteristic plants of this habitat are shoreweed (Littorella uniflora), water lobelia (Lobelia dortmanna) and quillwort (Isoetes lacustris), which occur near the shores of the deep oligotrophic lakes as well as in the oligotrophic tarns of the fells and corries.

In more open catchments, where the streams do not fall so directly from the mountainsides into the lakes, the waters become enriched with dissolved minerals as they pass through the soil and the lakes fed by them are said to be mesotrophic or moderately rich in nutrients. Windermere, Bassenthwaite Lake and Esthwaite Water are good examples of relatively shallow mesotrophic lakes which support a wide range of species and greater numbers than their oligotrophic counterparts. Aquatic plants are more abundant, including a number of pondweeds (Potamogeton spp.), such as P. crispus, P. berchtoldii and the local P. alpinus, Canadian waterweed (Elodea canadensis) and the rare six-stamened waterwort (Elatine hexandra). Stands of emergent and swamp vegetation are found at intervals along the shallow shores of the lakes, flanked in some cases by rich fen and by alder and willow carr.

In Windermere the fish include pike, perch and eel as well as trout and char. Pike, perch, trout and char are also found in Buttermere, Crummock Water and Coniston Water, but the char is absent from Bassenthwaite and Derwentwater and became extinct in Ullswater in the 19th century. A rare whitefish, the vendace (Coregonus albula), is found in Derwentwater and Bassenthwaite, while a second rare species, the schelly (Coregonus laveratus), is found in the more oligotrophic waters of Ullswater and Haweswater and in Red Tarn at 720 m on Helvellyn.

The diversity of habitats along the lake shore, varying from rocky and gravelly shores to silty swamps and fen woodland, supports a wide range of invertebrates and breeding birds, including great crested grebe, grey heron, tufted duck, pochard, reed warbler and sedge warbler.

Away from upland areas, ponds are frequent in kettle-holes and hollows in the glacial till, as at Harnsey Tarn and Thurstonfield Lough, or as cut-offs (ox-bow lakes) on the flood plains of rivers, as at Siddick Pond. Lowland pools are often surrounded by intensively-farmed land and their nutrient status tends to be relatively high, ranging from mesotrophic to eutrophic. They are particularly vulnerable to eutrophication and pollution of the waters draining into them. In spite of this, lowland pools frequently support a good range of plant and animal species and are often important as inland breeding, roosting and wintering sites for coastal and other birds and as breeding sites for frogs, newts and dragonflies.

Disused quarries and gravel-pits can develop into important sites for wildlife if they become flooded, as in the Longtown area near Carlisle and at Oulton Ponds, and may support a wide range of plant and animal species. Many of these sites are of local or county importance for the bird populations which they support for all or part of the year.

3.6.2 Running water

The area of running water (1,940 ha) quoted in Table 1 is the total area of rivers exceeding 20 m in width, above mean high water mark. The smaller streams and gills, although not included in this measurement, are nevertheless an important wildlife habitat. The upper reaches of streams and rivers are the most oxygen-rich and pollution-free and support a characteristic invertebrate fauna of stonefly, blackfly, mayfly and caddis fly nymphs, together with dipper and wagtails which feed on them.

Cumbria has a large number of rivers, many of which radiate out to the coast from the Central Fells (see Figure 1), but the largest river in the county is the Eden, which rises between the Howgill and Mallerstang fells in the south-east of the county and flows northwards in the broad vale between the Lake District fells and the Pennines and then across the Carlisle Plain and into the Solway. Other major rivers are the Lune, the Duddon, the Esk and the Derwent.

River banks are an important wildlife refuge and provide breeding sites for a variety of bird species including sand martin, common sandpiper and kingfisher as well as water voles and, less frequently, otters. The riverside flora is interesting and varied, with local stands of reed canary-grass (Phalaris arundinacea), monkeyflower (Mimulus guttatus) and Indian balsam (Impatiens glandulifera), while in fast-flowing rivers the river water-crowfoot (Ranunculus fluitans) may be locally abundant.

River banks often provide stretches of unimproved neutral or marshy grassland which contrast markedly with adjacent agricultural land and which may be the only unimproved grassland habitat in the area. In many parts of the county semi-natural woodland also survives, mainly along streams and riversides, and both the Eden Gorge and the Duddon Valley harbour important semi-natural woodlands.

3.6.3 Threats to open water habitats

The plant and animal communities of open water habitats are strongly influenced by the nutrient status of the water. Change in this status, usually by enrichment with nutrients, leads to replacement of the characteristic species with other less specialised species. This is particularly a problem for standing water in lowland areas, where agricultural improvement of surrounding land may lead to eutrophication of the waters from fertiliser run-off. Over-eutrophication from excessive fertiliser input or from pollution by slurry or silage effluent causes rapid growth and death of plant material and results in anoxic conditions and the loss of practically all aquatic life. Although this is mainly a problem of agriculturally developed lowland areas, upland ponds, tarns and streams are also subject to local eutrophication and are particularly vulnerable because of their naturally low nutrient status.

Pollution of streams and ponds with pesticides or with domestic and industrial effluents has led to the impoverishment or loss of the living communities from many sites. Even large rivers may be lacking in important species for considerable distances downstream from the source of pollution.

Many small ponds on farmland have been filled in during the agricultural improvement of adjacent land. Larger pools, particularly those in old quarries and gravel-pits, are favourite sites for casual dumping of rubbish and frequently become official dumping and landfill sites, with the consequent loss of valuable wildlife habitat. Waters draining from rubbish-tips and spoil-heaps may contain toxic substances leached from these sites which are injurious to life in the waterways which receive them, and the overflow from inadequate sewerage facilities may cause occasional or permanent eutrophication of water bodies.

Intensive recreational use of lakes and rivers can cause damage to and destruction of their marginal vegetation and has led to lakeshore erosion on parts of Coniston Water, Windermere and other lakes. Recreational activities also cause disturbance to wildlife, and it is noticeable that breeding birds avoid areas regularly used for recreation. The increase in year-round recreational use of the lakes means that there is now a threat of disturbance to their wintering populations of wildfowl and other birds.

The dredging of rivers and streams to improve flow and drainage adversely affects their flora and fauna, as many species require quiet shallows, while the straightening and regrading of their banks can result in the total loss of riparian vegetation and its associated wildlife. More sensitive improvement schemes are designed in such a way as to leave undisturbed areas in bays and backwaters away from the main channel, in which riparian communities can flourish. Considerable scope still exists for increasing the availability of open water and associated habitats in lowland areas by restoring damaged ponds and creating new ponds.

3.7 Coastal and intertidal habitats

The coastland of Cumbria stretches for about 300 km along the western and southern boundaries of the county from the Scottish border to Lancashire. Above high water mark there are over 7,600 ha of coastal habitat, mainly saltmarsh, sand and shingle. Sand-dunes and fixed dune vegetation cover 1,450 ha, while maritime cliffs are a small but important component. Between high and low water marks there are in addition almost 30,000 ha of intertidal habitat, mainly in the Solway to the north and in Morecambe Bay and the Duddon/Walney area to the south.

Many of these habitats are nationally or even internationally important and support rare and uncommon species of plants and animals. Much of the coastal vegetation and landscape has been modified by centuries of settlement, agriculture and industry, though most of the coastal towns and villages have now declined as active centres of trade and industry.

TABLE 9 ANALYSIS OF COASTAL HABITAT CLASSES IN CUMBRIA

	Total area (ha)	% of county area	% of total semi-natural area	% of total coastal area
Saltmarsh	3,890.0	0.6	1.5	50.9
Coastal rock, shingle, sand and mud	2,214.2	0.3	0.8	29.0
Open dune	518.2	0.08	0.2	6.8
Fixed dune	937.9	0.1	0.4	12.3
Maritime cliff	76.1	0.01	0.03	1.0
Total	7,636.4	1.1	2.9	100.0
Intertidal	29,611.0			

3.7.1 Intertidal

Intertidal mudflats, saltmarsh, sand, shingle and rock are an extensive and important group of habitats covering almost 30,000 ha below mean high water mark. The largest areas occur in Morecambe Bay and the Solway, which are exceeded only by the Wash in size and importance. Other important areas are found on the west coast in the estuaries of the Duddon and Esk and at Allonby Bay. Together they form a chain of sites which is of national and international importance for its bird life.

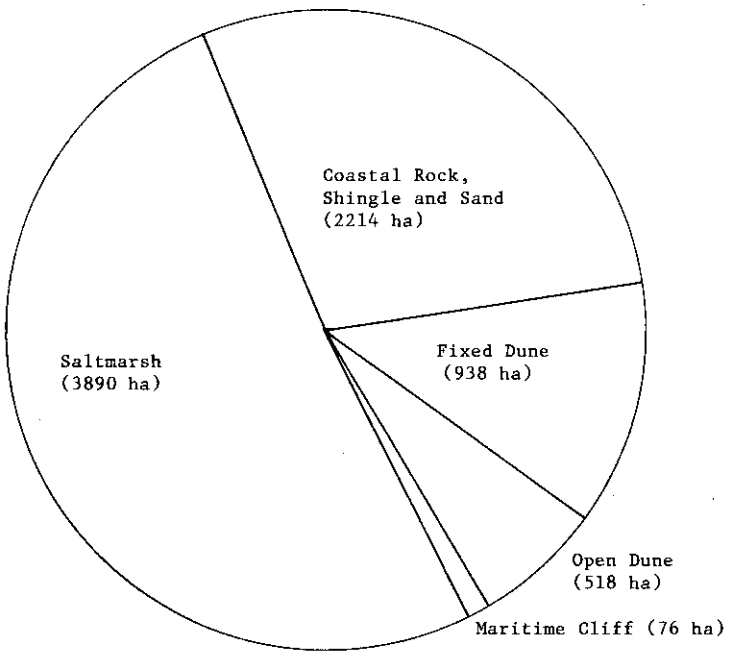


Figure 31 Relative proportions of coastal habitat classes in Cumbria

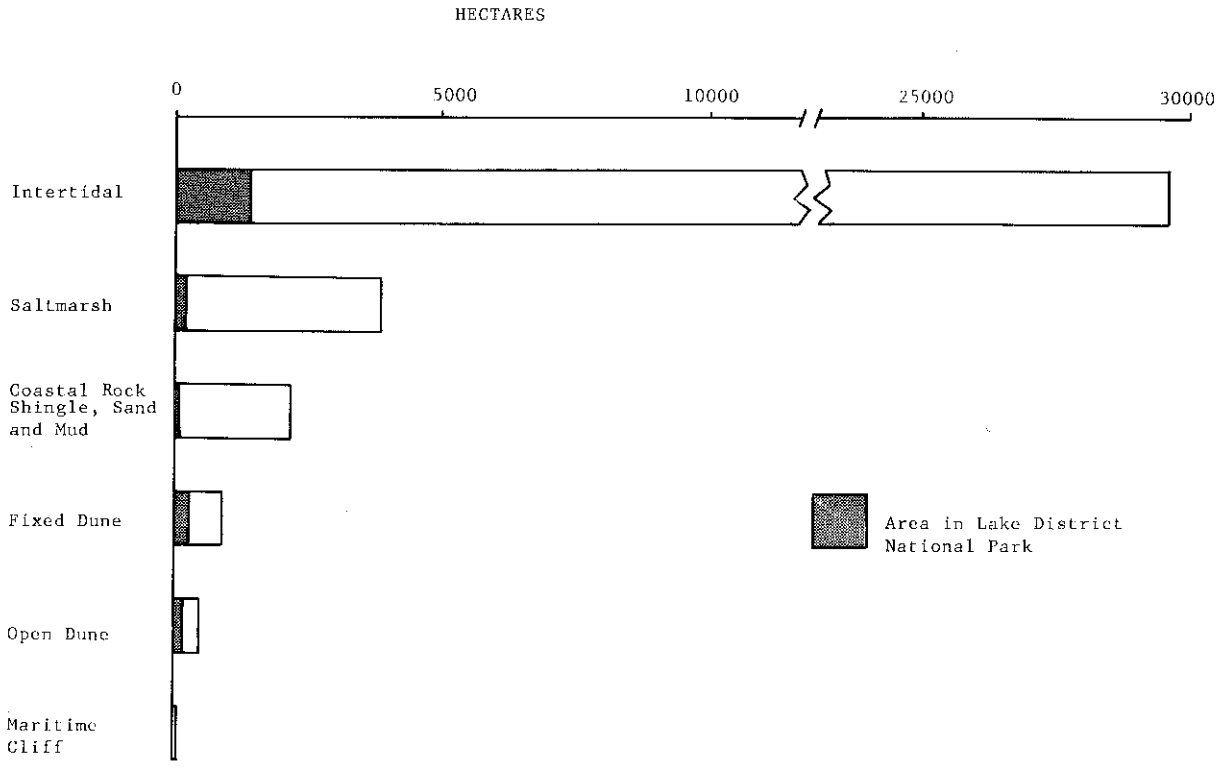


Figure 32 Areas of coastal habitat classes and proportions in the National Parks

The systems of sandbanks, mudflats and saltmarshes in the intertidal zone are in a constant state of flux, with shifting channels and alternate phases of building and erosion. The sediment is predominantly sand, but there are also areas of mud and silt and occasional boulder-strewn mussel beds. Because of their unstable nature, intertidal habitats are generally unvegetated, though some saltmarsh plants such as glasswort (Salicornia spp.) may be present locally and eelgrass (Zostera spp.) and algal beds may be found in a few places where the substrate is relatively stable.

Relatively few invertebrate species are adapted to the extreme conditions of intertidal habitats, but those that do occur are found in vast numbers. The main species are ragworm (Nereis diversicolor), lugworm (Arenicola marina) and the shrimp-like Corophium volutator. Shelled bivalves include the cockle (Cardium edule), baltic tellin (Macoma balthica) and mussel (Mytilus edulis).

The abundance of food attracts large numbers of wading birds and wildfowl, and many of these Cumbrian sites support vast populations of wintering birds and also of spring and autumn migrants in passage between their winter and summer haunts. Geese use the intertidal areas as a safe roosting area and feed on the saltmarsh and also further inland, whilst the waders feed in the intertidal zone and roost at high tide on the saltmarsh and shingle banks.

The Morecambe Bay and Walney Island area has one of the largest populations of wintering and passage migrant waders in Britain (Ratcliffe 1977) and is considered to be the third most important estuarine site in Europe (Prater 1981). At peak periods over 200,000 waders may use the area at any one time, and 12 species occur in internationally important numbers, including ringed plover, dunlin, bar-tailed godwit and shelduck.

The Solway, considered the third most important site for wildfowl in Britain and the sixth most important for waders, regularly supports 85,000 wintering waders including 11 species considered nationally important, of which oystercatcher, sanderling, knot, curlew, redshank and turnstone are recorded in internationally significant numbers. Wintering wildfowl numbers regularly reach 29,000 on the Solway, with internationally important populations of pink-footed goose, shelduck and whooper swan and the entire Spitzbergen population of barnacle goose. The area is also of national importance for Bewick's swan, pintail, wigeon, goldeneye and scaup.

3.7.2 Saltmarsh

In sheltered bays and estuaries the accumulation of sand, silt and mud may generate extensive new land surfaces, just above high water mark, which are colonised by salt-tolerant plants to form saltmarsh.

Saltmarsh habitats cover almost 4,000 ha, excluding those areas below mean high water mark, and represent 50% of the coastal habitat resource. The largest and best area of this habitat is on the Solway coast, but important smaller examples occur on the Esk and Duddon estuaries, with additional isolated patches on Walney Island and in other parts of Morecambe Bay.

Like the intertidal areas which they flank, these extensive saltmarshes are of great importance for their bird life. Their invertebrate fauna feeds the wintering waders and some breeding species, while their vegetation feeds the grazing wildfowl. The extensive and relatively undisturbed marsh at Rockcliffe supports significant populations of breeding birds, including lesser black-backed and herring gulls, common and arctic terns, black-headed gull, redshank, lapwing and oystercatcher.

Many of the marshes are divided by small creeks on their seaward edge and are regularly inundated by the sea, whilst their inland margins are only covered at high spring tides. The vegetation which has developed in response to these differences shows a well-defined sequence of communities progressing inland from the shore. Good examples of this zonation are to be found on the Drigg coast and Duddon estuary, both of which show more than 12 different types of saltmarsh. The seaward edge is usually occupied by pioneer species, mainly common saltmarsh-grass (Puccinellia maritima) and glasswort, but common cord-grass (Spartina anglica) has invaded some areas around Morecambe Bay and as far north as the Esk estuary. This species has invaded many saltmarshes further south and poses a serious threat to the survival and growth of other saltmarsh species because of its dense growth. Further inland there is a transition to grassy saltmarsh with species such as sea rush (Juncus maritimus), red fescue (Festuca rubra), common scurvygrass (Cochlearia officinalis), sea plantain (Plantago maritima) and thrift (Armeria maritima), with lightly grazed and ungrazed areas supporting common sea-lavender (Limonium vulgare) and sea wormwood (Artemisia maritima).

On the Solway marshes, in the north of the county, there is a well developed broad transition from saltmarsh to neutral grassland through species such as sea couch (Elymus pycnanthus), Yorkshire-fog (Holcus lanatus), soft-rush (Juncus effusus) and common bird's-foot-trefoil (Lotus corniculatus). Additional interest on these marshes is provided by areas of brackish water, which often support extensive stands of common reed (Phragmites australis). Transitions into species-rich freshwater fen occur in places, with meadowsweet (Filipendula ulmaria) and yellow iris (Iris pseudacorus), and provide further habitats of interest. Over 10% of the total British population of the rare natterjack toad (Bufo calamita) occurs on the Solway, the northern limit of its range, where it breeds in shallow pools on the landward edge of the marshes.

3.7.3 Sand-dunes

Dune systems develop on exposed coasts where windblown sand accumulates to form sand-dunes, which are colonised and stabilised by vegetation. Cumbria has 518 ha of open dune and a further 938 ha of the more complex fixed dune, including dune grassland, heath, slacks and scrub. The mosaic of dune types which is often present provides a diversity of habitats which support a wide range of plant and animal species.

Dune systems are found at intervals along the length of the west coast. In the northern part, the best example occurs just south of Silloth, where the dunes extend southwards along Allonby Bay as far as Maryport. In the southern part of the county the main areas of interest are around Drigg Coast on Ravenglass and Eskmeal Dunes, at Haverigg and Sandscale Haws on the Duddon estuary, and around North and South Walney.

Dune vegetation forms a distinct zonation sequence, moving inland from the shore. Just inshore of the strandline are the unstable 'embryo dunes'. These are poorly vegetated, but may support sand couch (Elymus farctus) and lyme-grass (Leymus arenarius), which give way to marram (Ammophila arenaria) and occasionally sea-holly (Eryngium maritimum). Behind these come mobile 'yellow dunes', which are dominated by marram and commonly contain sand sedge (Carex arenaria), sea bindweed (Calystegia soldanella) and wild pansy (Viola tricolor). Further inland, on the stablised 'grey dunes', other grasses take over to form species-rich dune grassland. This is often dominated by red fescue (Festuca rubra), sheep's-fescue (F. ovina), common bent (Agrostis capillaris) and herbs including bloody crane's-bill (Geranium sanguineum), lady's bedstraw (Galium

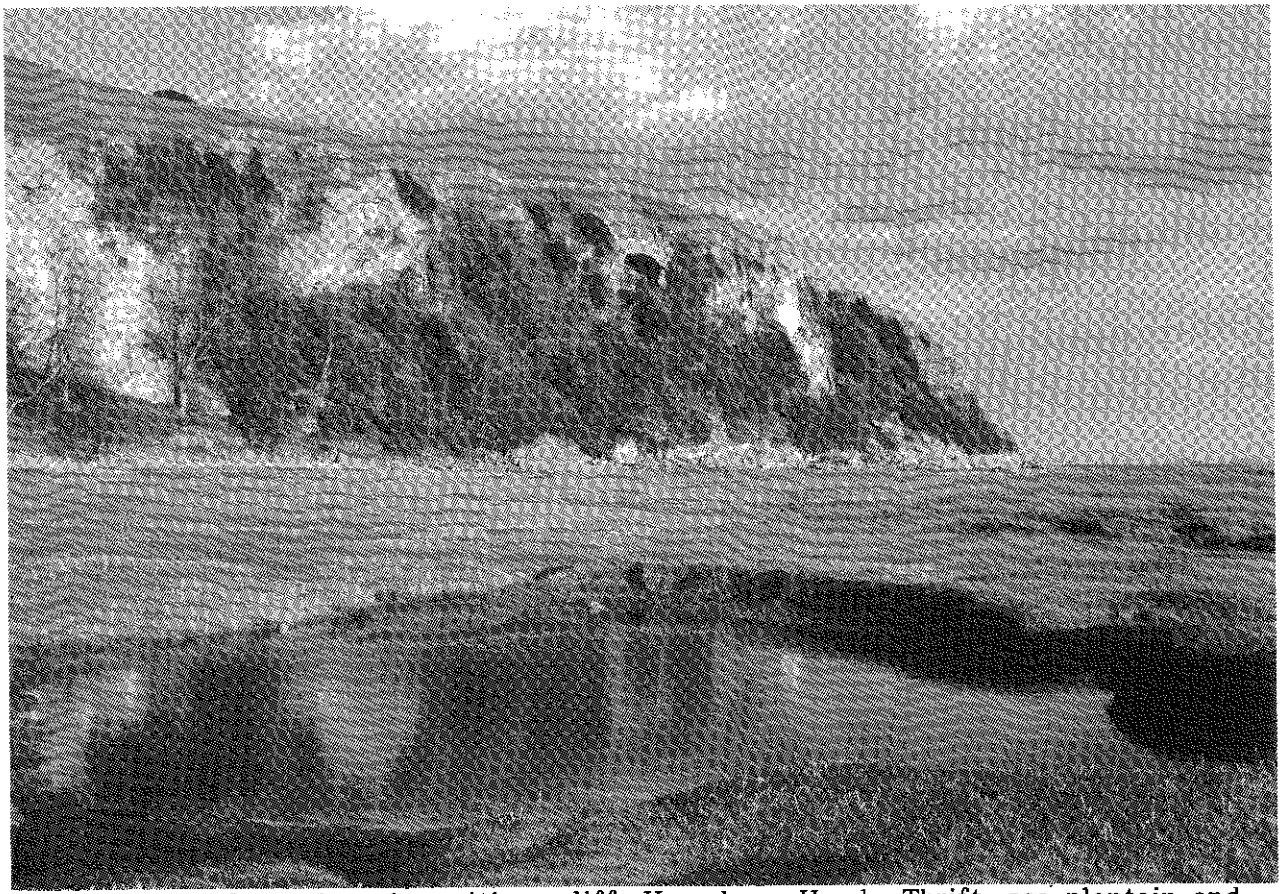


Photo 25 Saltmarsh and maritime cliff, Humphrey Head. Thrift, sea plantain and other herbs grow in the short grass sward. The limestone cliff carries broadleaved woodland below and yew on the upper part, with calcareous grassland above.
P Wakely 1986

Photo 26 Eroding saltmarsh, Westfield, Glasson. Thrift, sea-lavender and sea plantain are abundant on this part of the marsh. Periodic erosion of saltmarsh is a natural process, accompanied by deposition at other sites. P Wakely 1989

Photo 27 Sand-dunes, Sandscale Haws. Open dunes, dominated by marram and rosebay willowherb, with fixed dunes (dune slack), dominated by creeping willow, behind. P Wakely 1983

Photo 28 Eroding dunes, North Walney. Paths through the open dunes in the foreground and the fixed dunes in the middle distance are eroding as a result of over-use by motor-cyclists. Eroded paths are also visible on the high dunes beyond.
P Wakely 1983

verum), wild thyme (Thymus praecox), harebell (Campanula rotundifolia) and burnet rose (Rosa pimpinellifolia). In the southern part of the county this is the habitat of the nationally rare dune helleborine (Epipactis dunensis).

In areas where the soil has become leached, dune heath may develop, generally dominated by heather (Calluna vulgaris) and bell heather (Erica cinerea). Good examples occur at Blitterlees Bank near Silloth and on the Ravenglass dunes, which support dyer's greenweed (Genista tinctoria), western gorse (Ulex gallii) and the locally rare field gentian (Gentianella campestris). This latter area is the largest and best known example of this rare habitat on the west coast of England and Wales. Some dunes have small areas of 'grey dune' which are dominated by mosses and lichens with some heather.

At Eskmeals, large areas of dune have been colonised by sea-buckthorn (Hippophae rhamnoides), forming dune scrub. Sandscale Haws and Haverigg Haws provide good examples of calcareous dune habitat with lime-loving species such as pyramidal orchid (Anacamptis pyramidalis), blue fleabane (Erigeron acer), kidney vetch (Anthyllis vulneraria) and carline thistle (Carlina vulgaris). Dune slack communities develop in the damp hollows between the dunes and may be dominated by creeping willow (Salix repens) or by rushes (Juncus spp.) and sedges (Carex spp.) with marsh pennywort (Hydrocotyle vulgaris), marsh helleborine (Epipactis palustris) and other orchids. The pools and ditches of wet dune-slacks provide important habitat for dragonflies and other invertebrates and may support large breeding colonies of the nationally rare natterjack toad and great crested newt (Triturus cristatus) as well as more common amphibians.

On South Walney, the dune system is important for breeding birds. It supports a large colony of lesser black-backed and herring gulls and is the southernmost breeding site of eider duck on the west coast.

Around Maryport and Silloth docks there are important areas of disturbed dunes and grassland which support a variety of plants characteristic of sand, shingle and dunes, intermixed with plants of unimproved neutral grassland. The proximity of the docks and the past management of the land have favoured the establishment of a variety of interesting species which have become locally common. Pyramidal orchid (Anacamptis pyramidalis), perennial wall-rocket (Diplotaxis tenuifolia), sea-holly, yellow horned-poppy (Glaucium flavum), narrow-leaved everlasting-pea (Lathyrus sylvestris), common broomrape (Orobanche minor), Isle of Man cabbage (Rhynchosinapis monensis) and sea radish (Raphanus maritimus) all grow in the vicinity of Maryport harbour, where there are also thriving colonies of butterflies, including the small blue (Cupido minimus), a species scarce in Cumbria.

3.7.4 Coastal rock and shingle

This habitat category has been extended to include areas of mud and sand above mean high water mark. It covers approximately 2,200 ha of the Cumbrian shoreline and represents an important interface between intertidal areas and the marshes and dunes above mean high water mark. This habitat is widespread throughout the length of Cumbria's coastline and represents almost one third of the coastal habitat resource (excluding intertidal areas). Good examples of shingle coast are found at Allonby Bay, around Seascale, at Haverigg Haws and on Walney Island.

The foreshore is generally a hostile environment for plants and animals, but a few specialised plants are able to maintain a foothold in some places. Typical species include sea sandwort (Honkenya peploides), sea rocket (Cakile maritima), thrift, sea campion (Silene maritima), yellow horned-poppy and Isle of Man cabbage. Less common species include Ray's knotgrass (Polygonum oxyspermum subsp. raii), sea spurge (Euphorbia paralias) and Portland spurge (E. portlandica).

The shingle spits around Foulney Island support oysterplant (Mertensia maritima) at its southernmost site in England, and the Walney Island shingles collectively have some of the richest shingle beach flora in Britain.

Some of the shingle spits and sand bars are important for breeding birds. Allonby Bay is important for ringed plover and the nationally rare little tern. Foulney Island supports breeding colonies of Sandwich, common, arctic and little terns.

The coasts of Walney Island are also of geological interest. At South End Haws in South Walney there has been rapid development of sand and shingle spits derived from the local erosion of boulder clay, and Haws Point has developed entirely during the 20th century. These sites are therefore important for studying the rate of growth of sand and shingle spits and contemporary accretion processes.

3.7.5 Maritime cliff

Maritime cliff occurs where there are exposures of bare rock at the coast, though these can be partially vegetated. It is a very localised habitat, with only 76 ha recorded for the whole county. However, it should be noted that this does not take into account the vertical element of cliff-faces.

The largest example on the west coast is the 5 km stretch of exposed sandstone cliff around St Bees Head. These cliffs are an important breeding site for guillemot, fulmar, kittiwake, razorbill, puffin and shag. They are notable as the only breeding site in England for the black guillemot. The cliffs also support a diverse flora in the crevices and ledges of crumbling sandstone. Near the base, thrift, common scurvygrass and sea campion grow in abundance and sea spleenwort (Asplenium marinum) occurs in the damp crevices. The rare rock sea-lavender (Limonium binervosum) can also be found. Higher up, bloody crane's-bill, wood vetch (Vicia sylvatica) and orpine (Sedum telephium) grow and soft shield-fern (Polystichum setiferum) occurs in several rocky recesses. This site is also of geological interest because of its maritime cliffs of the Permian rock sequence and the sedimentary structures which they display.

The other main area of exposure is along the northern edges of Morecambe Bay, where there are four exposures of Carboniferous Limestone cliffs at Far Arnside, Humphrey Head, Barker Scar and Skelwith Hill. These areas all provide refuges for an interesting range of limestone-loving plants (see Sections 3.2.7 and 3.8) as well as supporting more characteristic maritime cliff species. Species present include hoary rock-rose (Helianthemum canum), spring cinquefoil (Potentilla tabernaemontani), rock samphire (Crithmum maritimum) and a rare endemic whitebeam, Sorbus lancastriensis.

The last three sites are also of geological interest, Humphrey Head and Barker Scar being particularly rich in fossilised corals and other marine animals.

3.7.6 Threats to coastal habitats

The areas of flats, marshes and their associated grassland provide a habitat for large numbers of feeding and breeding birds. However, many of the marshes are also used for grazing cattle and sheep. Grazing at low levels is beneficial because it helps to open up the sward, keeping the more vigorous species under control and allowing other species to colonise. The short, grazed turf is also preferred for grazing by wildfowl. Overgrazing of saltmarsh produces a short, species-poor turf which is prone to erosion. Activities such as bait-digging, wildfowling and turf-cutting can be accommodated at relatively low intensities, but over-exploitation can significantly reduce the value of the habitat for wildlife. Reclamation of saltmarsh for agriculture, by building sea-banks, has been carried

out extensively over several centuries, so that a large proportion of the total resource has been lost throughout the county, although the Solway marshes have been least affected in this respect.

Coastal areas are favoured sites for certain kinds of industrial development, as the sea provides an easily accessible place for the release of by-products of various industrial processes and of domestic effluents, especially in the urban areas around Workington, Whitehaven and Barrow-in-Furness. This can cause pollution problems which could adversely affect marine life and bird and other animal populations around the coastline. The potential long-term effects of these sources of environmental pollution are as yet unknown.

The coastline has long been an attractive place, visited by thousands of people who take part in various casual recreational pursuits. This can disturb breeding animals and birds but has its greatest effect on areas of sand-dunes, where visitor pressure can be particularly acute and localised. The trampling of many feet can disturb the vegetation cover and lead to serious erosion problems, destroying interesting and rare plants and their habitats. Motorbike scrambling is a serious problem on sand-dunes, because, as well as disturbing breeding birds, it can be the cause of serious erosion, leading to the loss of large areas of dune habitat.

The proposal to construct tidal barrages which would impound fresh water in large estuaries around the coast of Britain presents a considerable threat to coastal and intertidal habitats. If such barrages were to be constructed in Morecambe Bay and the Solway, most of the intertidal and saltmarsh habitat in Cumbria would be lost.

3.8 **Rock and scree**

This section includes a number of distinct habitat types, which have been recorded separately on the habitat maps - namely rock, scree and inland acidic and basic cliffs. The total area of inland rock and scree in Cumbria has been estimated at 5,500 ha, 0.8% of the county area, but this underestimates the surface area on steep slopes and near-vertical rock-faces.

Rock and scree are most abundant in the Central Fells of the Lake District, with other important areas in the Yorkshire Dales, in the Howgills and along the western flanks of the Pennines. In general terms these rock exposures can be classified into two types, depending on their base status. The Borrowdale Volcanics and Skiddaw Slates are generally base-poor, as is the Millstone Grit of the Pennines, but the Carboniferous Limestone of the Pennines and South Lakeland is base-rich and, where it outcrops, as in the Appleby Fells and at Whitbarrow, Scout and Cunswick Scars, its cliffs and screes support a characteristically rich and interesting flora of lime-loving species.

Cliffs, scars and scree-slopes are the product of past glacial activity which scoured and plucked the valley sides to produce over-steepened slopes and exposed cliff-faces, while subsequent frost-shattering of the exposed rock led to the development of scree-slopes. Typical examples of these features can be seen at the heads of Langdale and Wasdale, and a most impressive example is the Wastwater screes along the southern side of the lake.

In the Central Fells and in south-east Cumbria, glacial activity has produced a variety of crags, knolls, ledges and other rock features, and in many places rocky gills have cut deeply into the fellsides. These steep-sided gills and ravines

are largely inaccessible to grazing animals and have a sheltered, damp microclimate, different from that of the exposed hillsides. Consequently they often support a rich and characteristic flora of flowering plants, ferns, mosses and liverworts.

Bare rock and scree are colonised initially by lichens and bryophytes, but, as soils develop, other plants are able to grow. The attractive parsley fern (Cryptogramma crispa) is typical of dry, acidic scree slopes and is often accompanied by the lemon-scented fern (Oreopteris limbosperma). As slope stability increases, bilberry (Vaccinium myrtillus) and bell heather (Erica cinerea) are able to colonise, taking advantage of the free-draining soils, and eventually an almost complete cover of dry heath can develop, which would be recorded under that category in this survey (see Section 3.4.1).

Limestone scree-slopes support a number of characteristic ferns, such as limestone fern (Gymnocarpium robertianum) and brittle bladder-fern (Cystopteris fragilis), and rare and uncommon flowers, such as dark-red helleborine (Epipactis atrorubens) and lily-of-the-valley (Convallaria majalis). Where flushed areas of acidic scree experience some base enrichment, species such as carline thistle (Carlina vulgaris) may be found growing alongside common butterwort (Pinguicula vulgaris) and yellow saxifrage (Saxifraga aizoides).

Montane cliff and ledge communities in Cumbria often contain a mixture of arctic-alpine and lowland plant species. Sheltered rock-ledges, in particular, may support a rich assemblage of tall herbs and ferns, which should properly be considered under Section 3.3.2, but, as they are invariably too small in extent to map, were recorded by means of a 'target note' and included within the surrounding rock and scree habitat. The plant species of these habitats include mountain sorrel (Oxyria digyna), wood crane's-bill (Geranium sylvaticum), goldenrod (Solidago virgaurea), wild angelica (Angelica sylvestris), marsh hawk's-beard (Crepis paludosa), great wood-rush (Luzula sylvatica) and scaly male-fern (Dryopteris affinis). Being inaccessible to grazing, rock-ledges and gullies also provide a refuge for more common species such as heather (Calluna vulgaris) and bilberry (Vaccinium myrtillus) and for trees such as birch (Betula spp.), rowan (Sorbus aucuparia) and ash (Fraxinus excelsior) and shrubs such as juniper (Juniperus communis) which are absent from the surrounding hillsides.

In the damp environment of the deep, sheltered gills, mosses and liverworts abound, together with a variety of ferns including beech fern (Phegopteris connectilis), oak fern (Gymnocarpium dryopteris), the filmy-ferns (Hymenophyllum spp.) and flowering plants such as purple saxifrage (Saxifraga oppositifolia) and roseroot (Sedum rosea).

The steep, broken cliffs of high mountains such as Helvellyn have a characteristic arctic-alpine flora which includes some species more familiar to us in maritime situations, namely thrift (Armeria maritima) and sea plantain (Plantago maritima), together with alpine species such as alpine lady's-mantle (Alchemilla alpina), alpine cinquefoil (Potentilla crantzii) and alpine catchfly (Lychnis alpina).

Limestone cliffs and ledges have their own characteristic flora, with attractive species such as hoary rock-rose (Helianthemum canum), spotted cat's-ear (Hypochoeris maculata), bloody crane's-bill (Geranium sanguineum), blue moor-grass (Sesleria caerulea), burnet-saxifrage (Pimpinella saxifraga), bloody crane's-bill (Geranium sanguineum) and wood sage (Teucrium scorodonia). The limestone cliffs of the Morecambe Bay area are the habitat of rock whitebeam (Sorbus rupicola) and the endemic Lancastrian whitebeam (S. lancastriensis).

The rocky areas of crags and slopes provide habitat for a varied range of bird species including stonechat, wheatear and ring ouzel and nest sites for raven, peregrine and golden eagle.

Cliff, rock and scree communities are usually very small in extent and very easily damaged. Many of their species are uncommon or rare and endangered. The unstable nature of scree, the severely restricted habitat of cliffs and the high wildlife value of rock-ledges make them vulnerable to the activities of climbers, walkers and scramblers. New developments in mountain recreational activities, such as gill-scrambling, need to be carefully controlled if they are not to cause irreparable damage to this scarce resource.

3.9 Limestone pavement

The present survey recorded 770 ha of limestone pavement in Cumbria, an area which is small by comparison with other semi-natural habitats but which, nevertheless, represents 38% of the total resource of this habitat in Britain (Ward & Evans 1976). The actual extent of this landform in Cumbria may be close to 1,000 ha, since a number of pavements are completely wooded and have consequently been recorded as woodland.

Limestone pavement is very localised in its distribution. The main occurrences are in the Morecambe Bay area of South Lakeland, around Arnside and Beetham, on Whitbarrow, Hampsfield Fell, Farleton Knott and Hutton Roof, and elsewhere in the county at The Clouds near Ravenstonedale and at Great Asby and Little Asby near Appleby. It is also found on Long Fell and neighbouring fells on the western edge of the Pennines and more locally around the periphery of the Lake District where limestone outcrops, as at Clints Crags and Bothel Crags in west Cumbria.

Limestone pavement is a glacial landform of considerable geomorphological interest, occurring where level or gently-sloping limestone strata lie close to the surface and the overlying shallow soils have been stripped off by past glaciation. The surface of the limestone, which may be polished, pocketed or frost-shattered, is typically marked with a pattern of runnels and solution hollows, bearing witness to the erosive action of organic acids in the water which formerly percolated through the overlying soil. This action was most pronounced in the vertical joints down which the water drained, and these have become deep clefts, known as grikes, separating the intervening blocks of limestone, the clints. Solution has also taken place along the horizontal joints and lines of weakness, so that the walls of the grikes afford a variety of niches for colonisation by plants and animals.

Limestone pavements support a rich and characteristic flora, growing on the debris in the bottom of grikes, on the grike walls and in pockets and fissures on the surface. The grikes provide a sheltered, humid environment protected from grazing animals, in which a variety of rare and unusual ferns and flowering plants can thrive. Among the ferns, hard shield-fern (Polystichum aculeatum), male-fern (Dryopteris filix-mas), hart's-tongue (Phyllitis scolopendrium), wall-rue (Asplenium ruta-muraria) and maidenhair spleenwort (A. trichomanes) are common, while the much rarer green spleenwort (A. viride) and rigid buckler fern (Dryopteris villarii) may be locally plentiful. The flowering plants of the grikes include wall lettuce (Mycelis muralis), baneberry (Actaea spicata) and angular Solomon's-seal (Polygonatum odoratum) as well as the more common dog's mercury (Mercurialis perennis) and herb-Robert (Geranium robertianum), while solution

pockets on the pavement surface are colonised by various mosses and liverworts and by the tiny annual rue-leaved saxifrage (Saxifraga tridactylites). In favourable areas the pavement surface may be colonised by blue moor-grass (Sesleria albicans), common rock-rose (Helianthemum nummularium) and spring cinquefoil (Potentilla tabernaemontani). Trees such as ash (Fraxinus excelsior), holly (Ilex aquifolium) and yew (Taxus baccata) and shrubs such as hawthorn (Crataegus monogyna), blackthorn (Prunus spinosa), buckthorn (Rhamnus catharticus) and alder buckthorn (Frangula alnus) may also establish themselves in the grikes and, in the absence of grazing, a woodland cover may develop, as on parts of Whitbarrow and Hutton Roof and on several pavements between Arnside and Beetham.

The limestone pavements and scars of Cumbria are, like its woods, fells, crags and lakes, unique, important and irreplaceable elements of the scenery of the county. They are of considerable scientific importance not only for their flora but also for their geology and geomorphology. The rock exposures themselves and the fossils which they contain provide a valuable record of geological history of the area, while their unique and subtly varied forms provide information about the events and processes of more recent glacial and post-glacial times. Many limestone pavement sites are also of archaeological importance, having been favoured areas for settlement up to the Iron Age.

Limestone pavements are threatened with destruction by the removal of stone for a variety of purposes. At Sandside and Middlebarrow quarries near Arnside, where limestone is quarried for roadstone and building purposes, significant areas of botanically rich pavement have been quarried away. On Farleton Fell the scale of quarrying has been such that one limestone pavement, Clawthorpe Fell, declared a National Nature Reserve, now stands on an isolated pillar of rock in the middle of a huge quarry.

The removal of loose rock for use as walling stone has probably been going on for centuries, but the removal of weathered rock from the pavement surface for use in rock gardens and decorative walling is a more recent phenomenon. Starting with the vogue for rock gardens at the end of the 19th century, it has been given fresh impetus by the availability of hydraulic machinery and by new overseas markets. Although the Wildlife and Countryside Act 1981 provided the means for their special protection, a number of limestone pavements in South Lakeland have been severely damaged in recent years and a large area of pavement at Orton Scar, in the Eden District, has been destroyed.

Ward & Evans (1976) found that 39% of the total area of limestone pavement in Britain had been damaged or destroyed by stone removal and that of 537 pavements, only 3% were undamaged. As stone removal has continued since that date, the damaged area may now be 45 - 50%.

In one or two localities, topsoil, rubble and waste have been tipped on limestone pavement, destroying its value as a habitat, while on Dalton Fell, Beetham Fell, Hampsfield Fell and Whitbarrow conifer planting has greatly reduced the botanical interest and wildlife value of their limestone pavements. Heavy grazing can be also damaging to the flora of limestone pavements, particularly where the grikes are wide enough to allow the entry of sheep.

The high scientific interest, national rarity and remarkable beauty of limestone pavements have contributed to their conservation in the face of pressures to exploit them for commercial gain. It is important that the diversity of their origin, structure and formation should be appreciated and that a wide range of sites encompassing this diversity should be preserved.

Photo 29 Limestone pavement and quarry, Clawthorpe Fell. Open fissures in the weathered rock hold blue moor-grass, ferns and woodland plants including small trees and shrubs. Quarrying is a threat to a number of limestone pavements in Cumbria. P Wakely 1989

Photo 30 Limestone pavement with scattered scrub, trees and bracken, Hutton Roof. Undisturbed fissured pavement with hawthorn and juniper scrub and scattered ash and sycamore. Dense bracken occupies soil-filled hollows among the pavements. D A Ratcliffe 1974

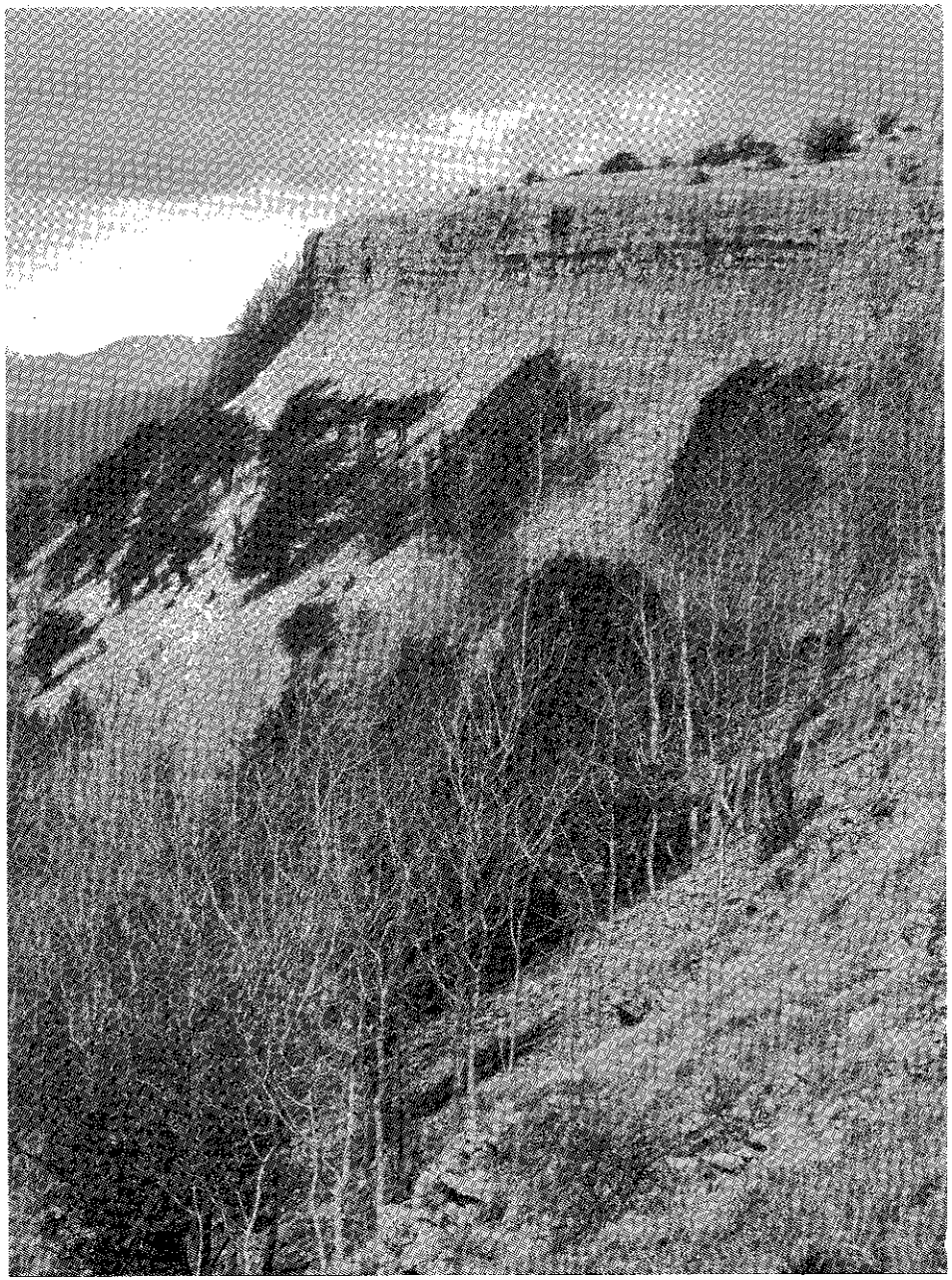


Photo 31 Limestone cliff and scree, Scout Scar, Kendal. The cliffs have a characteristic flora of lime-loving plants. The rocky scree below carries yew/ash woodland. P Wakely 1984

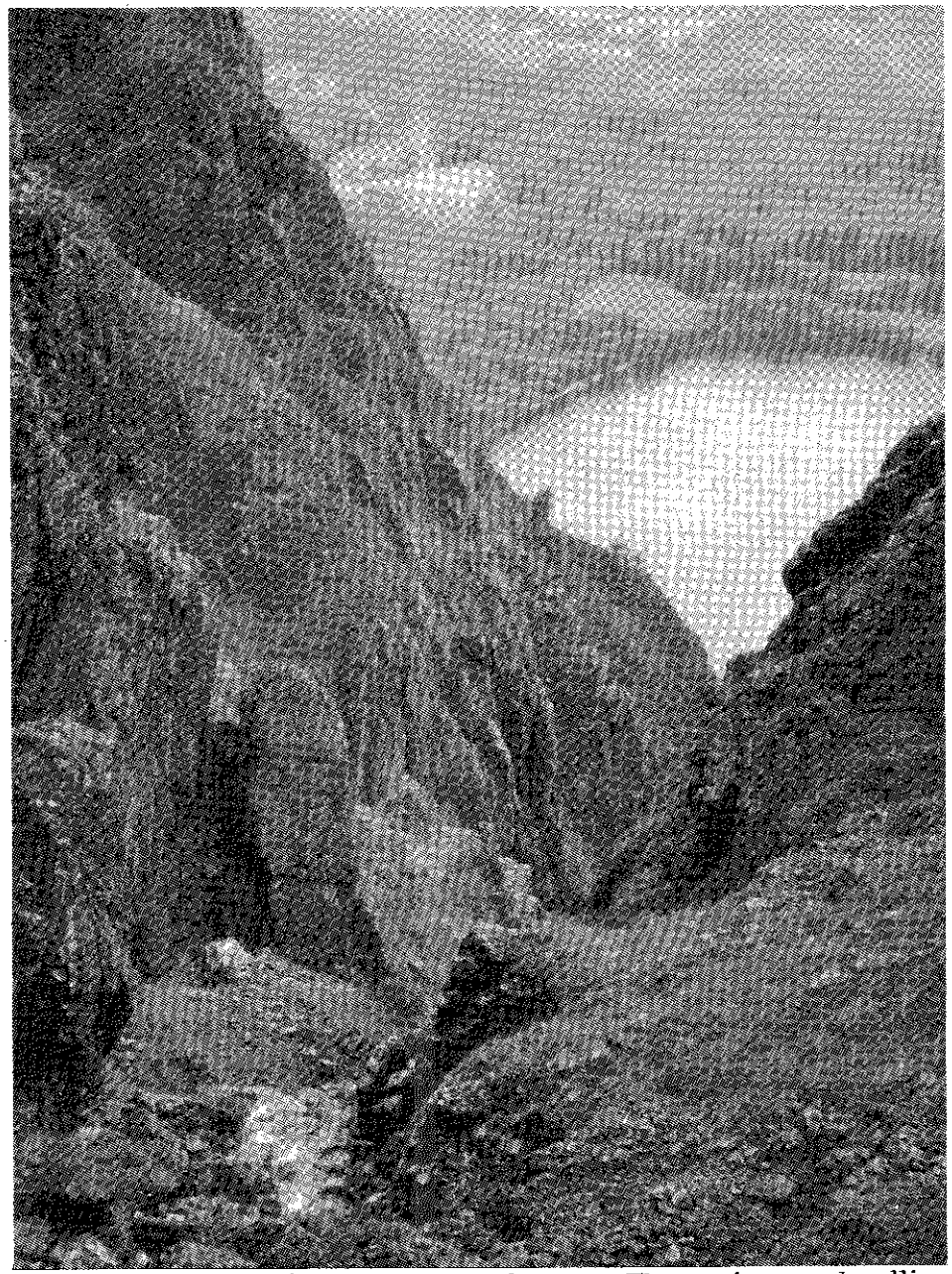


Photo 32 Rocky gully, Wastwater Screes. The ravines and gullies of the Lake District Fells are important for their alpine plants and are rich in ferns, mosses and liverworts which thrive in moist, sheltered conditions. D A Ratcliffe 1982

3.10 **Quarries, mines, spoil and refuse-tips**

Almost 2,000 ha were recorded in this category, which includes actively worked quarries and mines and their spoil as well as disused quarries and spoil-heaps which have been partly colonised by vegetation. Long-abandoned sites which have become vegetated were recorded under various habitat types according to their vegetation.

Slate quarries occur throughout the Lake District and generate large heaps of spoil, which are slowly colonised by lichens and mosses and by a few flowering plant species such as sheep's-fescue (Festuca ovina), bilberry (Vaccinium myrtillus), heather (Calluna vulgaris) and birch (Betula spp.). The quarry faces and ledges are also slowly colonised and provide refuges for plants, away from grazing animals, and protected nest sites for birds such as raven and peregrine.

Disused limestone quarries are more rapidly colonised and often support a rich assemblage of flowering plants, ferns and bryophytes. The quarry faces and ledges may develop a similar vegetation to natural limestone cliffs, while the quarry floor and spoil-heaps may be rapidly colonised by lime-loving ruderal and grassland species such as hoary plantain (Plantago media), musk thistle (Carduus nutans), small scabious (Scabiosa columbaria), marjoram (Origanum vulgare), wild thyme (Thymus praecox) and various orchid species. A disused limestone quarry in south Cumbria is notable as the only known site in the region for a tiny rare snail, Succinea oblonga, and supports a good variety of butterflies and other invertebrates.

Limestone quarries and their spoil often provide lime-rich substrates in areas where the soils are generally acidic or neutral, and they constitute wildlife refuges of considerable interest and value in areas where most of the surrounding land has been agriculturally improved. The floors of these and other quarries are often wet and may provide important examples of marsh, flush, marginal, emergent and open-water habitats.

The spoil-heaps of the Pennine lead mines have a very characteristic flora, which is restricted by the presence of lead and other metals in the soil. Lead-tolerant species such as spring sandwort (Minuartia verna), sheep's sorrel (Rumex acetosella) and various lichens and mosses thrive in the absence of competition from other plants. Lead-tolerant varieties of fescue and bent grasses (Festuca and Agrostis spp.) are also found, and these have proved useful in the reclamation of metalliferous spoil in more industrial areas.

In addition to their wildlife value, many old quarries and mines are of considerable geological importance, providing exposures of fossils, minerals and rock strata which would not otherwise be available for study. It is important that their geological interest and value should not be destroyed either by the activities of over-zealous collectors and commercial entrepeneurs or by infilling of the site with refuse and spoil.

Opencast coal-mining is prevalent in the area between Whitehaven and Cockermouth in west Cumbria. The ecological impact of this form of mining is very different from that of traditional quarries and mines. It involves the rapid and complete destruction of the habitat over a large area while the mine is in operation, followed by the reclamation, landscaping and rehabilitation of the area after mining has ceased. The re-creation of semi-natural vegetation on such sites is a difficult process, particularly where it has not been possible to retain islands of the original habitat from which colonisation might take place, and most opencast sites are restored to agricultural use.

Disused sand- and gravel-pits often have good open water habitat and are valuable ornithological sites. They frequently offer good opportunities for habitat creation and may also provide an important refuge for arable weeds such as scarlet pimpernel (Anagallis arvensis), fumitory (Fumaria spp.) and corn spurrey (Spergula arvensis) which have become increasingly rare on farmland as a result of the use of herbicides.

Many of the deep pits created by iron-mining in the Barrow-in-Furness area, such a Burlington Pits, are now rich sites of wildlife interest with open water, emergent and marsh vegetation, and sometimes carr, scrub and woodland habitats, with a wide range of bird, invertebrate and plant species.

In industrial areas, spoil-heaps, refuse-tips and derelict land provide important sites for colonisation by tall herb and ruderal species, including garden escapes, which support a varied community of butterflies, bees and other insects together with insect-eating and seed-eating birds. In this way they provide wildlife sites of considerable interest and of local importance in the otherwise restricted urban environment. Wet areas may develop into ponds and marshes, and scrub and woodland may also develop, making such sites even more valuable for wildlife.

Where the wildlife value and potential of such sites is not recognised, they are in danger of being levelled and reseeded or possibly landscaped and planted with exotic trees and shrubs of limited conservation value, with the aim of improving the amenity of the site.

3.11 **Built-up land**

The survey recorded 18,000 ha of built-up land in Cumbria, including scattered buildings, and estimated that the metalled surfaces of roads and railways make up another 8,500 ha. The area of road surface was calculated from the County Council Highways Department's figures for the length and mean width of various categories of road in each district. The area of ballasted railway surface was calculated by measuring the length of railway on the maps and multiplying by an average width of 7 m. These areas amount to 2.6% and 1.3% of the county area respectively.

The built-up land is mainly associated with urban development around coastal ports, mining areas and inland distribution centres such as Carlisle and Kendal, but small towns and villages are scattered throughout the county except for the uplands.

The area of built-up land appears to be divided fairly equally between the districts (Appendix 1) ,but, when district size is taken into account, it can be seen that in the largest district, Eden, built-up land accounts for only 1.2% of the district area, while in Barrow-in-Furness, the smallest, it accounts for 25% of the district. The remaining districts have between 2.4 and 3.4% built-up land (Allerdale 2.4%, South Lakeland 3.0%, Carlisle 3.1% and Copeland 3.4%).

The built-up environment has its own characteristic wildlife, and some species, such as swallow, house martin, barn owl and various species of bat, rely almost exclusively on buildings for their breeding sites. Many bat species prefer older houses and barns, but the pipistrelle appears to thrive in newly-built housing estates, particularly where timber cladding has been used, and may be present in large numbers.

The gardens of urban and suburban areas can support a rich insect fauna, including many butterflies and moths, and their shrubs and hedges provide food and nest sites for resident birds such as the robin, blackbird, thrush, blue tit and great

tit. At various times of year they support transient populations of other birds, including occasional winter visitors such as brambling and waxwing and more familiar migrants such as warblers and finches.

Derelict urban sites can provide an open, sunny environment for insects and an opportunity for adventive and ruderal plant species to establish themselves.

Urban areas are seldom devoid of wildlife, and their open spaces and derelict land can be a rich source of wildlife interest of particular value to the local population, providing them with an opportunity to discover at first hand the beauty and interest to be found there. Urban wildlife sites are always vulnerable and may be destroyed or damaged by well-intentioned improvement as well as by redevelopment. The demolition of many old buildings and the chemical treatment of roof timbers have led to dramatic reductions in the populations of most of our native bat species. Fortunately bats are now protected by law and safe chemicals are available for timber treatment where bat roosts are known or suspected.

Excessive use of pesticides in gardens seriously diminishes their wildlife value, but this practice may be abating as more people become aware of the significance of food chains and learn instead to value the beauty and diversity of insect life in the garden. The current trend towards keeping small 'wild' areas of native plants and sowing wild flower seeds in gardens extends the appreciation of our native flora to a wider public and provides a little wildlife habitat where it is much needed.

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Appendix 1

CUMBRIA HABITAT DISTRIBUTION BY DISTRICT

Total area in ha

Habitat	Allerdale	Copeland	Carlisle	Eden	Barrow	S. Lakeland	Total
Broadleaved Woodland	2452.8	1669.5	2719.5	3529.1	109.9	9266.5	19747.3
Coniferous Woodland	13.2	6.5	33.5	100.8	0.0	140.5	294.5
Mixed Woodland	177.7	155.2	134.0	101.8	2.8	322.4	893.9
Dense/Cont. Scrub	340.4	207.8	125.8	244.5	39.3	341.6	1299.4
Acid Grassland	13876.5	16167.4	2837.2	48547.9	11.1	29205.8	110645.9
Neutral Grassland	487.8	231.9	343.7	907.6	12.2	301.8	2285.0
Calcareous Grassland	11.6	3.2	0.0	925.9	0.0	1251.0	2191.7
Marshy Grassland	1825.1	2239.5	2685.2	3486.3	93.4	1749.5	12079.0
Continuous Bracken	2949.2	3018.0	430.2	4270.6	41.4	9808.4	20517.8
Tall Herb & Fern	98.3	104.0	49.6	35.7	3.4	22.4	313.4
Dry Heath	5798.4	2825.0	1316.7	3847.9	0.0	2380.5	16168.5
Wet Heath	317.6	587.8	909.2	1360.6	0.0	1515.7	4690.9
Dry Heath/Acid Grassland	1280.7	1464.9	138.8	2458.7	0.0	2203.2	7546.3
Wet Heath/Acid Grassland	95.4	60.4	114.2	1785.3	0.0	912.5	2967.8
Blanket Bog	1587.4	928.3	3986.5	23878.1	0.0	976.6	31356.9
Raised Bog	1607.0	61.2	915.3	36.0	0.3	332.8	2952.6
Valley Bog/Basin Mire	309.2	409.1	155.0	312.6	0.0	457.5	1643.4
Flush/Soligenous Mire	1381.9	1650.1	124.2	1495.3	1.1	1991.9	6644.5
Swamp & Fen	86.8	46.9	24.0	18.2	2.6	39.9	218.4
Standing Water	1871.9	798.5	153.2	1631.3	190.1	2559.8	7204.8
Running Water	319.1	265.5	417.8	613.2	0.0	328.9	1944.5

Appendix 1 (contd)

Habitat	Allerdale	Copeland	Carlisle	Eden	Barrow	S. Lakeland	Total
Saltmarsh	1173.0	429.7	1326.9	0.0	156.2	804.2	3890.0
Coastal Rock, Shingle & Sand	438.1	196.3	840.6	0.0	153.4	585.8	2214.2
Open Dune	22.6	326.4	0.0	0.0	169.2	0.0	518.2
Fixed Dune	168.6	465.3	0.0	0.0	304.0	0.0	937.9
Maritime Cliff	3.9	65.6	0.0	0.0	0.2	6.4	76.1
Inland Rock & Scree	2062.0	1586.5	16.4	1186.8	0.7	720.9	5573.3
Limestone Pavement	3.1	0.0	0.0	454.6	0.0	319.7	777.4
Total semi-natural habitat	40759.3	35970.5	19797.5	101228.8	1291.3	68546.2	267593.6
Broadleaved Plantation	39.5	28.4	27.6	164.9	0.6	125.6	386.6
Coniferous Plantation	3951.4	4065.6	14791.5	6186.9	1.9	6779.7	35777.0
Mixed Plantation	96.0	81.4	163.3	486.0	3.9	367.4	1198.0
Total plantation	4086.9	4175.4	14982.4	6837.8	6.4	7272.7	37361.6
Quarry, Spoil & Refuse	691.8	350.8	103.2	317.8	103.4	388.9	1955.9
Built-up	2978.1	2518.5	3235.5	2509.3	1938.1	4776.0	17955.5
Agricultural, Road & Rail	77300.6	30717.2	65803.6	104753.8	4428.9	74150.5	357154.6
Total land area	125816.7	73732.4	103922.2	215647.5	7768.1	155134.3	682021.2
Semi-improved Grassland[1]	1743.0	912.0	41540.0	13150.0	317.0	6946.0	64608.0
Intertidal[2]	5172.0	2346.0	1226.0	0.0	4572.0	16295.0	29611.0

1 Included in agricultural total
2 Not included in land area

Appendix 2 CUMBRIA HABITAT DISTRIBUTION RELATIVE TO THE NATIONAL PARKS

Habitat	Total area (ha)	Area in LDNP	Area in YDNP	Area not in NPs	% in LDNP	% in YDNP	% not in NPs
Broadleaved Woodland	19747.3	10425.3	166.6	9155.4	52.8	0.9	46.3
Coniferous Woodland	294.5	118.4	18.9	157.2	40.2	6.4	59.7
Mixed Woodland	893.9	503.3	5.5	385.1	56.3	0.6	43.1
Dense/Cont. Scrub	1299.4	576.2	4.4	718.8	44.3	0.3	55.4
Acid Grassland	110645.9	62039.8	9396.4	39209.7	56.1	8.5	35.4
Neutral Grassland	2285.0	379.9	88.1	1817.0	16.6	3.9	79.5
Calcareous Grassland	2191.7	589.0	146.2	1456.5	26.9	6.7	66.4
Marshy Grassland	12079.0	5052.3	544.4	6482.3	41.8	4.5	53.7
Continuous Bracken	20517.8	16672.4	387.0	3458.4	81.3	1.9	16.8
Tall Herb & Fen	313.4	57.5	1.1	254.8	18.3	0.4	81.3
Dry Heath	16168.5	10952.7	311.1	4904.7	67.7	1.9	30.4
Wet Heath	4690.9	1530.8	848.6	2311.5	32.6	18.1	49.3
Dry Heath/Acid Grassland	7546.3	4664.3	779.4	2102.6	61.8	10.3	27.9
Wet Heath/Acid Grassland	2967.8	631.3	130.7	2205.8	21.8	4.4	73.8
Blanket Bog	31356.9	4862.1	684.8	25810.0	15.5	2.2	82.3
Raised Bog	2952.6	244.4	0.0	2708.2	8.3	0.0	91.7
Valley Bog/Basin Mire	1643.4	1209.9	37.1	396.4	73.6	2.3	24.1
Flush/Soligenous Mire	6644.5	4916.0	552.0	11765.0	74.0	8.3	17.7
Swamp & Fen	218.4	87.3	0.1	131.0	40.0	0.05	59.9
Standing Water	7204.8	6300.0	8.0	896.8	87.4	0.1	12.5
Running Water	1944.5	620.1	60.7	1263.7	31.9	3.1	65.0

Appendix 2 (contd)

Habitat	Total area (ha)	Area in LDNP	Area in YDNP	Area not in NPs	% in LDNP	% in YDNP	% not in NPs
Saltmarsh	3890.0	254.3	0.0	3635.7	6.5	0.0	93.5
Coastal Rock, Shingle & Sand	2214.2	95.6	0.0	2118.6	4.3	0.0	95.7
Open Dune	518.2	208.9	0.0	309.3	40.3	0.0	59.7
Fixed Dune	937.9	292.8	0.0	645.1	31.2	0.0	68.8
Maritime Cliff	76.1	11.6	0.0	64.5	15.2	0.0	84.8
Inland Rock & Scree	5573.3	4966.7	65.9	540.7	89.1	1.2	9.7
Limestone Pavement	777.4	57.5	1.4	718.5	7.4	0.2	92.4
Total semi-natural habitat	267593.6	138320.4	14238.4	115034.8	51.7	5.3	43.0
Broadleaved Plantation	386.6	167.1	3.3	216.2	43.2	0.9	55.9
Coniferous Plantation	35777.0	12951.6	606.4	22219.0	36.2	1.7	62.1
Mixed Plantation	1198.0	314.7	8.8	874.5	26.3	0.7	73.0
Total plantation	37361.6	13433.4	618.5	23309.7	36.0	1.7	62.3
Quarry, Spoil & Refuse	1955.9	307.7	5.2	1643.0	15.7	0.3	84.0
Built-up	17955.5	2606.3	171.0	15178.2	14.5	1.0	84.5
Agricultural, Road & Rail	357154.6	72845.4	6255.4	278053.8	20.4	1.8	77.8
Total land area	682021.2	227513.2	21288.5	433219.5	33.4	3.1	63.5
Semi-improved Grassland[1]	64608.0	7281.0	825.0	56502.0	11.3	1.3	87.4
Intertidal[2]	29611.0	1459.0	0.0	28152.0	4.9	0.0	95.1

1 Included in agricultural total
2 Not included in land area

Appendix 3 **HABITAT DISTRIBUTION BY DISTRICT WITHIN THE LAKE DISTRICT NATIONAL PARK**

Total area in ha

Habitat	Allerdale	Copeland	Eden	S. Lakeland	Total
Broadleaved Woodland	1406.9	1177.5	842.9	6998.0	10425.3
Coniferous Woodland	10.8	2.1	9.1	96.4	118.4
Mixed Woodland	103.7	125.0	4.0	270.6	503.3
Dense/Cont. Scrub	176.5	128.0	113.0	158.7	576.2
Acid Grassland	13717.5	15664.7	17524.1	15133.5	62039.8
Neutral Grassland	90.2	75.2	76.7	137.8	379.9
Calcareous Grassland	5.1	0.0	21.2	562.7	589.0
Marshy Grassland	867.0	1863.1	1561.9	760.3	5052.3
Continuous Bracken	2888.7	2893.0	2641.9	8248.8	16672.4
Tall Herb & Fern	12.0	25.8	8.1	11.6	57.5
Dry Heath	5785.0	2820.6	1226.1	1121.0	10952.7
Wet Heath	280.6	582.9	324.4	342.9	1530.8
Dry Heath/Acid Grassland	1242.5	1463.9	1117.1	840.8	4664.3
Wet Heath/Acid Grassland	48.2	50.4	241.3	291.4	631.3
Blanket Bog	1587.4	922.7	2066.5	285.5	4862.1
Raised Bog	0.0	0.0	34.3	210.1	244.4
Valley Bog/Basin Mire	284.2	388.8	204.3	332.6	1209.9
Flush/Soligenous Mire	1374.1	1632.9	678.1	1230.9	4916.0
Swamp & Fen	40.2	13.1	1.6	32.4	87.3
Standing Water	1814.1	700.4	1405.2	2380.3	6300.0
Running Water	164.3	211.7	135.3	108.8	620.1

Appendix 3 (contd)

Habitat	Allerdale	Copeland	Eden	S. Lakeland	Total
Saltmarsh	0.0	118.8	0.0	135.5	254.3
Coastal Rock, Shingle & Sand	0.0	67.9	0.0	27.7	95.6
Open Dune	0.0	208.9	0.0	0.0	208.9
Fixed Dune	0.0	292.8	0.0	0.0	292.8
Maritime Cliff	0.0	9.5	0.0	2.1	11.6
Inland Rock & Scree	2055.3	1573.2	710.9	627.3	4966.7
Limestone Pavement	3.1	0.0	9.2	45.2	57.5
Total semi-natural habitat	33957.4	33012.9	30957.2	40392.9	138320.4
Broadleaved Plantation	23.7	20.3	37.0	86.1	167.1
Coniferous Plantation	3133.1	3388.6	1174.0	5255.9	12951.6
Mixed Plantation	44.4	56.6	120.0	93.7	314.7
Total plantation	3201.2	3465.5	1331.0	5435.7	13433.4
Quarry, Spoil & Refuse	93.2	4.5	52.4	157.6	307.7
Built-up	362.9	277.5	263.4	1702.5	2606.3
Agricultural, Road & Rail	18161.9	13071.7	12821.0	28790.8	72845.4
Total land area	55776.6	49832.1	45425.0	76479.5	227513.2
Semi-improved Grassland[1]	757.0	641.0	1826.0	4057.0	7281.0
Intertidal[2]	0.0	1109.0	0.0	350.0	1459.0

1 Included in agricultural total
2 Not included in land area

APPENDIX 4 Cumbria Habitat Survey Community Programme Schemes

1 C.P. Scheme R/W10/0043/3 July 1983 - September 1986

Project base	1	Newton Rigg College of Agriculture, Penrith	July 83 - Sept 83
	2	NCC NW England Regional Office, Bowness-on-Windermere	Oct 83 - Sept 84
Area surveyed		1500 km^2, Eden and S. Lakeland Districts	
Supervisor		Peter Kelly	July 83 - Sept 84
Survey Officers		John Gallacher	July 83 - Sept 84
		Jenny Shimmin	July 83 - Sept 84
		Judy Palmer	July 83 - Feb 84
		Barrie Matthews	July 83 - Nov 83
		Glynn Allen	Feb 84 - Sept 84
		Karl Smith	Apr 84 - Sept 84
Cartographic Assistant		Hilary Mirrey	July 83 - Sept 84
Typist/Clerical Assistants		Dorothy Thomas	Aug 83 - Oct 83
		Jane Crowe	Sept 83 -June 84
		Anne Simmons	Nov 83 -Sept 84
		Jean Baty	July 84 - Aug 84

2 C.P. Scheme R/W10/0086/4 October 1984 - December 1985

Project base	1	NCC NW England Regional Office, Bowness-on-Windermere	Oct 84 - Apr 85
	2	Keld Farm, Lazonby, nr. Penrith	May 85 - Oct 85
Area surveyed		1420 km^2, Carlisle and Eden Districts	
Supervisors		Peter Kelly	Oct 84 - Mar 85
		Glynn Allen	Apr 85 - Dec 85
Survey Officers		Julie Bridgeman	Oct 84 - Dec 85
		Ruth Densley	Oct 84 - Dec 85
		Rigby Jerram	Nov 84 - Dec 85
		Madelaine Thorley	May 85 - Oct 85
		Alison Raw	Nov 85 - Dec 85
Cartographic Assistant		Ann Kyle	Nov 84 - Oct 85
Typist/CA		Linda Bowden	Oct 84 - Oct 85
		Trudie Nicholson	Dec 85

APPENDIX 4 (contd)

3 C.P. Scheme R/BAO/0015/5 June 1985 - May 1986

3A W. Cumbria Project June 85 - May 86

Project base	1	BTCV, Workington	June 85
	2	Workspace, Cleator Moor	July 85 - Jan 86
	3	Mobet Building, Derwent Howe, Workington	Feb 86 - May 86
Area surveyed		920 km^2, Allerdale and Copeland Districts	
Supervisor		Anne Riddell	July 85 - May 86
Survey Officers		Steve Garner	June 85 - May 86
		Catherine Mowat	June 85 - May 86
		Paul Appleton	June 85 - Dec 85
		Ian Watts	June 85 - May 86
		Ken Perry	Feb 86 - May 86
Cartographic Assistants		Rod Moore	July 85 - May 86
		Geraldine McNamara	Mar 85 - May 86
CA/Typists		Katherine Ritson	July 85 - Jan 86
		Diane Routledge	July 85 - May 86
		Shona Morton	Feb 86 - May 86

3B E. Cumbria Project January 86 - May 86

Project base	NCC NW England Regional Office, Bowness-on-Windermere	
Supervisor	Rigby Jerram	Feb 86 - May 86
Survey Officers	Rigby Jerram	Jan 86 - May 86
	Julie Bridgeman	Jan 86 - Feb 86
	Ruth Densley	Jan 86 - May 86
	Alison Raw	Jan 86 - May 86
Cartographic Assistants	Ann Kyle	Jan 86 - May 86
	Christine Banks	Feb 86 - May 86
CA/Typists	Linda Bowden	Jan 86 - May 86
	Anne Simmons	Feb 86 - May 86

APPENDIX 4 (contd)

4 C.P. Scheme R/W10/0089/6 May 1986 - May 1987

4A W. Cumbria Project

Project base Mobet Building, Workington

Area surveyed 1250 km^2, Allerdale, Copeland, Carlisle and Eden Districts

Supervisor	Anne Riddell	May 86 - May 87
Survey Officers	Steve Garner	May 86 - May 87
	Ken Perry	May 86 - July 86
	Jane Benson	Aug 86 - May 87
	Alison Rowley	Oct 86 - May 87
	Christine Dodd	Oct 86 - Apr 87
Cartographic Assistants	Rod Moore	May 86 - July 86
	Geraldine McNamara	May 86 - Mar 87
	Julie Thorburn	Aug 86 - May 87
CA/Typists	Diane Routledge	May 86 - July 86
	Lesley Groves	Aug 86 - May 87
	Sheena Campbell	Sept 86 - May 87

4B S. Cumbria Project

Project base NCC NW England Regional Office, Bowness-on-Windermere

Area surveyed 1150 km^2, S. Lakes and Eden Districts

Supervisor	Rigby Jerram	May 86 - July 86
	Ken Perry	Aug 86 - May 87
Survey Officers	John Hooson	May 86 - Mar 87
	Jonathan Turner	July 86 - Mar 87
	Simon Groves	Aug 86 - Jan 87
	Ken Graham	Aug 86 - Mar 87
	Kath Green	Aug 86 - Mar 87
Cartographic Assistants	Ann Kyle	May 86 - Aug 86
	Nigel Brown	Sept 86 - May 87
	Christine Banks	May 86
	Chris Hallam	July 86 - May 87
Clerical Assistants	Anne Simmons	May 86 - May 87
	Anne Henderson	July 86 - Aug 86
	Fiona Martucci	Nov 86 - May 87

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