This report is based upon work undertaken by the authors in the early 1980s for the then Nature Conservancy Council. It was never published and has only recently been draw to the attention of the JNCC. The report is now being published because of the continued value of the work comparing documentary and map sources to identify changes in the land use extent in four study areas and of many lowland raised mires between 1845 and 1978. Many sections, particularly that on current status, are now rather dated and should not be taken as a reflection of the current status of any particular site, group of sites or geographic area.

An Historical Survey of Lowland Raised Mires, Great Britain

O.M. Bragg, R.A. Lindsay, H. Robertson and others

REPORT TO THE NATURE CONSERVANCY COUNCIL, 1984

The fault is great in man or woman

who steals a goose from off the Common.

But what can plead that man's excuse

who steals the Common from the goose?"

18th century Surrey Rhyme

SUMMARY

The cumulative effect of the reasonable requirements of successive generations for encroachment onto natural habitats becomes unreasonable at the point of final extinction of an individual habitat. Trends in this direction tend to be insidious because they are invisible without reference to the past, and appropriate historical records are seldom available.

An exceptional habitat in this respect is lowland raised mire, for which past changes in land use have been recorded by both Ordnance and Geological Surveys since the mid-19th century, as well as by the habitat itself.

The Historical Survey of Lowland Raised Mires was undertaken by the peatlands group of the UK Nature Conservancy Council (NCC) Chief Scientist's Team during the late 1970s. The work focused on four study areas containing concentrations of raised mires below 30 metres a.s.l. in the Lancashire Lowlands (22 sites), the river valleys of South Cumbria (37 sites), around the Solway Firth (38 sites) and in the upper Forth Valley (19 sites). For every lowland raised mire within each study area, land uses were mapped at five survey dates from Ordnance Survey First Edition (1845–1865) and Second Edition (1883–1900) maps; post-War (1945–1949) and recent (1959–1974) air photographs; and by field survey (1975–1978). The seven land use categories distinguished were moss (unmodified peatland), agriculture, drained moss, peat cuttings, woodland, forestry and urban (built structures).

The results are presented first for individual sites, geographical groups of sites and study areas. For each study area and group, information on the history of mossland use derived from literature as well as from the data themselves are discussed.

During the latter half of the 19th century, the principal expanding land use on lowland raised mires was agriculture. The impact was greatest in Lancashire, where 73% of the moss area was converted. The first half of the 20th century saw the expansion of drainage and commercial peat extraction. There was peat industry in Lancashire, but because mossland availability here was already limited by the established dominance of agriculture, peat cutting expanded most significantly onto previously 'unused' raised mires further north, especially in the Solway (24%). Peat cutting and drainage together accounted for 35–44% of the lowland raised mires of South Cumbria, the Solway and the Forth Valley study areas by the 1950s. A third new land use, namely commercial forestry, appeared during the final 20 years of the study, and woodland including forestry covered 14%, 21% and 30% of the lowland raised mire in these three study areas respectively by 1978.

In view of the clear south–north trends in intensity of expansion of the principal land uses, the data are then re-worked to provide a comparison of the progress of mire land use change between England and Scotland. In England, the decline in mossland was most rapid during the 19th century, slowing during the 20th century to give a concave curve over the 120 years of the survey. By 1978, agriculture accounted for 49% and all other uses for 40% of the original moss area, so that only 11% remained unconverted. In Scotland, on the other hand, the rate of decline accelerated into and through the 20th century, land use in 1978 being divided between agriculture (36%), woodland including forestry (30%) and all other uses (22%) leaving 15% unconverted.

Overall, 1,803 ha (13%) of the 14,257 ha of mossland identified in the 1850s remained unconverted in 1978. Its decline through the survey period was clearly linear, trending towards an extinction date during 1989.

The final phase of the study examined the condition of vegetation on the surviving areas of mossland. A simple objective quality scoring system for vegetated open moss, taking into account the presence of *Sphagnum*, indicator and intrusive vascular species was devised and three quality levels were

defined on this basis (scores 20+, 10–20 and <10). Areas that had been burnt and those with scattered trees were assigned to separate quality classes.

26% of the remaining moss areas in both England and Scotland fall within the highest (score 20+) quality class. A further 24% of the total fall within the second (score 10–20) quality class, and almost all of this is in Scotland. Scattered trees are more than twice as extensive in Scotland than in England, whilst the lowest quality of open moss (score <10) and burnt areas were recorded only in England.

Overall, 50% of the remaining mossland attains a quality score of 10 or more. 36% is of low quality (score <10), has scattered trees or is burnt; and pessimistic assignment to this category of all areas for which quality assessment was not possible increases the total to 50%.

Checking of the nature conservation status of the remaining mossland reveals that 82.3% of the remaining resource, but only 10.4% of the moss area that existed in the mid-19th century, currently has statutory protection as SSSI and/or NNR.

This protection is in place on only 15 of the 34 sites that still have unconverted surface. The 18 unprotected sites include three with vegetation of the highest (score 20+) quality extending to a total area of 212 ha, including the site with the fourth largest expanse of unconverted moss identified (Longbridge Muir); two with areas of fair-quality (score 10–20) vegetation extending to 15 ha; and 10 whose condition has not been ascertained (53 ha). Thus, 280 ha or 15% of the remaining moss area is still available for conversion to other uses. On the other hand, six of the statutorily protected sites are degraded, indicating that a nature conservation designation does not necessarily mean that a site's mossland characteristics, especially vegetation, will be preserved.

CONTENTS

1. INTRODUCTION

1.1 Background

The need for action to safeguard the wildlife of Britain has never been more pressing. Nonetheless, conservationists continue to face a cool – if not incredulous – response from the majority of land owners and users, who maintain that the countryside is in the good hands of those who know and love it best. Although it is generally accepted that a few 'cowboy' land owners do great damage within the confines of their own estates, the vast majority of owners and tenants are demonstrably moderate, even trifling, in their demands on the landscape and its wildlife. Is it any surprise, therefore, that conservationists are dismissed as unreasonable cranks, unable to see life's realities, when they criticise even the 'reasonable' attitude shown by most landowners? In fact, their inability to see wisdom in the *status quo* lies both in the past and in the future, and hinges on a difference in timescales.

The mixture of traditions, planning controls, agricultural incentives and general economic pressures which mould the modern countryside means that most land uses are ephemeral. Activities that may be expedient or positively encouraged on a particular piece of land in one decade may prove totally unsuitable in the next due to market forces, government policies, or even changes in individuals' domestic circumstances. The majority of land uses are sufficiently flexible and controllable to adapt; indeed modern technology can convert or return almost any piece of land to virtually any use, given sufficient resources and incentives.

Nature conservation is exceptional in this respect. There is no technology on earth that can re-create ancient wildwood; all that can be done is to leave Nature to the task for at least 500 years. The timescale is even longer for bog, which so far has taken 8,000–10,000 years to form. In other words, an area of 'wild' undisturbed habitat that has been converted to some other land use can seldom, if ever, recover in a few decades. Thus each small encroachment effectively constitutes a permanent loss. Each generation takes a small area of the habitat, and each generation is recognised as being moderate in its demands, but eventually the process will insidiously devour the whole site just as surely as would a single episode of complete destruction. There is no target for an accusing finger until the last hapless developer proposes his modest 10-acre scheme and is told that it is greedy and irresponsible because it will destroy the site, even though previous generations thought nothing of 50-acre or 100-acre developments. Although each generation may have been moderate and reasonable in its demands, the cumulative effect through successive generations is still complete destruction.

This need not cause undue concern so long as extensive areas of natural landscape remain, because small losses will have a negligible effect on survival of the whole. The problem arises in recognising the point at which further loss becomes dangerous by threatening the long-term existence of habitats. Britain is a crowded island where the long history of man's activities has ensured that only small isolated patches of 'natural' landscape now survive; we are no longer rich in this irreplaceable resource. Every small encroachment brings the possibility of extinction closer, not only for individual species but also for the natural habitats upon which these species depend. For many habitats, even slow encroachment is now a harbinger of doom.

Unfortunately, each generation mentally wipes the slate clean. Much that has occurred in the past is buried in the past, and the baseline is taken to be the situation at the start of each new generation. Subsequent proposals for piecemeal encroachment are considered without reference to past losses. Encroachment is thus doubly dangerous; first by affecting only small pockets of land and thus seeming reasonable, and secondly by contributing to long-term trends that are effectively invisible. It is only when cumulative losses are recognised that the nature of the threat can be assessed in its

true context. This cannot be achieved on the basis of the 'here and now'. It is necessary to refer to the past, obtaining such information as is available for the land use patterns of earlier generations. There are many potential pitfalls in adopting such an approach. For the present study, however, these proved largely avoidable due to a fortuitous combination of three important factors. First, the UK Ordnance Survey has provided standardised and comprehensive large-scale mapping of Britain since 1840. Secondly, an equally comprehensive Geological Survey, describing both solid and drift deposits, began a mere 20 years later. Finally, there exists one habitat which occurs in discrete units, was recognised and mapped by both the Ordnance and the Geological Surveys, is useful enough to have undergone significant land use change during their currency, and is sufficiently difficult to re-create that there is little possibility of disturbed/destroyed habitat reverting to a truly natural state. The habitat is lowland raised mire.

1.2 Lowland raised mires

The conditions that favour the formation of raised mires are not individually remarkable. However, a truly remarkable result arises through their combination. The location may be a shallow basin in estuarine clays or silts which tends to retain shallow open water for much of the year; the important factor is waterlogging. This encourages the development of fen vegetation which, as it dies back each year, becomes saturated and anoxic so that it cannot be broken down further by the normally efficient aerobic microbial decomposers, and so slowly accumulates as fen peat. The basin has no permanent inflow or outflow so that the vegetation relies largely on local soils and rainfall for nutrients; and as the peat accumulates, it increasingly binds up the already meagre supply. Trees such as willow, alder, and even oak may eventually colonise and form a canopy over the peat, but the limited nutrient inflow remains a problem for vegetation. Indeed, nutrient levels become so low that a highly specialised type of moss, *Sphagnum*, begins to appear on the ground. This has profound implications for the trees because *Sphagnum* is a highly efficient water and mineral trap. The few nutrients that are still available are rapidly bound up within the *Sphagnum* carpet and the trees, finding that peat accumulation is making it increasingly difficult to obtain nutrients from the mineral soil beneath, begin to fail.

By now the surface of the peat has actually risen above the basin's original water table but it remains, oddly, as wet as ever. This is because a continuous carpet of *Sphagnum* is so efficient at retaining water that it can, in effect, maintain its own near-surface water table, almost regardless of height above the surrounding mineral land and the regional water table. This peculiar state of affairs has its own peculiar consequences. The microbial decomposers are now not merely waterlogged and without oxygen, but also severely deprived of nutrients. Not surprisingly therefore, the process of decomposition – part of Nature's most fundamental cycle – comes to a halt. With nothing now standing in its way, the *Sphagnum* carpet builds up layer upon layer of its own undecomposed remains, overwhelming the few remaining trees and still continuing to grow upwards until a height of 20-30 feet above the surrounding land is achieved. Thus it forms, in effect, a 30-foot (10 m) high compost heap, and a very old compost heap at that; since it grows at only 1–2 mm per year, a 10-metre deep *Sphagnum* peat deposit can take up to 10,000 years to form.

Because the margins of the peat body tend to drain outwards, slightly higher levels of oxygen and nutrients are found here, favouring decomposition. Thus, although the centre of the moss may be 30 feet above the surrounding land, its margins are lower, the whole peat body forming a large dome. The most incredible feature of all is that the surface at the crown of the dome is wetter and more treacherous than the surrounding mineral ground, 30 feet below. Although directly incident rainfall is now the only water supplied to the dome, the water table is still maintained at the peat surface, almost as though the whole system were still a lake.

1.3 The value of raised mires

Peat, the basic product of raised mire formation, is a well known and highly valued commodity. Since earliest times it has been used as a fuel. Today, in various parts of the world, huge power stations use peat-fired turbines; and the escalating cost of coal and coke has recently stimulated new interest in the production of compressed peat briquettes for the domestic fuel market. Peat is probably equally well known in its other long established role as 'the gardener's friend'. There cannot be a garden shed in the country without at least one bag of peat, potting compost or bulb fibre. Peat as a horticultural growing medium has yet to be improved upon. The garden of England – the East Anglian Fen country – owes its fame to the peat which, drained and fertilised, now forms the rich brown soil of the area. Thus the bulk of our vegetable produce relies on peat. During the First World War, field wound dressings were made from *Sphagnum* moss because it was the most efficient sterile absorbent material that could be obtained with relative ease; and peat has long been used as a more general aid to health in balneology, the slightly odd practice of wallowing in a bath of liquid peat to cure such diverse ills as arthritis and acne. In Russia, people even live in houses constructed from compressed peat blockboard.

So much for the many uses of extracted peat; but what of the bogs themselves? What use are they if the peat is left in place? Man has fished the seas and lakes, lived in woodlands, tamed the lowlands and foothills, and scaled the highest peaks; but still an air of mystery and danger hangs over peat bogs, which remain desolate and unfamiliar because we have never really come to terms with them. Indeed, there is still a commonly held belief that bog land is wasteland – or worse, dangerous wasteland – which does grave injustice to this unique habitat. Nonetheless, over and over again, we are confronted by aspects of its multi-faceted value to mankind.

In a Danish museum display case, there is a human figure whose every piece of clothing, every feature, and even every skin pore is as clear as on the figures inspecting it from outside the case. The principal difference between the one inside and those outside is that the former has been dead for more than 2,000 years. Tollund Man owes his remarkable preservation to the fact that, when sacrificed to the God of the Harvest, he was placed in a grave dug in a peat bog and so was immersed in peat acids for two millennia. His existence alone is enough to provide a fascinating insight into a lifestyle of the past, even revealing the composition of the undecomposed last meal found in his stomach. However the implications are far wider, in that not only human remains, but everything which falls into an area of bog is preserved in the same way.

If we take a core of peat from the present surface down to the bottom of the bog and analyse the remains found at each level, we can in effect travel back through time because the remains found at any level are those which fell to the mire surface when that level was the surface. Thus the peat is a natural museum, cataloguing the events of its surroundings over the last 6,000 or more years. Perhaps the most important remains which can be obtained from such a peat core are grains of pollen. Hay fever sufferers will know only too well how pollen seems to get everywhere. So it does, and always has; and although some species travel more easily than others, a careful analysis of the types of pollen preserved at each level of a peat core can be used to determine the vegetation which surrounded the developing bog and thus, finally and most importantly, the climate of the period. The really vital information comes from analysis along the length of the core, which gives a detailed and continuous record of climatic fluctuation since 4000 BC. It has been estimated that a shift of just 0.5^{o}C in the overall weather pattern of Europe would force a radical alteration in the present distribution of crop species. If such a change came suddenly, without warning, it could mean ruin for many farmers. An increasingly vocal group of climatologists believes that what may face us in the near future is a distinct shift in climate over just a few years. Although this is regarded as an extreme view by the majority of scientists, all are agreed that the climate will change eventually; the points under debate are how quickly and by how much. International Meteorological Year, in 1979, focused

climatology research on precisely these questions; however all current research is of little use unless it can be related to the past pattern of climate change. In this context, major shifts may prove to be totally consistent with historical patterns of fluctuation; but on the other hand, apparently small changes may turn out to be parts of a slow but steady unidirectional trend. Assessing climatic trends from 200 years' records is like trying to use a microscope to appreciate Leonardo's Mona Lisa. With magnification and a limited field of view, the famous smile loses its enigmatic nature and becomes a blob of burnt umber oil paint. To appreciate the beauty of the masterpiece it is necessary to dispense with the microscope, stand well back, and look upon the whole picture. In the same way, we need to see the longest possible climate record before we can appreciate the true implications of observed recent changes. For Britain, peat bogs provide an accessible long record, stretching back at least to the last Ice Age.

This is just one aspect of the value of peat bogs which has been repeatedly demonstrated, although perhaps not always fully recognised, in an astonishing variety of ways since the beginning of human history in Britain. This value includes their ability to provide food and to harbour biodiversity. In the past, huge flocks of overwintering teal, widgeon and other wildfowl were important sources of meat during the winter months. Nowadays, most surviving raised mire remnants are too small to support birds in such numbers, and besides, they can find better pickings elsewhere. However large flocks of pink-footed geese still rely on the seed heads of the white-beaked sedge *Rhyncospora alba* to prepare for their autumn migration. Raised mire also provides a range of 'unseen' environmental functions; for example, its ability to store rainwater and pollutants means that its presence within a river catchment improves the water quality and influences the flow regime of the river itself.

1.4 Threats

The long-held attitude that peatland is wasteland, fit for nothing but exploitation or reclamation, has stimulated not only peat extraction but also large-scale conversion to agricultural use. Thus, over the centuries, enormous effort has gone into the reclamation of such areas as the Somerset Levels, the Lancashire Lowlands and the East Anglian Fens. More recently, new techniques in sylviculture have rendered forestry planting on raised mires practical, so that they have attracted new interest amongst those charged with responsibility for producing a strategic resource of timber against a background of increasing scarcity of plantable land. Since the 1920s, therefore, bogs that had not already been developed for agriculture have been drained and afforested.

Most peatland areas that are not under peat extraction, agriculture or forestry are used as rough grazing and/or grouse moor, introducing more subtle threats that potentially reduce their wildlife interest even if prejudice to their long-term survival is less clear. Perhaps the most universal of these is burning, a long-established method of allegedly improving the quality of grazing. This may be achieved under some circumstances, but by and large such practice does more harm than good. Sometimes the fire is started as an indirect result of some other activity, such as burning out hedge stumps or even by the careless tossing aside of a lighted cigarette, but the effect is the same. Fire kills *Sphagnum*. Without a living layer of *Sphagnum* moss the bog is dead. No longer does it lay down peat, and no longer can it maintain the water table at its surface. Protected from further fires, especially if pockets of *Sphagnum* have survived, the mire can recover. However with repeated burning this cannot happen, and the bare peat surface which results is colonised by dwarf shrubs and then by trees, whilst the peat mass itself slowly oxidises away. A raised mire without a living layer of *Sphagnum* is like a tree without leaves – a dead trunk with bare branches slowly rotting down to nothing.

Other threats are generally less widespread, but can cause localised damage where they do occur. Spraydrift from nearby agriculture or forestry can result in detrimental inputs of fertiliser, herbicide or

insecticide that are virtually impossible to confirm or deny afterwards. Trampling and grazing by livestock can also cause problems. Perhaps the worst effect is when cattle have been given food concentrate before being turned out onto the bog to graze. The dung deposited as a result is very high in nutrients and tends to cause localised breakdown of the *Sphagnum* carpet. However, in general, the problem becomes acute only when dealing with high stocking levels on small sites, where the combination of heavy trampling and enrichment by dung can severely damage an actively growing bog surface.

1.5 Approach and objectives of the historical land use survey

The *Historical Survey of Lowland Raised Mires* was undertaken by the peatlands group of the Nature Conservancy Council (NCC) Chief Scientist's Team during the late 1970s. As the statutory conservation body for the UK, NCC undertook this work in order to gain insights that would support the development of a national peatland conservation strategy. The intention was to trace the land use history of a sample of mire sites over as long a period as possible. It was hoped that the sample could be made large enough, and the sites sufficiently widespread, to allow assessment not only of the overall pattern of habitat loss, but also of any regional variations within this pattern.

From the discussion above, it emerges that most of the land use changes that are likely to permanently and irreversibly alter the wildlife interest of raised mires are quite obvious. They are easily recognisable on both maps and aerial photographs and tend to be fairly well documented. Therefore, the primary focus of the study was to quantify these changes on the basis of such documentary data sources. The methods and outcome are described in Sections 2–4 of this report. However, it is important to bear in mind that, even where the original mire surface has survived, less obvious forms of exploitation such as burning and spraydrift may have rendered that surface lifeless and devoid of nature conservation interest. Therefore the concluding phase of the study (Section 5) asked the simple question: which of the surviving areas are still actively growing raised mire, and which are not?

2. METHODS

The study proceeded in four stages. The first task was to locate appropriate sites, and thus to define the study areas. These were regions in which, at least at some time in documented history, mires formed a significant component of the landscape. Secondly, reliable sources of historical information for these areas were identified, and a practical period of study was thus defined. The third stage was extraction of data from these sources. Finally, the data were collated to yield land use histories for individual sites, groups of sites, study areas and the total mire area. These stages are described in greater detail below.

2.1 Selection of study areas

A desk study of the peatlands of Scotland, Wales and north, west and south-west England was carried out in 1976. Mire sites lying at altitudes below 1000 feet above sea level were identified from 1" Ordnance Survey maps (some were subsequently checked on 2½" Ordnance Survey maps and on air photographs), and an inventory produced in the form of a card index.

It was decided that the present study should include only raised mires, and that these should be below 100 feet (30 metres) altitude in order to avoid confusion with areas of blanket mire, which were considered to be beyond the scope of the present exercise. Four major concentrations of sites which fitted these criteria were identified from the card index; in lowland Lancashire, the river valleys of South Cumbria, the Solway Firth and the Forth Valley. These were defined as the four study areas.

2.2 Sources of information

The study aimed to trace the history of the total area of raised mire within the study areas by comparing patterns of land use recorded at a series of dates. Thus, sources of land use information which covered all four study areas in a detailed and comparable manner, and resulted from surveys carried out over periods which were short in relation to the total length of the survey, were sought.

Although they contain much relevant information dating from at least the middle of the 18th century, enclosure and tithe maps proved to be unsuitable because they were not produced for all the sites involved. Similarly, the first Land Use Survey of Great Britain, carried out in the 1930s, did not provide complete cover of the study areas.

The earliest appropriate source discovered was the Ordnance Survey First Edition (6" to 1 mile), which was begun in 1840 and completed in 1865. Problems of ambiguity of map symbols could be largely overcome by reference to the 6" Geological Survey maps produced in the 1870s.

Subsequent complete coverage was achieved by the Ordnance Survey Second Edition (6" to 1 mile), carried out between 1883 and 1900.

More recent information was obtained from air photographs. Photography covering the whole of Britain was available from a survey carried out immediately after the Second World War (1945–1949). Most sites were re-flown between 1970 and 1974, although for a small number of them the most recent photographs dated from 1959.

The final set of data was collected by field survey. Some sites (in South Cumbria) were visited in 1975 and 1976, and the remainder in 1978. At this stage, current patterns of land use were mapped, and more detailed investigations of the vegetation of surviving moss areas were carried out.

2.3 Land use mapping

As outlined above, land use data were compiled from five sources, each originating from a survey carried out over a short and defined period, as follows:-

Ordnance Survey First Edition	1840 – 1865
Ordnance Survey Second Edition	1883 – 1900
Air photographs	1945 – 1949
Air photographs	1959 – 1974
Field survey	1975 – 1978

The baseline for the study was established from the earliest of these sources, the Ordnance Survey First Edition. The first step was to determine the boundary of raised mire vegetation on each site at this stage. Since no specific symbol for bog vegetation was employed, it was initially assumed that the parts of the sites denoted as 'rough grazing' and 'marsh' were in fact open bog, and the outlines of areas so defined were traced from the maps. The tracings were then checked against areas of peat marked on the 1870 Geological Survey maps where possible. However, since the relevant geological maps for Lancashire had been destroyed during the Second World War, outlines of sites here were compiled solely from the Ordnance Survey maps. In a few cases, areas of recently cut or drained peat which formed integral parts of sites were included; otherwise, only mire areas which were apparently unmodified at this stage were mapped.

A second tracing of each of the areas so defined was then prepared from the relevant Ordnance Survey Second Edition map. Again, 'rough grazing' and 'marsh' symbols were assumed to denote open bog vegetation. Other symbols now appeared within the site boundaries; it was possible to identify areas of woodland (deciduous, coniferous or mixed), agriculture (including rough pasture and orchards), scrub (including furze), urban development (such as buildings and railways), peat cuttings and drained moss.

The air photographs were mostly examined in pairs using a mirror stereoscope. The distinctive surface patterns of unmodified areas of bog made it possible to map these directly. All other land uses shown on the earlier Ordnance Survey maps could be identified on the photographs, and in some cases additional detail was apparent; for example, coniferous plantations could be distinguished from areas of self-sown conifers. For each site, the pattern of land use shown by each set of air photographs was drawn onto tracing paper overlaid on the relevant modern Ordnance Survey (scale 1:10,000) map.

During the 1978 field survey, the land use maps were again updated.

Thus, for each site defined from the First Edition Ordnance Survey maps, a series of five tracings, each detailing the pattern of land use at one of the survey dates, at a scale of 6" to 1 mile (1:10,560) or 1:10,000, was produced.

2.4 Land use categories and measurement of areas

The quality of land use information available from the different sources varied. In order to render the data comparable over the whole period, all the uses recorded were fitted into seven categories, as follows:

Category	*Details*
Moss:	unmodified peatland; essentially areas where the original bog surface remained, but including areas which had been burnt or which carried scattered trees;
Agriculture:	divided into fields and cultivated;
Drained moss:	identified by the presence of ditches;
Peat cuttings:	both traditional and commercial enterprises;
Woodland:	deciduous, coniferous and mixed woods, both semi-natural and planted, and scrub;
Forestry:	commercial plantations; and
Urban:	buildings (including farms), railways, motorways, airfields, refuse tips and mineral workings.

The area of each land use shown on each tracing was then measured. In most cases, this was achieved by means of square grid overlays drawn so that each square represented one hectare. The number of complete squares within each land use boundary was counted, and the fraction of each marginal square included was estimated by eye. For a few sites, the measurements were checked by computer planimetry, which indicated errors in the range 5–9%.

Thus, for each site, a set of data which detailed the total area devoted to each land use category at each survey date was obtained. Similar data for groups of sites and whole study areas were then derived by summing the data for their constituent sites.

3. LAND USE HISTORIES FOR THE FOUR STUDY AREAS

3.1 Lancashire Lowlands

Post-glacial conditions favoured growth of peat over large areas of the Lancashire Lowlands (MAFF 1958). The resulting distribution of peatland is shown in Figure 1. Chat Moss is the subject of possibly the earliest written reference to a bog burst, quoted by Gorham (1953) from the *Itinerary* written by John Leland between 1535 and 1543, as follows: “In the very toppe of Chate moore where the mosse was hyest and brake, is now a faire plaine valley, and a rill runneth in hit, and peaces of smaul trees be founde in the bottom”.

Man has long exploited the so-called ‘mosses’ of Lancashire, as sources of domestic fuel and as agricultural land. The documented history of their reclamation dates back at least to the 17th century; there are records from 1680 of parts of the Fylde mosses being `taken in' for improvement and cultivation. By the end of the 18th century, methods of bringing mossland under the plough and appropriate crop rotations appear to have been well established (Oldfield 1956).

The 19th century brought the Industrial Revolution, and with this came expansion of urban centres in south Lancashire to form a close network of markets for agricultural produce. Accordingly, agricultural pressure on the mosslands increased, and various private enclosure agreements which involved them even preceded the general Enclosure Act of 1845 (Oldfield 1956).

At this stage also, steam railway came to the area. The Liverpool and Manchester line, opened in 1830, offered the world's first regular passenger-carrying service. Amongst the achievements of its engineers was the section of floating track which crossed Chat Moss (Davis 1975). One of the series of U.K. postage stamps issued on 12th March 1980 to commemorate the 150th anniversary of the Liverpool and Manchester Railway bears the caption "Third Class Carriage and Cattle Truck crossing Chat Moss".

Thus, by the time of the first Ordnance Survey (1845), the Lancashire mosses were far from unmodified. Twenty-two discrete mire sites, already representing only remnants of the original mossland areas, were identified as the baseline for this study. Their locations are shown in Figure 2.

Geographically, the sites fall into three groups:

- the Mersey Mosses (Sites 1–3), lying immediately to the west of Manchester;
- the Southport Mosslands (Sites 4–11), including seven sites between the rivers Alt and Ribble; and
- Wyre group (Sites 12–22), which includes all the lowland mosses of the Fylde (the area between the rivers Ribble and Lune) and Heysham Moss (Site 22), but is dominated by the Over-Wyre mosses (Sites 16–21).

Land use data for each site are given in Table 1, and Table 2 summarises the data for each of the groups and for the whole study area. The data are presented graphically in Figure 3, and discussed for each group in turn in Sections 3.1.1–3.1.3.

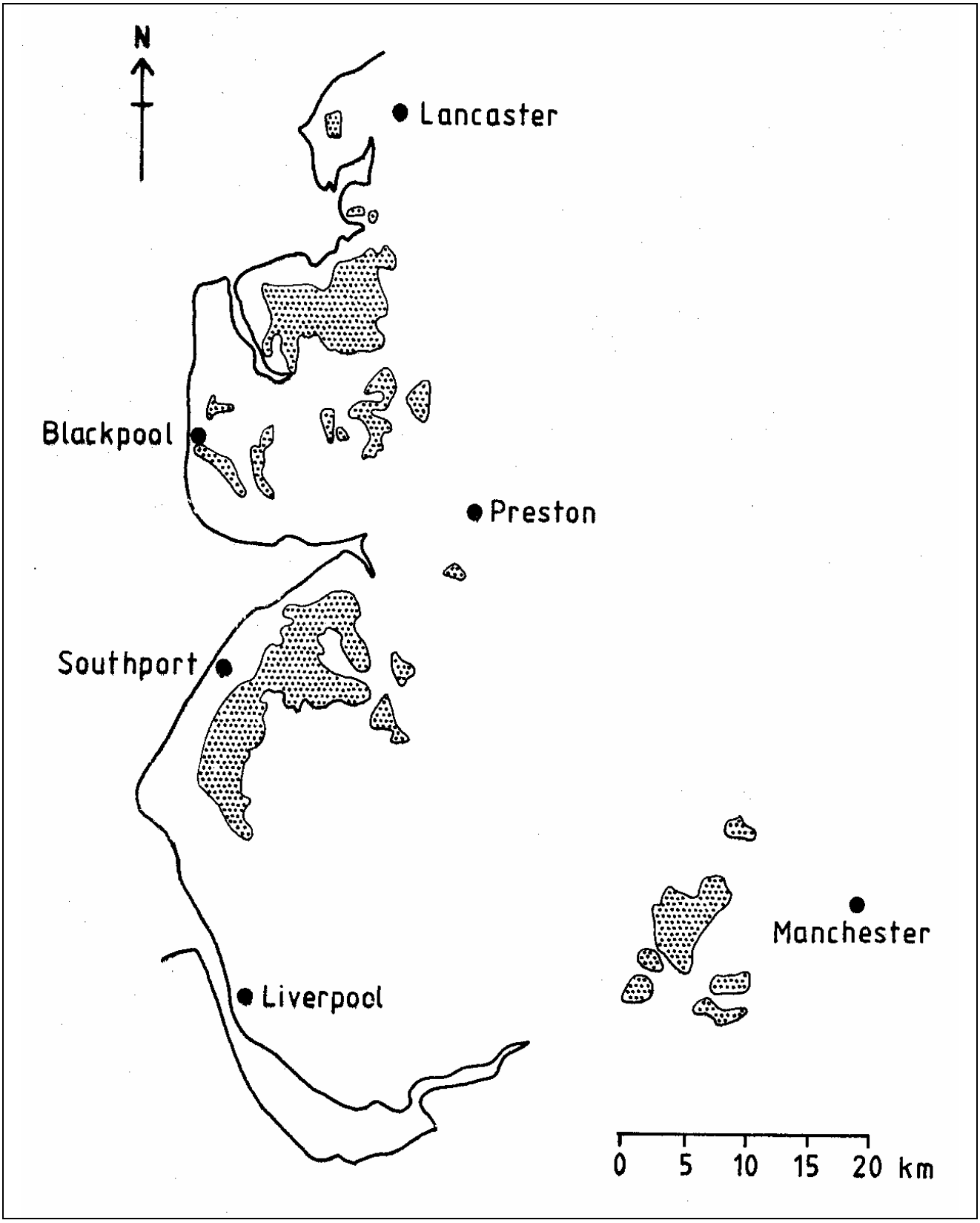


Figure 1. The distribution of lowland peat (shaded areas) in Lancashire. From *The Atlas of Britain and Northern Ireland*. Clarendon Press, Oxford, 1963.

Table 1. Lancashire Lowlands: land use areas (ha) for individual sites at each of the five survey dates.

STUDY AREA	LANCASHIRE LOWLANDS																					
GROUP	MERSEY			SOUTHPORT								WYRE										
SITE NUMBER	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
SITE NAME	Chat Moss	Holcroft Moss	Risley Moss	Altcar Moss	Plex Moss	Martin Mere	Mere End	Hoscar Moss	Tarleton Moss	Croston Moss	Farington Moss	Great Marton Moss	Weeton Moss	Carr House Green Common	Inskip Moss	Rawcliffe Moss	Rawcliffe Moss West	Stalmine Moss	Pilling Moss	Black Lane	Cockerham Moss	Heysham Moss
SURVEY DATE	1845	1845	1845	1845	1845	1845	1847	1845	1847	1847	1848	1844	1844	1844	1844	1845	1845	1845	1845	1845	1844	1845
Moss	1276	185	451	57	50	58	6	14	267	43	194	25	34	53	42	249	51	277	221	45	575	56
Peat cuttings	75																					
SURVEY DATE	1894	1888	1891	1892	1892	1892	1892	1893	1909	1893	1893	1891	1891	1892	1892	1890	1891	1890	1890	1891	1890	1891
Moss	486	89	169	14	1	1		11			19		5	1		1	2	17	4		169	16
Agriculture	799	87	267	21	48	47			267	41	175	25	28	51	41	245	47	256	212	43	406	40
Peat cuttings	40																					
Woodland	26	7	15	18		10	6	3		2			1	1	1	2	1	3	4			
Urban		4		3	1											1	1	1	1	2		
SURVEY DATE	1945	1945	1945	1945	1945	1949	1946	1945	1945	1946	1946	1945	1955	1945	1950	1945	1945	1945	1945	1945	1947	1950
Moss	100	24	33			1					4			1				1			81	2
Agriculture	773	80	299	19	47	38	1		249	41	190	25	28	51	41	240	49	272	216	42	430	42
Drained moss	50	9	61																		58	
Peat cuttings	300	60		15																		7
Woodland	48	8	27	20	2	19	5	14	1	2			6	1	1	9	1	3	4	1	6	3
Urban	40	4	31	3	1				17								1	1	1	2		2
SURVEY DATE	1976	1959	1959	1971	1973	1970	1977	1973	1974	1977	1977	1977	1966	1967	1977	1977	1977	1977	1977	1977	1977	1961
Moss	46	28	28																		2	2
Agriculture	812	98	307	19	46	37		14	238	41	190	15	28	35	40	243	49	271	218	42	454	44
Drained moss	71	2	59																		99	
Peat cuttings	246	49																			1	5
Woodland	106	4	26	35	4	21	6		1	2	3		6	1	2	6	1	4	2	1	19	3
Urban	70	4	31	3					28		1	10		17			1	2	1	2		2
SURVEY DATE	1978	1978	1978	1978	1978	1978	1978	1978	1978	1978	1978	1978	1978	1973	1978	1978	1978	1978	1978	1978	1978	1978
Moss	5																				2	4
Agriculture	813	135	307	19	48	40		14	238	41	190	15	28	35	40	243	49	271	218	42	469	42
Drained moss	79	12	53																		84	
Peat cuttings	205																				1	1
Woodland	181	38	60	35	2	18	6		1	2	3		6	1	2	6	1	4	2	1	19	7
Urban	70	10	31	3					28		1	10		17			1	2	1	2		2

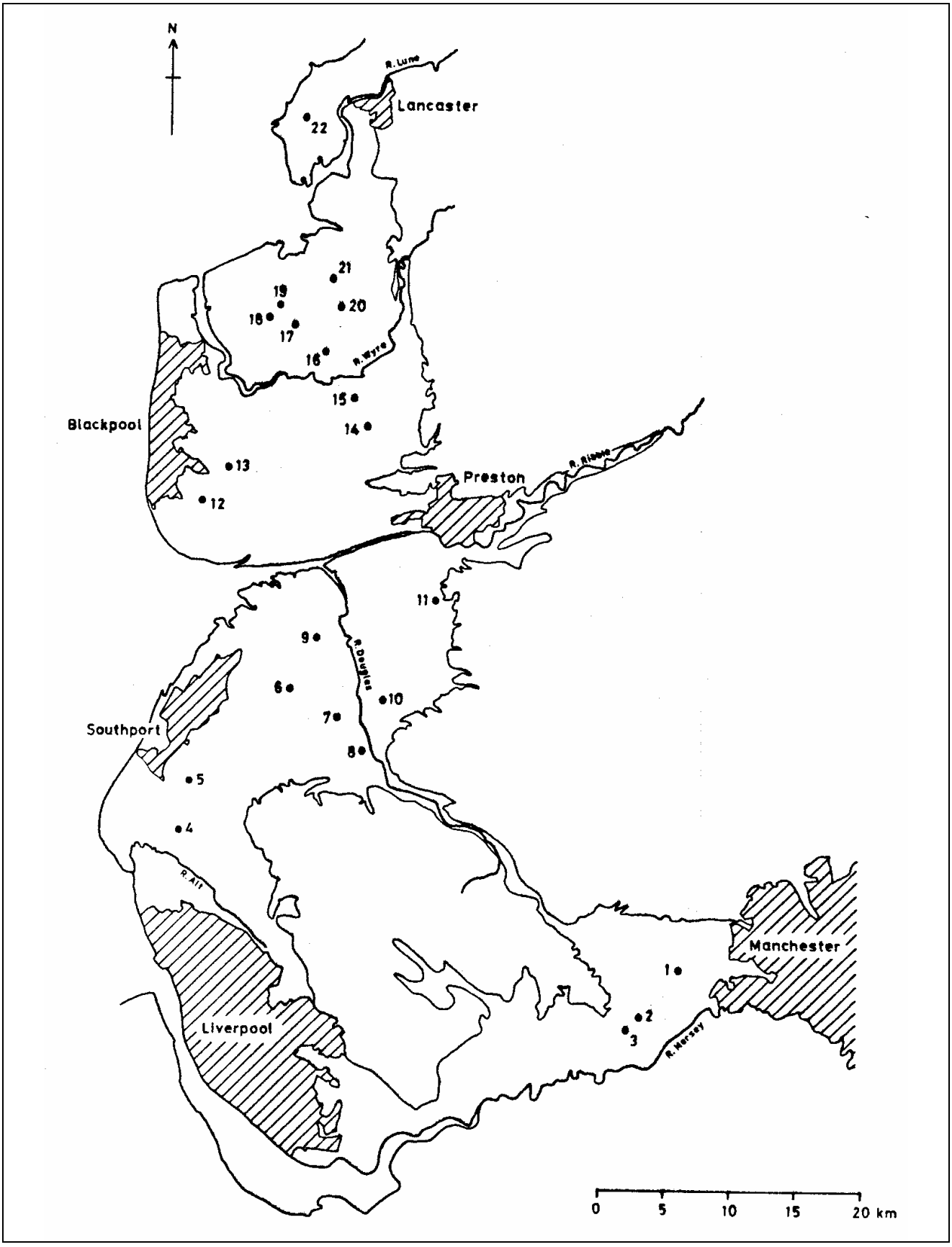

N
R. Lune
Lancaster
22
21
19
20
18
17
16
R. Wyre
15
14
Blackpool
13
12
Preston
R. Ribble
11
9
R. Douglas
6
10
7
Southport
8
5
4
R. Alt
Manchester
1
2
3
Liverpool
R. Mersey
0
5
10
15
20 km

Figure 2: Lancashire Lowlands : locations of sites included in the survey. 30 m contour and major urban areas also shown. Key to sites:

1	Chat Moss [Bedford Flow, Astley, Worsley, Barton, Irlam, Little Woolden, Great Woolden and Cadishead Mosses]	11	Farington Moss [Leyland Moss, Much Hoole Moss, Little Hoole Moss]
		12	Great Marton Moss [Lytham Moss]
2	Holcroft Moss [Glazebrook Moss, Pestfurlong Moss]	13	Weeton Moss
3	Risley Moss [Rixton Moss, Woolston Moss]	14	Carr House Green Common [Higham Nook, Kellet's Bridge]
4	Altcar Moss	15	Inskip Moss
5	Plex Moss [Halsall Moss, Barton Mere, Renacres Moss]	16	Rawcliffe Moss
		17	Rawcliffe Moss (west)
6	Martin Mere [Scarisbrick Moss, Wyke Hey Moss]	18	Stalmine Moss [Pilling Moss (west)]
7	Mere End	19	Pilling Moss
8	Hoscar Moss	20	Black Lane
9	Tarleton Moss [Hesketh Moss]	21	Cockerham Moss [Winmarleigh Moss, Gull Moss]
10	Croston Moss [Mawdesley Moss]	22	Heysham Moss [Brown Moss]

[names in square parentheses denote mire areas lying adjacent to the main site, which were treated as part of it in the collation of land use data]

Table 2: Lancashire Lowlands: summary of land use data for the total mire area and for each of the descriptive groups.

Survey date	Land use	GROUP						TOTAL AREA	
		Mersey		Southport		Wyre			
		ha	%	ha	%	ha	%	ha	%
1844 – 1848	Moss	191	96	689	100	162	100	4229	98
	Peat cuttings	75	4					75	2
	Total	198		689		162		4304	
1888 – 1909	Moss	744	37	46	7	215	13	1005	23
	Agriculture	115	58	599	87	139	86	3146	73
	Peat cuttings	40	2					40	1
	Woodland	48	2	39	6	13	1	100	2
	Urban	4	0	4	1	6	0	14	0
	Total	198		688		162		4305	
1945 – 1955	Moss	157	8	5	1	85	5	247	6
	Agriculture	115	59	585	85	143	88	3173	74
	Drained	120	6			58	4	178	4
	Peat cuttings	360	18	15	2	7	0	382	9
	Woodland	83	4	63	9	35	2	181	4
	Urban	75	4	21	3	7	0	103	2
	Total	194		689		162		4264	
1959 – 1977	Moss	102	5			4	0	106	2
	Agriculture	121	61	585	85	143	88	3241	75
	Drained	132	7			99	6	231	5
	Peat cuttings	295	15			6	0	301	7
	Woodland	136	7	72	10	45	3	253	6
	Urban	105	5	32	5	35	2	172	4
	Total	198		689		162		4304	
1973 – 1978	Moss	5	0			6	0	11	0
	Agriculture	125	63	590	85	145	89	3297	76
	Drained	144	7			84	5	228	5
	Peat cuttings	205	10			2	0	207	5
	Woodland	279	14	67	10	49	3	395	9
	Urban	111	6	32	5	35	2	178	4
	Total	199		689		162		4316	

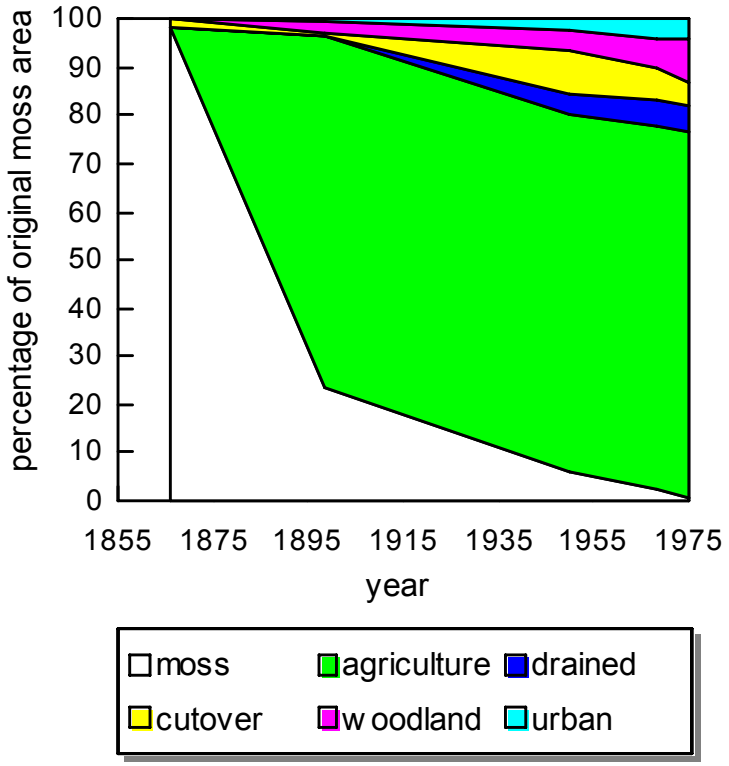
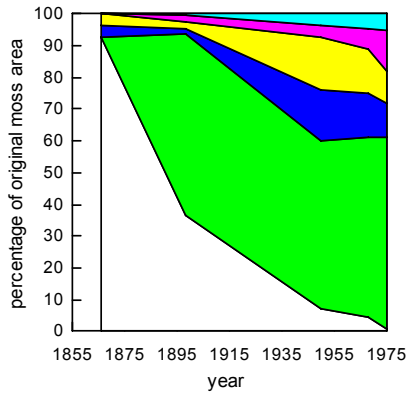


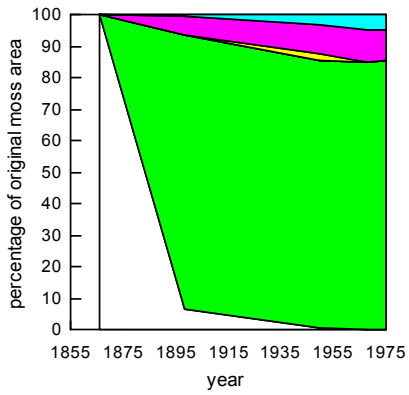
Figure 3. Summary of the sequence of land use changes on raised mires in the Lancashire Lowlands study area between the mid-19th century and the 1970s.

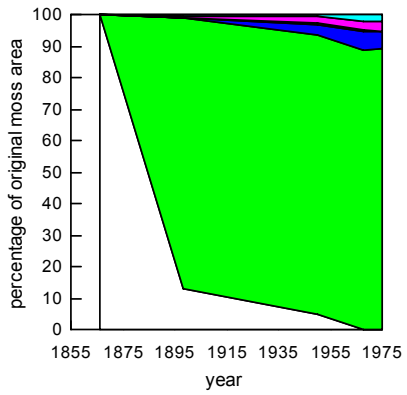
Left: time series of changes, expressed as percentages of the total raised mire area.

Below: time series data for each of the three groups of sites in the Lancashire Lowlands.

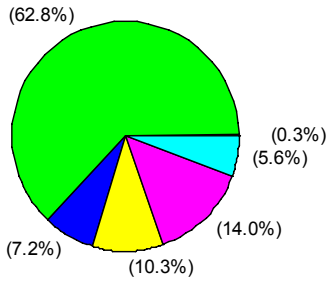
Bottom row: pie charts showing the fraction of the original raised mire area under each land use at the final survey date in the 1970s.

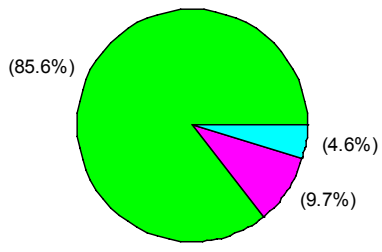


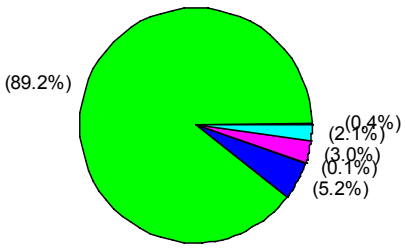




MERSEY (1987 ha)	SOUTHPORT (689 ha)	WYRE (1628 ha)







3.1.1 The Mersey Mosses

In 1845, 1912 hectares of unmodified mossland, in three distinct units, lay between the Glaze Brook and the River Mersey (Figure 4). Chat Moss in particular already bore distinct signs of man's activities; it was crossed by the Liverpool and Manchester railway, and substantial parts of it, in addition to the 75 hectares of peat cuttings included in the survey, were devoted to other land uses.

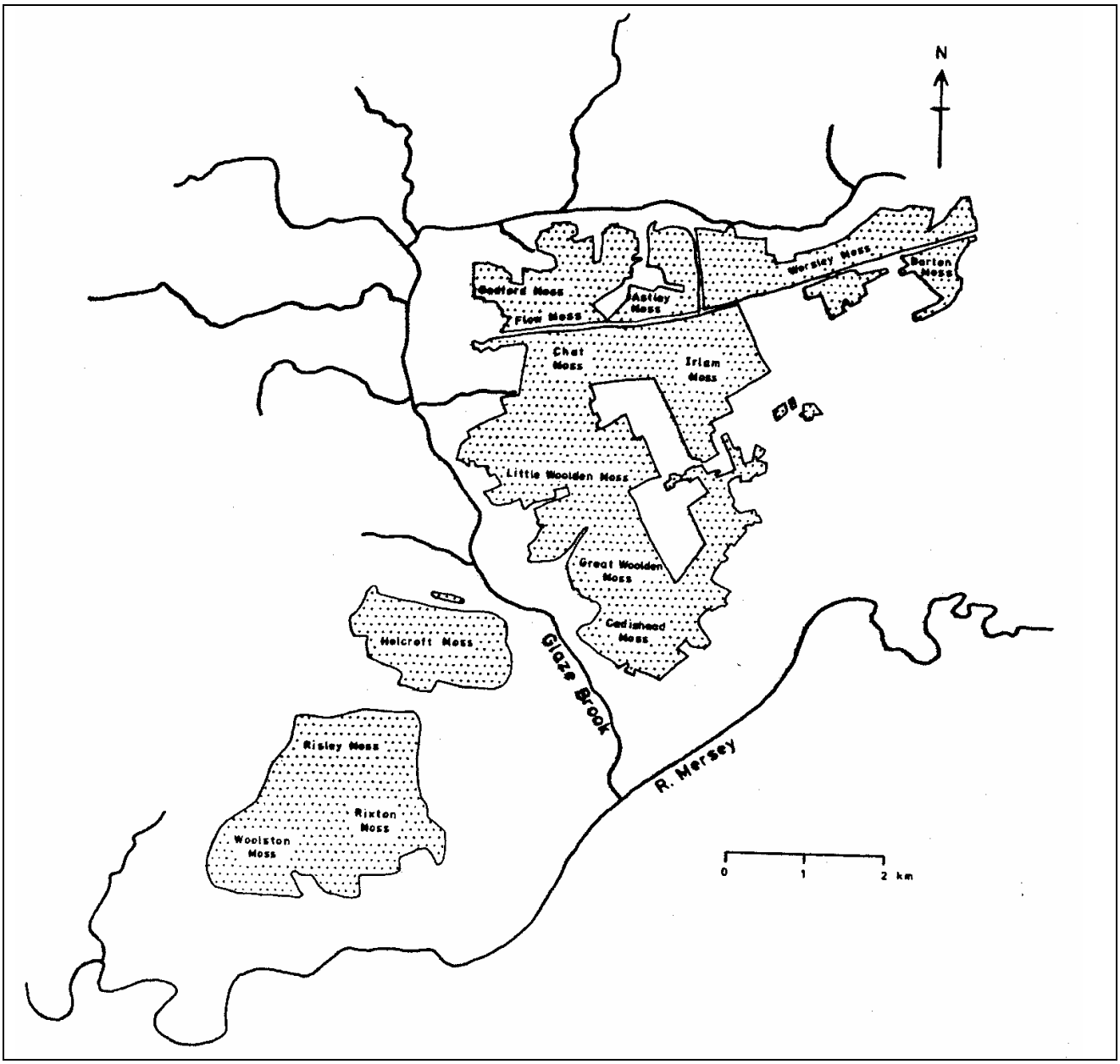


Figure 4. The Mersey Mosses, surveyed in 1845.

During the latter half of the nineteenth century, 1153 hectares (58%) were converted to agricultural use, and a further 48 hectares became wooded. These changes were accompanied by a small decline in the area of peat cuttings, but they occurred mostly at the expense of the moss area. Subsequent agricultural expansion was much slower, however, increasing by only 5% between the 1890s and 1978.

Around the beginning of the 20th century, this area became one of the centres of the Lancashire peat industry. Two companies, based near Glazebury, operated peat fields on Chat Moss, Risley Moss and Rixton Moss (Taylor & Alexander 1954). The data in Table 1 are not entirely consistent with this account, since they indicate that new areas of peat cutting, totalling 320 hectares, had appeared by 1945 on Chat and Holcroft Mosses but not on Risley Moss (which includes Rixton Moss). This may indicate some inconsistency in site boundary definitions between the two accounts, but it seems more likely that some peat cuttings were mis-identified as drained moss and *vice versa* during interpretation of the 1945 air photographs. However, parts of all three sites had been drained at this stage, and urban development was also recorded.

The cut area declined after 1945, and on Holcroft Moss apparently reverted in part to mossland. However, in general, expansion of agriculture, woodland, and urban developments continued, on both cutover and undisturbed areas, throughout the 1960s. Then, during the final period of the survey the area of woodland suddenly doubled, apparently obliterating all but the last few hectares of open moss.

Thus, in 1978, only 5 hectares (of Chat Moss), representing 0.25% of the mire area at the beginning of the survey, remained intact. The major land use was agriculture (63%); and of the rest of the area, any part which had not been cut, drained or built upon, was wooded.

3.1.2 The Southport Mosslands

The extent of intact peatland at the beginning of the survey is shown in Figure 5. Although originating from the largest block of peatland shown in Figure 1, the total area of moss at this stage was only 689 hectares, making this the smallest of the Lancashire groups (Table 1). The outlines of all eight sites indicate that substantial reclamation had occurred before 1845, and that Martin Mere had already been reduced to a ring of isolated fragments.

Apart from temporary peat cutting on Altcar Moss around 1950, only three land uses – agriculture, woodland and urban development – were recorded subsequently. However, their effects were devastating. Tarleton and Croston Mosses were completely converted, largely to agriculture, during the first survey period; whilst the smallest site, Mere End, became completely wooded. By 1949, only 5 hectares of moss remained, on Martin Mere and Farington Moss; and woodland was spreading across both of these sites by 1977.

Taylor & Alexander (1954) suggest that the quality of peat in this locality is particularly suitable for agriculture because it is composed largely of *Phragmites* remains and thus less 'sour' than the more widespread *Sphagnum* peats. Certainly, reclamation for agriculture during the latter half of the 19th century sealed the fate of the Southport mosses; by 1900 only 89 hectares of moss were not under cultivation, and of this area, 39 hectares were already covered by woodland. Apparently, much of this originated as shelter wood and game coverts, although there is a record of 20 acres of forestry on Plex Moss (Tew 1956, MAFF 1958).

Examination of modern Ordnance Survey maps suggests that the urban development recorded may be accounted for largely by nurseries and glasshouses (e.g. on Tarleton and Lytham Mosses), again emphasising the dominance of agricultural activity on the mosses of the area.

Thus, the final summary of land use for the Southport Mosslands is relatively simple. In 1978, no undisturbed moss remained; 85% of the area included in the study was devoted to agriculture and 5% to 'urban' use, and the remaining 10% was covered by woodland.

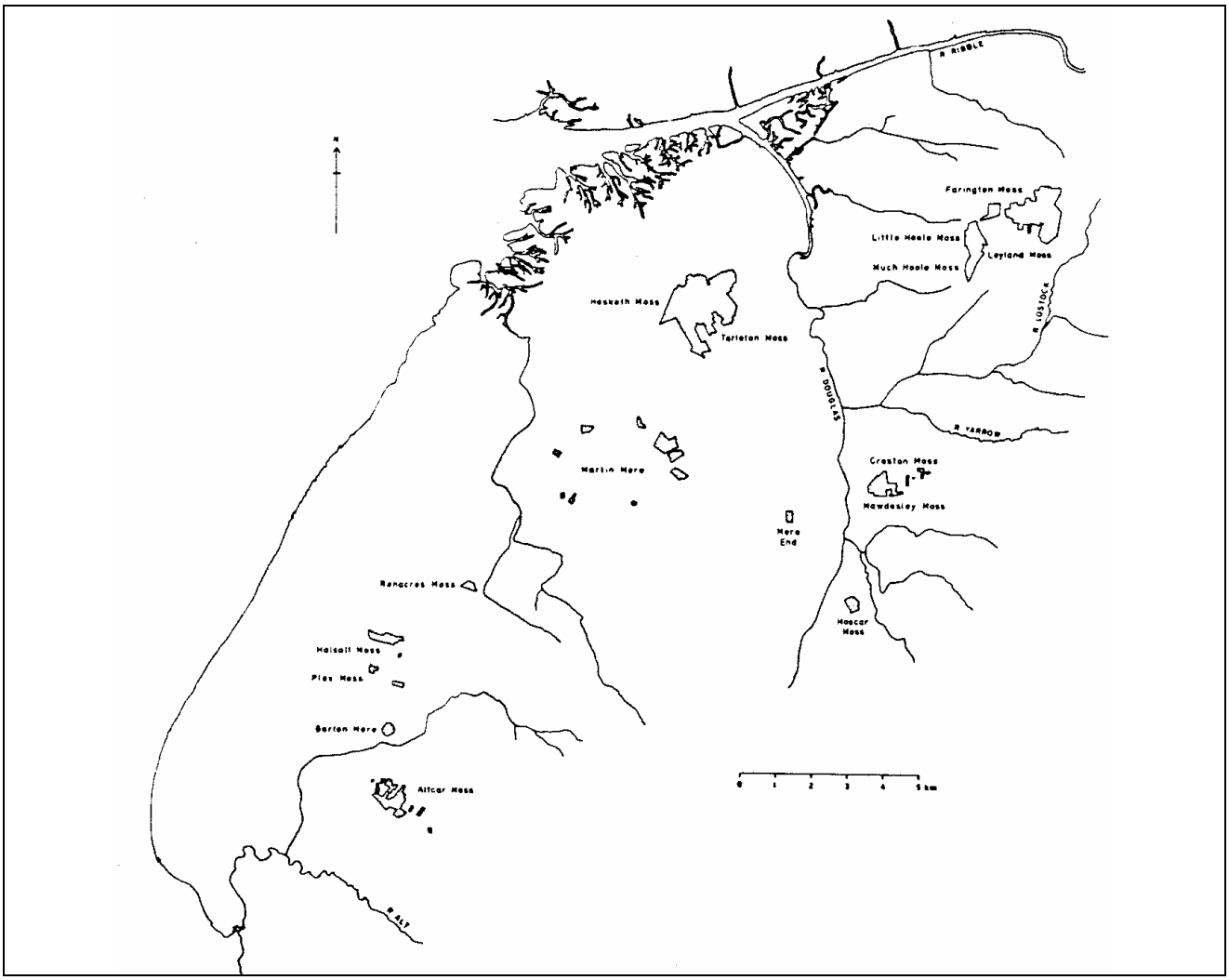


Figure 5: Southport group, surveyed between 1845 and 1848.

3.1.3 Wyre group

The extent of the Over-Wyre mosses in 1845 is shown in Figure 6. In addition to this cluster, four small sites lying to the south of the River Wyre (Sites 12–15) and Heysham Moss (Site 22) (see Figure 2 for locations) are included in the Wyre group.

As in the case of the Southport Mosslands, it is evident from Figure 6 that the large block of peatland from which the Over-Wyre mosses originated (Figure 1) was already fragmented at the beginning of the survey. Pilling Moss apparently 'burst' on 26 January 1744, but the main cause of fragmentation is more likely to have been human activity.

Between 1845 and the end of the century, expansion of agriculture onto mossland was proportionally greater even than in the Southport group. One important human factor in this was the Jenkinson family of Eagland Hill. Mr Jenkinson settled in a turf hut near the centre of Pilling Moss in 1845 and, with his increasingly numerous offspring, was responsible for much of the reclamation which by 1890 had obliterated virtually all of the wold moss in the area (Oldfield 1956). Only Cockerham Moss escaped this fate to retain the only substantial area of unreclaimed moss within the group by 1890 (Table 1).

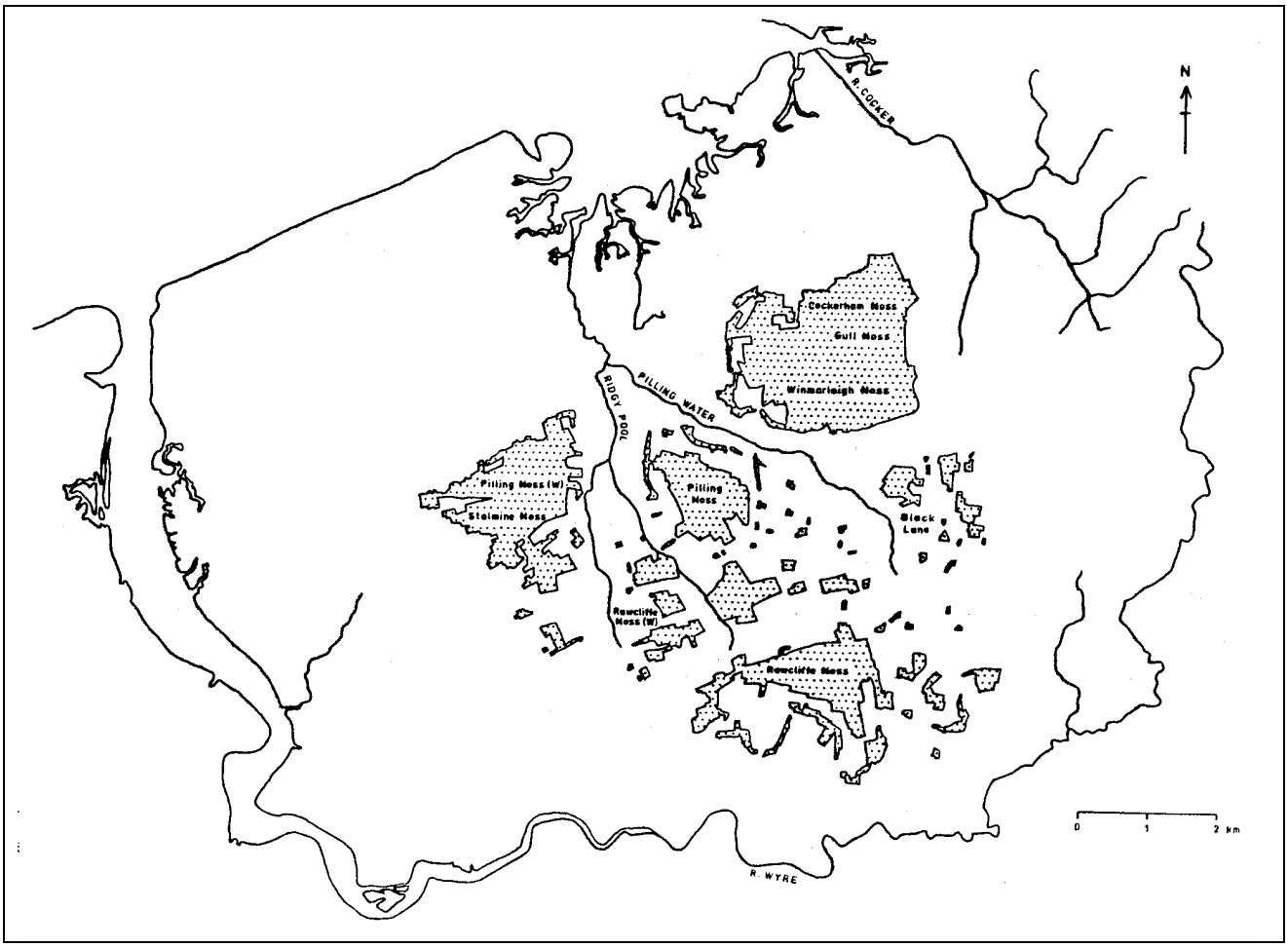


Figure 6. Wyre group, surveyed in 1844–1845.

At this stage, small areas of woodland had appeared on many of the sites. However, woodland never became so abundant as in the Southport group, and the final demise of nine of the eleven sites (Sites 12–20) by 1961 is attributable largely to further expansion of agriculture, and to localised urban development - the latter largely on Great Martin Moss and Carr House Green Common.

Peat cutting does not appear as a significant land use in the survey data. Nonetheless, there is documentary evidence that turbary has long been practiced here; according to Oldfield (1956), most of the Over-Wyre mosses were being cut for fuel in 1890, and in the Pilling/Rawcliffe area the practice still survived in 1958 (MAFF 1958). Perhaps the existence of domestic cuttings was masked by the way in which they were managed; often, areas which had already been taken in for agriculture were cut, producing so-called peat `dales' which were then returned to agricultural use. Nor was the area neglected by commercial peat enterprises. Parts of Cockerham Moss were cut – Winmarleigh Moss by the Fylde Peat Moss Litter Company between 1889 and 1892 (Charnley 1904), and Gull Moss in the early 1900s (Oldfield 1956). The survey data show only drainage on Cockerham Moss, although they do indicate a small amount of peat cutting on Heysham Moss.

In 1978, agriculture remained the major land use of the Wyre mosses, accounting for 89% of the area surveyed. The remainder, excluding 2 hectares of Cockerham Moss and 4 hectares of Heysham Moss (half of which had apprently reverted to its `wild' state since 1961), had been drained or cut, or was covered by buildings and woodland.

3.2 South Cumbria

The study area covers the series of clay- and silt-covered raised beaches which fringe the northern shore of Morecambe Bay and extends into the valleys of the rivers Duddon, Leven and Kent (Hall & Pollard 1970, Thomas 1972). The 37 sites included in the study (Figure 7) are concentrated in these three valleys; accordingly they are described as three groups, namely:

- Duddon (sites 1–12), including the three westmost sites on the Irish Sea coast and the isolated Leece Mosses (Sites 1–3 and 12) but dominated by the bogs which lie at the head of the Duddon Sands, namely Shaw Moss, Low Moss and the so-called Broughton Mosses (Sites 6–11);

- Leven (sites 13–21); and

- Kent (sites 22–37), including the mosses of the Winster and Lyth valleys (sites 22–35) and two sites (36–37) in the Hawes Water area, to the south of the Kent estuary.

As in the Lancashire Lowlands (Section 3.1), human activity on the South Cumbrian mosslands long preceded the beginning of the survey. Possibly the first attempts at drainage were made by Norse settlers between 900 and 1300 A.D., and there is plentiful evidence of later agriculture and peat extraction. However, the area remained isolated from the industrial part of Lancashire until the 19th century, which saw the opening of the Levens bridge over the River Kent in 1820, and of the Furness railway, which follows the coast westwards and northwards from Carnforth to Carlisle, in 1857 (Thomas 1972). The railway track crosses several of the mire sites, including The Mosses, Shaw Moss and Wreaks Moss (Sites 1, 4 and 6 in Figure 7).

Land use data for individual sites over the period of the survey are shown in Table 3, and are summarised for the three groups in Table 4. Figure 8 gives a graphical summary.

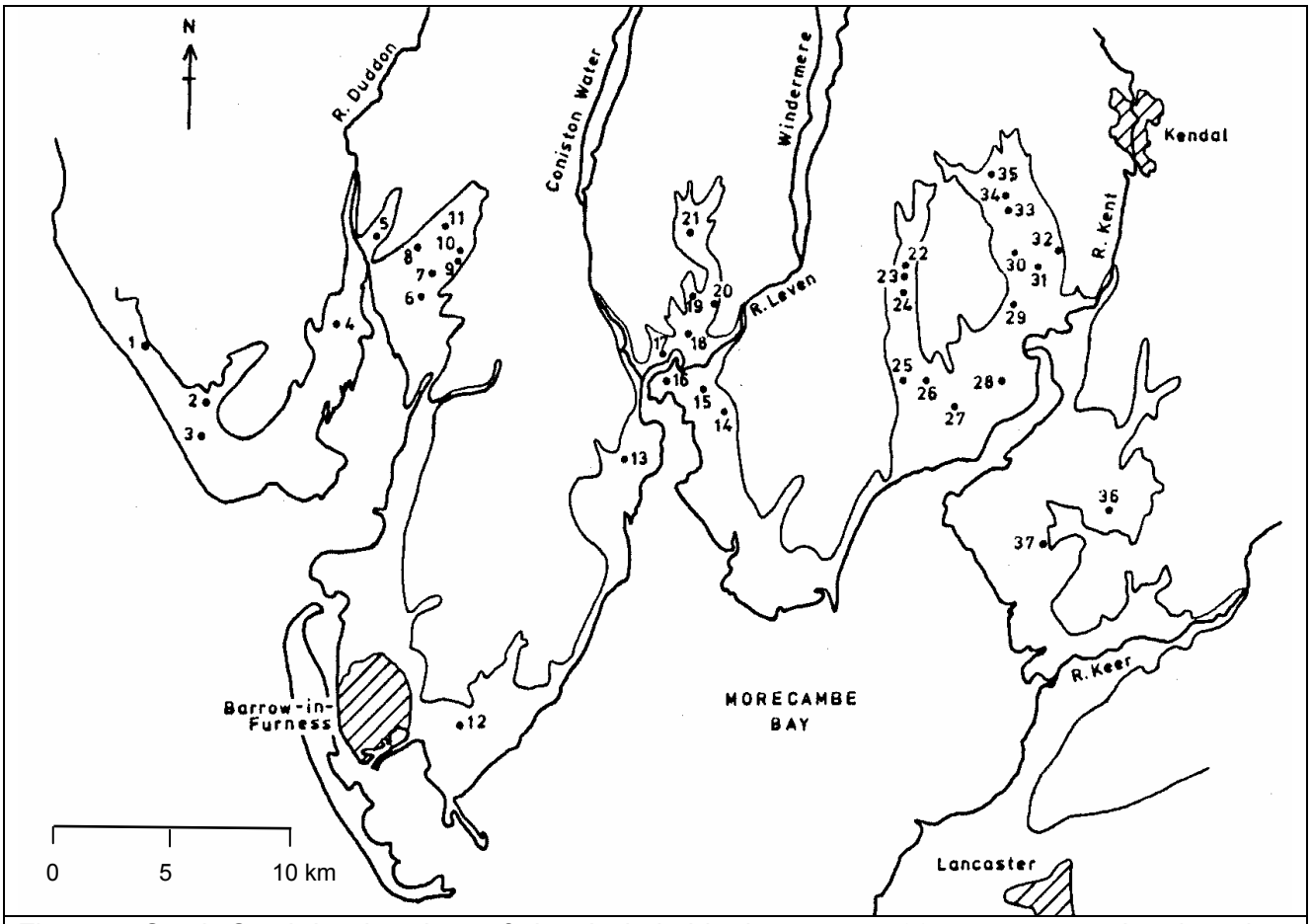


Figure 7: South Cumbria : locations of sites included in the survey. 30 m contour and major urban areas also shown. Key to sites:

1	The Mosses	13	Newland Moss	25	Low Green
2	Arrow Moss	14	Stribers Moss [Ellerside Moss, Deanholme Moss, White Moss, Reake Moss]	26	Nichols Moss
3	Kirksanton Moss			27	Meathop Moss [Catcrag Moss]
4	Shaw Moss [Arnaby Moss]	15	Deer Dike Moss [Fish House Moss, Burnbarrow Moss]	28	Foulshaw Moss [Stakes Moss, Bellart How Moss, Ulpha Moss]
5	Low Moss (Broughton)				
6	Wreaks Moss [Angerton Moss, Herd House Moss, Bank End Moss]	16	Meanhouse Moss	29	Rawson's Moss
		17	Roam Moss	30	Lyth Moss [Cowmire Moss]
7	White Moss [Black Moss, Rosthwaite Moss, Broad Fleet, Clay Lake]	18	Ireland Moss [North Ireland Moss, South Ireland Moss]	31	Levens Moss
				32	Park Moss [Quogs Moss]
8	Wall End Moss [Beancroft Moss]	19	Rough Moss [Waste Mires]		
		20	Elmlath Moss [Border Moss]	33	Savinhill Moss
9	Heathwaite Moss	21	Rusland Moss [Hulleter Moss, Hay Bridge Moss, Oxenpark Moss]	34	Cock Moss [Underbarrow Moss]
10	Farside Moss				
11	Row Ridding Latter-Rigg Moss [Thornthwaite Latter-Rigg Moss]			35	Blakebank Moss
		22	Stock Moss	36	Hale Moss [White Moss]
12	Leece Mosses [Stank Moss, Roosecote Moss]	23	High Moss		
		24	Low Moss (Winster)	37	Hawes Water Moss

[names in square parentheses denote mire areas adjacent to the main site, and regarded as part of it in the collation of land use data]

Table 3. South Cumbria: land use areas (ha) for individual sites at each of the five survey dates.

STUDY AREA	SOUTH CUMBRIA																																				
GROUP	DUDDON VALLEY												LEVEN VALLEY									KENT VALLEY															
SITE NUMBER	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37
SITE NAME	The Mosses	Arrow Moss	Kirksanton Moss	Shaw Moss	Low Moss (Broughton)	Wreaks Moss	White Moss	Wall End Moss	Heathwaite Moss	Farside Moss	Row Ridding Latter-Rigg Moss	Leece Mosses	Newland Moss	Stribers Moss	Deer Dike Moss	Meanhouse Moss	Roam Moss	Ireland Moss	Rough Moss	Elmlath Moss	Rusland Moss	Stock Moss	High Moss	Low Moss (Winster)	Low Green	Nichols Moss	Meathop Moss	Foulshaw Moss	Rawson's Moss	Lyth Moss	Levens Moss	Park Moss	Savinhill Moss	Cock Moss	Blakebank Moss	Hale Moss	Hawes Water Moss
SURVEY DATE	1860	1860	1860	1860	1846	1848	1848	1846	1848	1848	1848	1847	1847	1848	1848	1848	1848	1848	1848	1848	1848	1848	1848	1848	1848	1858	1858	1858	1858	1858	1858	1858	1858	1858	1857	1845
Moss	23	4	12	64	3	229	80	13	31	6	29	24	27	247	124	17	34	40	6	24	56	6	6	3	4	63	82	318	10	3	7	36	21	23	7	71	18
Drained moss															16																						
SURVEY DATE	1897	1888	1898	1898	1888	1889	1889	1889	1889	1889	1889	1890	1889	1889	1889	1889	1889	1889	1889	1889	1889	1889	1889	1889	1890	1897	1897	1897	1897	1897	1897	1897	1897	1897	1897	1889
Moss	17	4	3	49		189	45	3	30	4	24	18	14	174	113	9	19	21		8	38	6	3	3	1	60	64	295	7	1	4	14	17	18	5	33	15
Agriculture	6		9	15	3	40	35	10	1	2	5	6	12	48	9		15	14	2	16	2		3		2	2	12	19	3	2	3	21	4	4	2	34	2
Drained moss															7																						
Woodland														25	11	9		5	4		16				1	1	6	4				1		1		3	
Urban													1																							1	1
SURVEY DATE	1945	1945	1945	1945	1951	1947	1951	1951	1947	1951	1951	1945	1945	1945	1945	1945	1951	1951	1948	1948	1948	1947	1947	1947	1951	1950	1950	1950	1945	1945	1945	1945	1945	1948	1951	1945	1945
Moss	3	4	1	3		70	38	1	10	4	21	12	11	93	1	3	4	20			25					56	50	36				5	4	10	4		5
Agriculture	9		11	8	1	30	36	5	3	2	7	12	8	57	10	9	17	13	6	17	16		3	3	4	2	12	50	7	3	2	20	12	5	3	55	10
Drained moss	10												8	50	122						12	5	2			4	10	207								5	
Peat cuttings				43		120			17					24														1								2	
Woodland				10	2	9	6	6	1		1			23	7	5	13	7		6	3	1	1			1	10	24	2		4	11	5	8	1	8	2
Urban	1																												1		1					1	1

(Table 3 continuation)

STUDY AREA	SOUTH CUMBRIA																																			
GROUP	DUDDON VALLEY												LEVEN VALLEY									KENT VALLEY														
SITE NUMBER	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37
SITE NAME	The Mosses	Arrow Moss	Kirksanton Moss	Shaw Moss	Low Moss (Broughton)	Wreaks Moss	White Moss	Wall End Moss	Heathwaite Moss	Farside Moss	Row Ridding Latter-Rigg Moss	Leece Mosses	Newland Moss	Stribers Moss	Deer Dike Moss	Meanhouse Moss	Roam Moss	Ireland Moss	Rough Moss	Elmlath Moss	Rusland Moss	Stock Moss	High Moss	Low Moss (Winster)	Low Green	Nichols Moss	Meathop Moss	Foulshaw Moss	Rawson's Moss	Lyth Moss	Levens Moss	Park Moss	Savinhill Moss	Cock Moss	Blakebank Moss	Hale Moss	Hawes Water Moss
SURVEY DATE	1970	1970	1970	1970	1974	1972	1972	1972	1972	1972	1972	1970	1970	1974	1974	1974	1974	1974	1974	1974	1975	1974	1974	1974	1974	1970	1970	1970	1970	1970	1970	1971	1971	1971	1971	1971
Moss	3	3		12		48	8	1	4			4	5	16	10			2								31	10	10					4	3	1		
Agriculture	9	1	12	19	1	62	51	6	2	4	10	19	11	59	13	7	21	10	6	17	3	6	6	3	4	6	13	29	7	3	3	20	6	5	1	36	12
Drained moss	10					7							11	9	4																					
Peat cuttings				11		101			25	2	15			41	68																					
Woodland				21	2	11	21	6			4	1		121	44	10	13	28		6	53					24	59	24	3		4	15	11	15	5	34	6
Forestry																												255								
Urban	1													1	1																				1	1
SURVEY DATE	1976	1978	1978	1976	1978	1976	1976	1976	1976	1976	1976	1976	1976	1975	1978	1978	1978	1978	1978	1978	1978	1978	1978	1978	1978	1978	1978	1978	1978	1978	1978	1978	1978	1978	1974	1978
Moss	3	3		12		29	8		13			4	5	16	10											31	10	10					2				
Agriculture	9	1	12	19	1	93	52	7	2	6	28	19	11	59	13	7	21	16	6	17	3	6	6	3	4	6	13	29	7	3	3	20	6	5	1	40	12
Drained moss	10					7							11	9	4			2																			
Peat cuttings				11		69			13					41	68																					
Woodland				21	2	31	20	6	2		1	1		121	44	10	13	22		6	53					24	59	24	3		4	15	13	18	6	30	6
Forestry																												255								
Urban	1													1	1																				1	1

Table 4. South Cumbria: summary of land use data for total mire area, and for each of the descriptive groups.

Survey date	Land use	GROUP						TOTAL AREA	
		Duddon		Leven		Kent			
		ha	%	ha	%	ha	%	ha	%
1845 – 1860	Moss	518	100	575	97	678	100	1771	99
	Drained moss			16	3			16	1
	Total			591				1787	
1888 – 1898	Moss	386	75	396	67	546	81	1328	74
	Agriculture	132	25	118	20	113	17	363	20
	Drained moss			7	1			7	0
	Woodland			70	12	17	3	87	5
	Urban			1	0	2	0	3	0
	Total	518		592		678		1788	
1945 – 1951	Moss	167	32	157	27	170	25	494	28
	Agriculture	124	24	153	26	191	28	468	26
	Drained moss	10	2	192	33	233	34	435	24
	Peat cuttings	180	35	24	4	3	0	207	12
	Woodland	35	7	64	11	78	11	177	10
	Urban	1	0			4	1	5	0
	Total	517		590		679		1786	
1970 – 1975	Moss	83	16	33	6	59	9	175	10
	Agriculture	196	38	147	25	160	24	503	28
	Drained moss	17	3	24	4			41	2
	Peat cuttings	154	30	109	18			263	15
	Woodland	66	13	275	47	200	30	541	30
	Forestry					255	38	255	14
	Urban	1	0	2	0	2	0	5	0
	Total	517		590		676		1783	
1974 – 1978	Moss	72	14	31	5	53	8	156	9
	Agriculture	249	48	153	26	164	24	566	32
	Drained moss	17	3	26	4			43	2
	Peat cuttings	93	18	109	18			202	11
	Woodland	84	16	269	46	202	30	555	31
	Forestry					255	38	255	14
	Urban	1	0	2	0	2	0	5	0
	Total	516		590		676		1782	

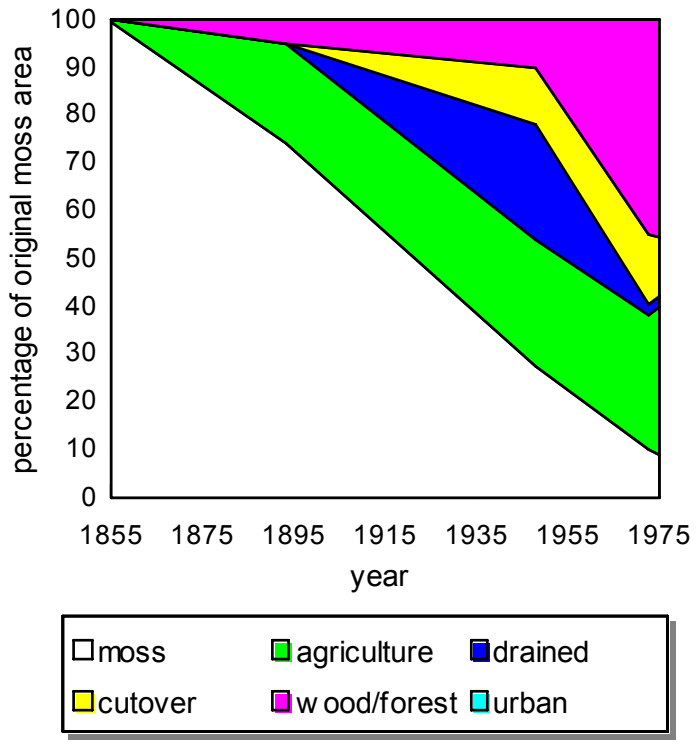
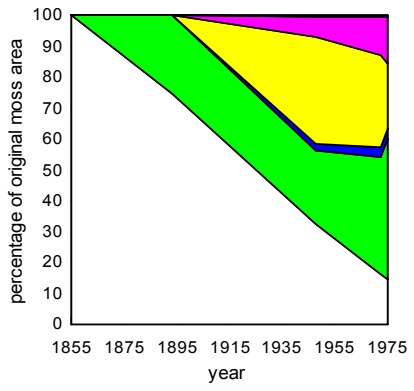


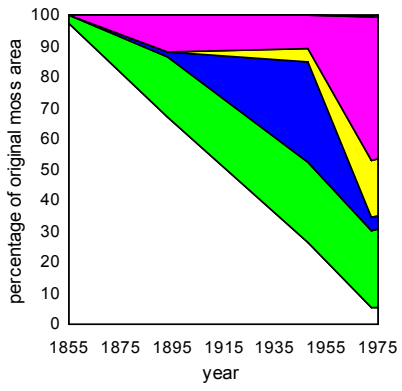
Figure 8. Summary of the sequence of land use changes on raised mires in the South Cumbria study area between the mid-19th century and the 1970s.

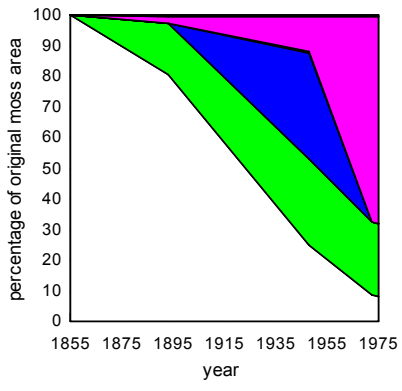
Left: time series of changes, expressed as percentages of the total raised mire area.

Below: time series data for each of the three groups of sites in South Cumbria.

Bottom row: pie charts showing the fraction of the original raised mire area under each land use at the final survey date in the 1970s.



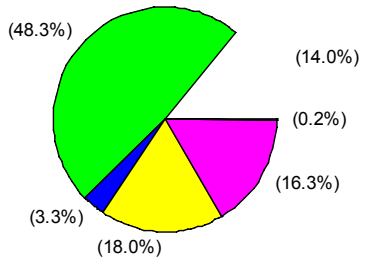


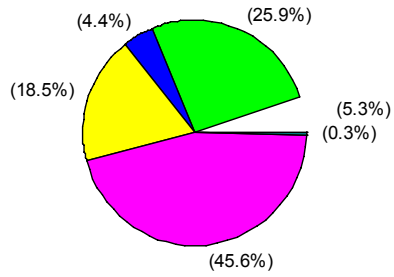


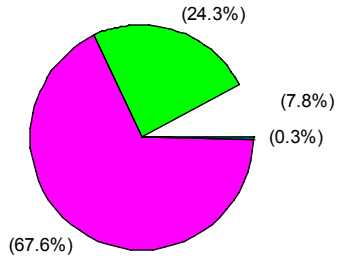
DUDDON VALLEY (518 ha)

LEVEN VALLEY (575 ha)

KENT VALLEY (678 ha)







3.2.1 Duddon Valley

The extent of the central Duddon Valley mosses at the beginning of the survey is shown in Figure 9. Four outlying sites (numbers 1–3 and 12 in Figure 7) are not shown on this map.

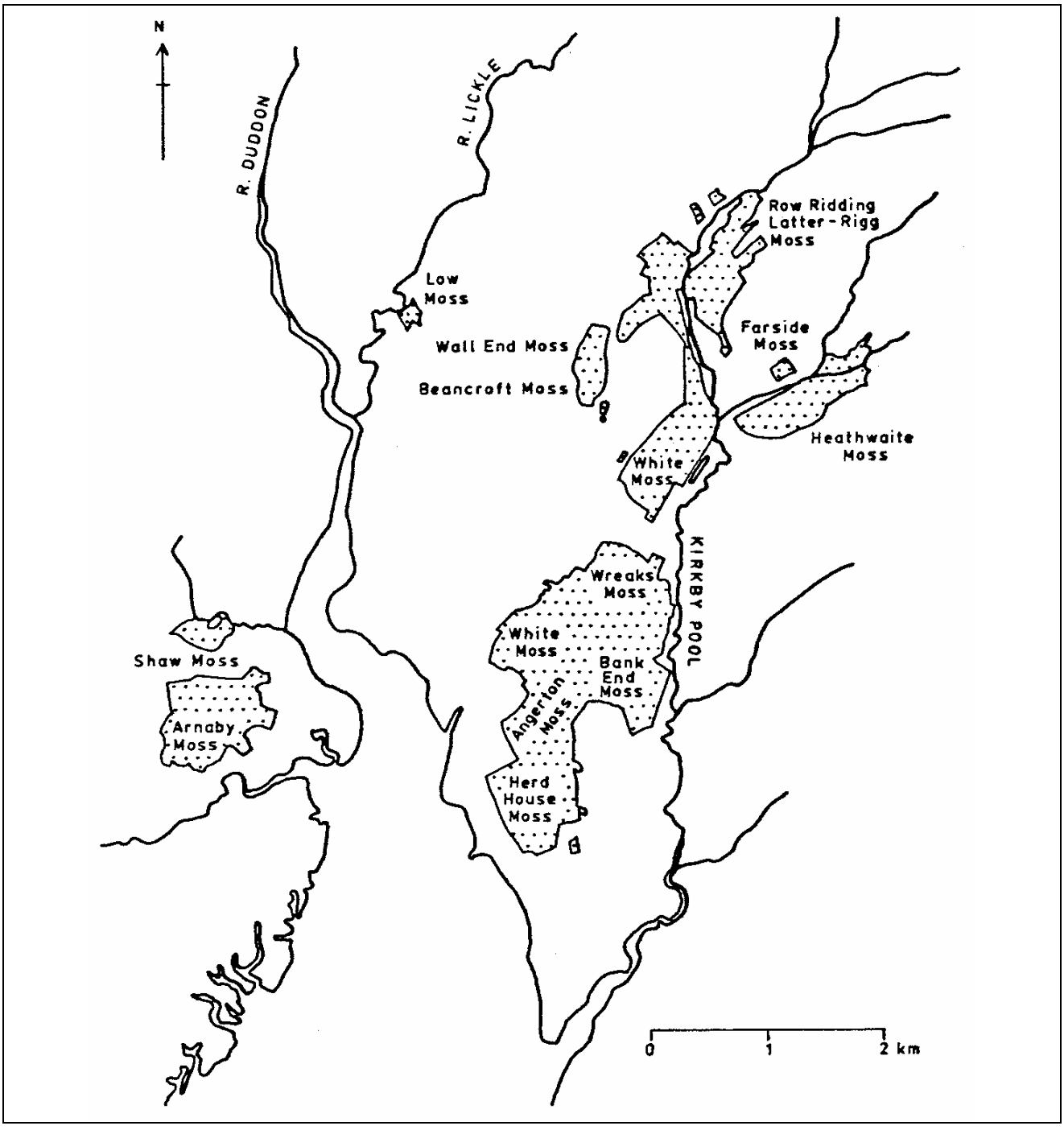


Figure 9: Duddon valley: Shaw Moss, Low Moss and the Broughton Mosses, 1846–1860.

During the latter half of the ninteenth century, the only land use changes recorded were from undisturbed moss to agriculture. Although cultivated areas appeared on all but one of the sites (Arrow Moss; see Table 3), reclamation was much less intensive than in the Lancashire Lowlands,

accounting for only 25% of the moss area before the end of the century. This comparative lack of agricultural interest may be attributed to the considerable problems of wet climate, poor drainage and remoteness from markets suffered by the region in general (MAFF 1958).

After 1900, peat cutting became a significant land use in the area. Cutting was recorded on Shaw and Wreaks Mosses, and later on Heathwaite Moss, from where it spread briefly onto two adjacent sites around 1970. On Shaw Moss, part of the cut area appears to have reverted to moss after 1950. Parts of The Mosses and Wreaks Moss were also drained during this period, and one hectare of 'urban development' appeared on The Mosses.

Woodland was not recorded until 1945, and then was confined to the central part of the group. The MAFF survey of 1958 mentions 16 acres of "estate woodland" on Wall End Moss and 16 acres of "shelter belts and game coverts" elsewhere in the valley. Although woodland continued to expand thereafter, it never appeared on the three westmost sites, and tree cover was comparatively low even at the end of the survey (16% as opposed to 31% for the whole study area).

Agriculture underwent a second expansion after 1951, and by 1978 the area under cultivation was almost double that at the start of the century. The increase was fairly general throughout the group, involving renewed activity on Arrow Moss where no land had been taken in since the beginning of the survey, and was the final land use of three complete sites - Kirksanton, Farside and Row Ridding Latter-Rigg Mosses. This activity may be associated with drainage improvements, and particularly with installation of tidal gates on the Galloper Pool between 1954 and 1958 (MAFF 1958).

At the end of the survey, nearly half of the mossland area was devoted to agriculture, 18% had been cut, 3% drained, and 16% was covered by woodland. 72 hectares of undisturbed moss remained, and this was made up of fragments of 3–29 hectares on seven of the twelve sites.

3.2.2 Leven Valley

The extent at the beginning of the survey of the Leven Valley mosses is shown in Figure 10. At this stage, they covered a total area of 591 hectares, which included 16 hectares of drained moss on Deer Dike Moss.

Woodland had appeared on six of the nine sites by 1889. Agriculture accounted for only 20% of the area at the turn of the century, but continued to expand slowly until after the Second World War. At this stage, large areas of newly drained moss appeared, particularly on Deer Dike Moss, although peat cutting on this site and on Stribers Moss did not reach its peak until the 1970s.

After 1950, a sharp decline in the drained area was more than matched by expansion of woodland, partly onto drained areas and partly onto previously undisturbed moss, so that by 1970 there was substantial tree cover on all but two sites. In the case of Rusland Moss, there is evidence to suggest that this increase was largely spontaneous, perhaps originating from 150-year-old pinewood (possibly planted) at the north of the site (McCarthy 1964).

By the end of the survey, 46% of the Leven valley moss area was covered by woodland. Substantial areas of agriculture (26%) and peat cutting (18%), and a small area of drained moss (4%) accounted for all but 31 hectares of the remainder. Parts of Newland, Stribers and Deer Dike Mosses remained undisturbed, although most of the 10 hectares of 'moss' recorded for the latter site appears to have recovered to this condition between 1945 and 1974.

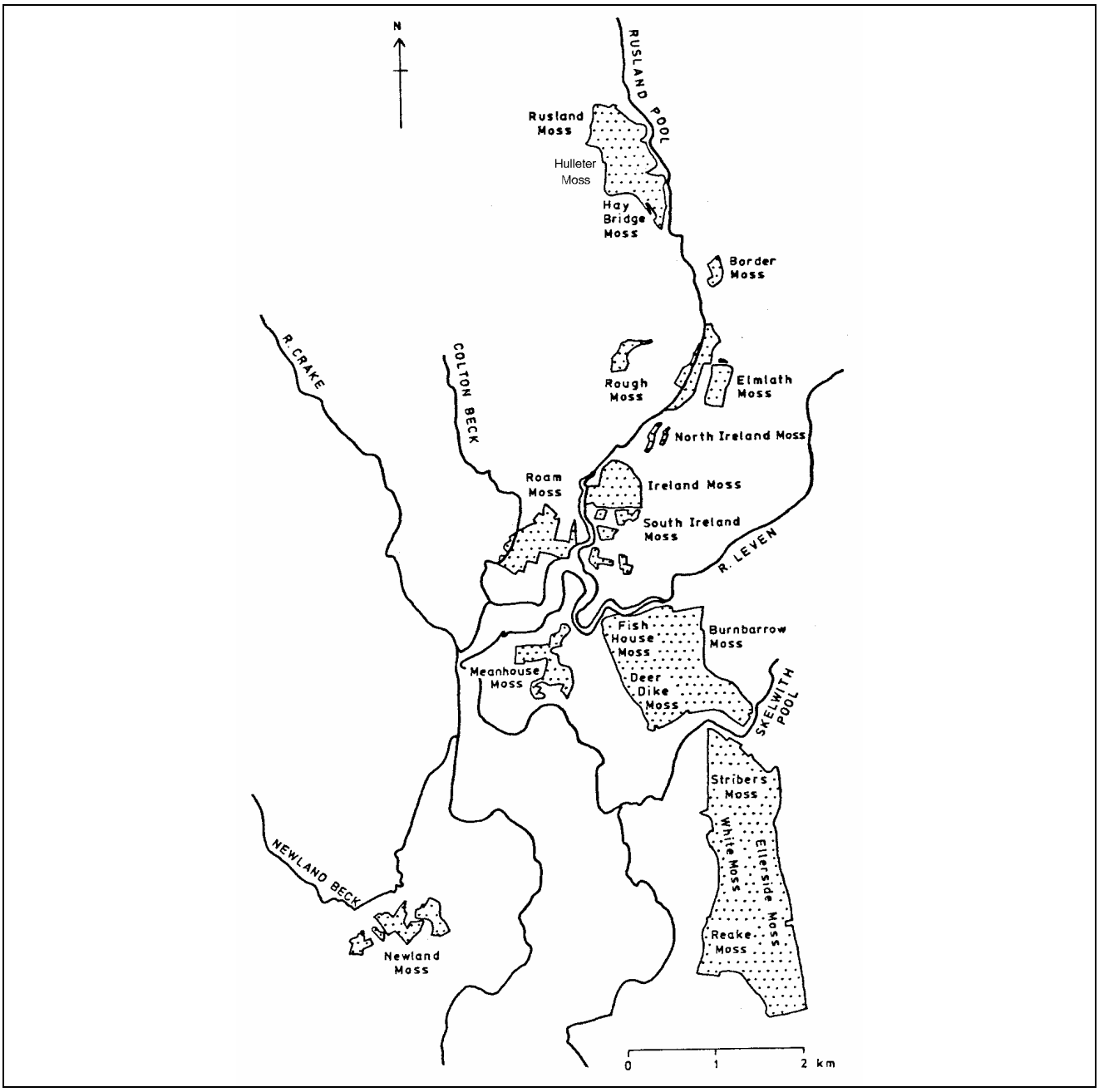


Figure 10. Extent of the Leven Valley mosses in 1847–1848.

3.2.3 Kent Valley

The extent of the Kent Valley sites (excluding Hale and Hawes Water Mosses) at the beginning of the survey is shown in Figure 11.

Here, agricultural use during the latter half of the 19th century was less than in either of the other two groups although, as in the Leven valley, it continued to expand until around 1950. At the turn of the century, woodland cover was less than in the Leven valley. Subsequently, woodland increased, large areas were drained, and peat cuttings appeared on two sites so that the land use data for the two groups were very similar by 1950.

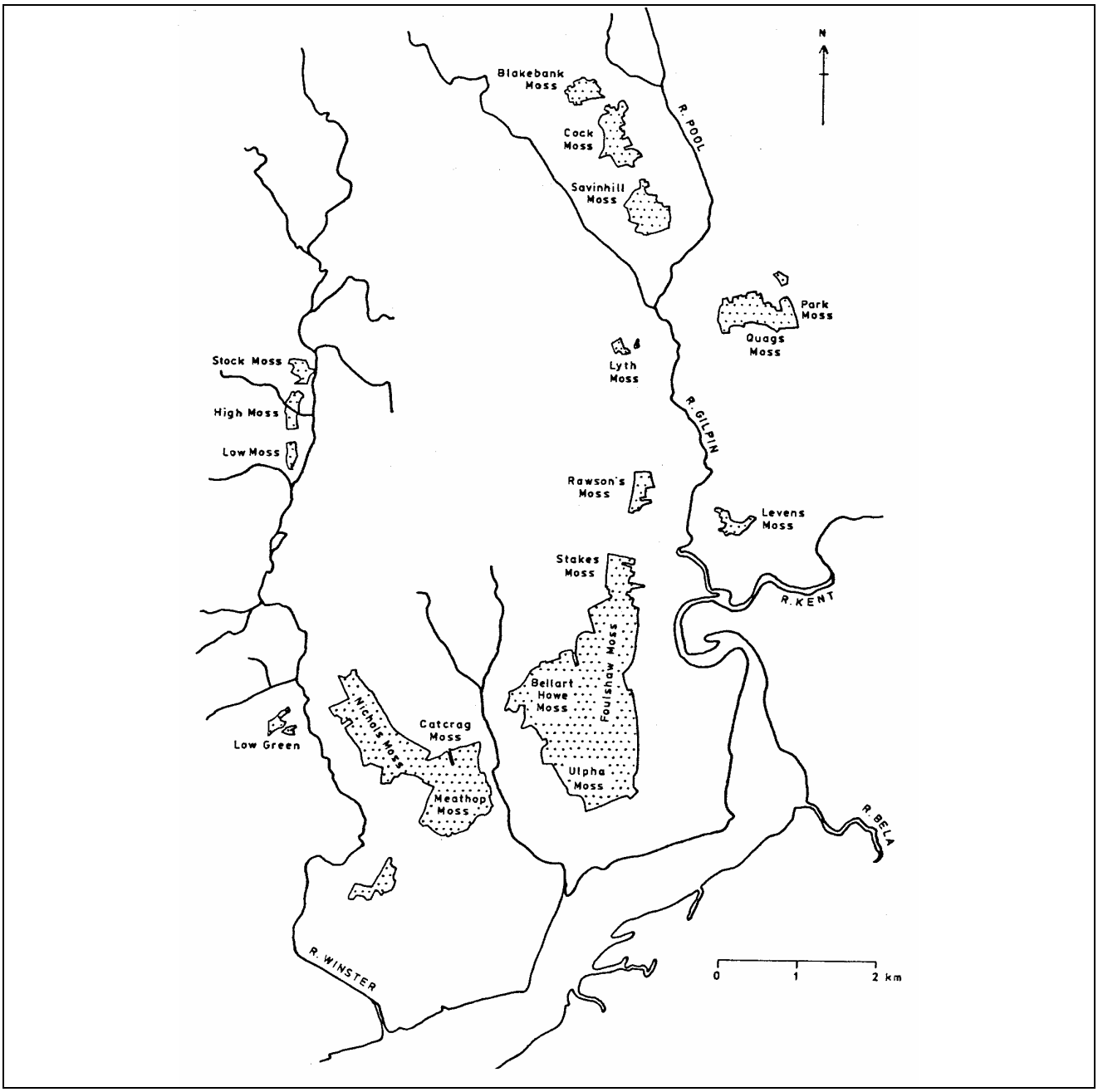


Figure 11. Extent of 14 of the 16 the Kent Valley Mosses in 1848–1858.

Then, the peat cuttings disappeared and the large drained area on Foulshaw Moss was afforested. On most other sites, woodland continued to expand. This appears to have occurred in part in conjunction with a decline in the area devoted to agriculture, for example on Hale Moss, although untilled areas also became wooded. The exceptions were Lyth Moss and the four Winster valley mosses, which were small sites that had already been completely devoted to agriculture.

By 1978, only parts of the three largest sites (Nichols, Meathop and Foulshaw Mosses) and 2 hectares of Savinhill Moss, remained intact. 68% of the total area was tree-covered – more than half of this being accounted for by the forestry plantation on Foulshaw Moss – and 24% was devoted to agriculture.

3.3 Solway

The Solway study group comprises 38 mire sites, which overlie warps and boulder clay (Stamp 1943a,b; Marshall 1961) on both the south and north sides of the Solway Firth (Figure 12). It includes 16 sites in England and 22 in Scotland.

As early as the 13th century, it was an offence to fell trees or to cut peat on the Solway mosslands, for fear of destruction of the King's deer. Moreover, life in this border area was unsettled until long after the 1745 Rebellion; a notable event in the history of the area was the Battle of Solway Moss in 1542, when the forces of Henry VIII drove back supporters of James V of Scotland (Fraser 1969). Thus, the mires of the Solway remained largely unaltered until fairly recent times. Many of them were densely wooded; in the 17th century, trees from Wedholme Flow were used exclusively for repair of the Skinburness sea dike. They were also undrained, and on 16 December 1771 Solway Moss "irrupted" (Walker 1772), the overflow allegedly forming Rosetrees Moss.

Enclosure began in northern Cumberland around 1790, and in Dumfriesshire 10 years later. During the following 60 years some reclamation was carried out. The methods employed were construction of drainage ditches and consolidation of the peat by application of sand, clay and lime. However, this was achieved in piecemeal fashion, producing only small areas of arable land and pasture. In 1900 the peatlands were still largely under common ownership and regarded as agricultural wasteland, useful only as sources of fuel (Marshall 1961).

The land use histories of individual sites from the mid 19th century are shown in Table 5. For descriptive purposes, the sites are divided geographically into three groups as follows:

- Wampool (Sites 1–11);
- Gretna (Sites 12 – 19); and
- Dumfries (Sites 20 - 38).

Table 6 and Figure 13 summarise the land use data for these three groups, and the history of each group is discussed below.

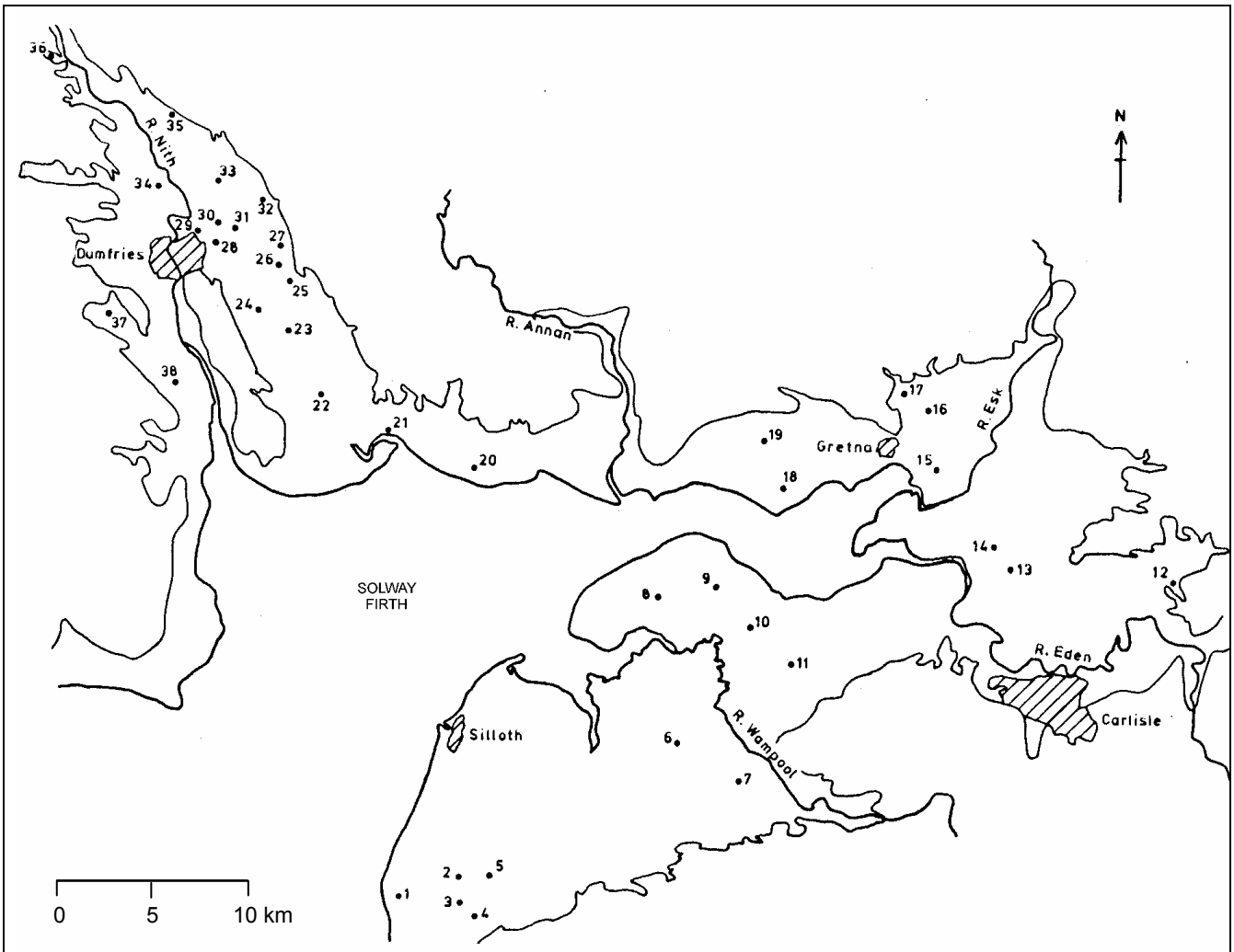


Figure 12. Solway: locations of sites included in the survey. 30 m contour and major urban areas also shown. Key to sites:

1	Salta Moss	15	Rosetrees Moss	27	Redhills Moss
2	Hangingshaw Moss	16	Solway Moss	28	Town's Moss
3	Chapel Moss	17	Newton Flow	29	Black Loch
4	Cowpar Bog	18	Westhills Moss	30	Sand Loch
5	Cockley Moss	19	Nutberry Moss [Dornock Flow, White Moss]	31	Carnsalloch Moss [Dargavel Moss, Downs Moss]
6	Wedholme Flow				
7	Oulton Moss	20	Priestside Flow	32	Steel Moss
8	Bowness Common	21	Lochar Moss (east)	33	Mossdale
9	Glasson Moss	22	Longbridge Muir [Ironhurst Moss, Holmhead Moss, Cockpool Moss, Stank Moss]	34	Black Moss
10	Drumburgh Moss [Fingland Moss, Whitriggles Moss]			35	Lightwater Moss [Hassock Moss]
11	Little Bampton Moss	23	Racks Moss	36	Moss Plantation
12	White Moss	24	Craigs Moss	37	Drungans Moss
13	Harker Moss	25	Greenlea Moss	38	Kirkconnell Flow
14	Rockcliffe Moss [Whitehill Moss]	26	Collin Moss		

[names in square parentheses denote mire areas adjacent to the main site, and regarded as part of it in the collation of land use data]

Table 5. Solway: land use areas (ha) for individual sites.

STUDY AREA	SOLWAY																																			
GROUP	WAMPOOL											GRETNA								DUMFRIES																	
SITE NUMBER	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38
SITE NAME	Salta Moss	Hangingshaw Moss	Chapel Moss	Cowper Bog	Cockley Moss	Wedholme Flow	Oulton Moss	Bowness Common	Glasson Moss	Drumburgh Moss	Little Bampton Moss	White Moss	Harker Moss	Rockcliffe Moss	Rosetrees Moss	Solway Moss	Newton Flow	Westhills Moss	Nutberry Moss	Priestside Flow	Lochar Moss (East)	Longbridge Muir	Racks Moss	Craigs Moss	Greenlea Moss	Collin Moss	Redhills Moss	Town's Moss	Black Loch	Sand Loch	Carnsalloch Moss	Steel Moss	Mossdale	Black Moss	Lightwater Moss	Moss Plantation	Drungans Moss	Kirkconnell Flow
SURVEY DATE	1865	1865	1865	1865	1866	1866	1865	1866	1866	1865	1865	1866	1864	1865	1864	1864	1858	1857	1857	1856	1856	1856	1856	1856	1856	1856	1856	1855	1855	1855	1855	1856	1855	1855	1855	1856	1850	1850
Moss	52	12	3	4	15	761	53	821	202	194	55	32	11	120	1	362	20	18	237	175	13	990	457	393	16	23	54	7	6	10	244	2	9	15	14	1	106	163
SURVEY DATE	1899	1899	1899	1899	1899	1901	1899	1899	1899	1899	1899	1899	1899	1899	1899	1900	1898	1898	1898	1898	1899	1899	1899	1899	1899	1899	1899	1899	1899	1899	1899	1899	1899	1899	1899	1899	1893	1899
Moss	52	12	3	4	13	679	36	757	189	178	33	32	10	81	1	354	19	18	197	115	7	947	449	372	11	22	13			5	206	2	8	15	5		16	117
Agriculture					2	57	10	51	12	13	8			13			1		50	58	2	16	8	17	5	1	41	4			26		1		1	1	84	17
Woodland						25	7	2	1	3	13		1	26		8				2	3	27		4				3	6	5	12				7		6	29
Urban								11																														
SURVEY DATE	1949	1949	1949	1949	1949	1949	1949	1951	1951	1951	1946	1951	1951	1951	1952	1946	1946	1946	1946	1946	1947	1947	1946	1946	1946	1946	1946	1946	1962	1946	1946	1946	1946	1953	1953	1953	1947
Moss		8		4		292	11	501	103	104	11	22	4	56		58			92	26		549	340	110	4	2					13		7	4	4		10	59
Agriculture	13	4	3		15	132	24	49	6	20	14	2		21	1	7	3	1	35	67	2	51	13	37	6	4	40	7			31		1	1	1	1	84	25
Drained moss						44	3	87			7			12		16	15	15	93	40	7	153	14	109		6	4				23	2						
Peat cuttings	39					271	6	125	94	61						242			23	31		180	74	117							125							
Woodland						22	9	30	15	8	24	7	7	31		39	2	2	14	11	3	57	16	17	6	11	10		6	10	46		1	10	8		12	79
Urban								29																							6							

(continuation of Table 5)

STUDY AREA	SOLWAY																																				
GROUP	WAMPOOL											GRETNA								DUMFRIES																		
SITE NUMBER	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38
SITE NAME	Salta Moss	Hangingshaw Moss	Chapel Moss	Cowper Bog	Cockley Moss	Wedholme Flow	Oulton Moss	Bowness Common	Glasson Moss	Drumburgh Moss	Little Bampton Moss	White Moss	Harker Moss	Rockcliffe Moss	Rosetrees Moss	Solway Moss	Newton Flow	Westhills Moss	Nutberry Moss	Priestside Flow	Lochar Moss (East)	Longbridge Muir	Racks Moss	Craigs Moss	Greenlea Moss	Collin Moss	Redhills Moss	Town's Moss	Black Loch	Sand Loch	Carnsalloch Moss	Steel Moss	Mossdale	Black Moss	Lightwater Moss	Moss Plantation	Drungans Moss	Kirkconnell Flow
SURVEY DATE	1970	1970	1970	1970	1971	1970	1970	1973	1973	1973	1971	1970	1968	1973	1974	1970	1970	1964	1970	1967	1973	1973	1974	1974	1974	1974	1974	1974	1974	1974	1974	1974	1974	1975	1975	1974	1975	1969
Moss				4		219		452	88	88	8	19		7		24			19	18		254		84															20
Agriculture	16	11	3		14	136	25	105	13	40	20	2	1	26	1	7	3	1	102	79	2	36	24	66	10	12	37	7	1	2	81	2	4	14	5	1	88	25
Drained moss						25	14	87				3				16	15	7	8	13	7	84	109	180							39							5
Peat cuttings	34					341		116	93	61						264			103	36		117	25	64	2					2							
Woodland	2	1			1	40	14	56	22	10	27	7	10	89		50	2	10	13	28	3	57	16	11	4	11	17		5	8	46		5	1	9		18	113
Forestry																						442	283								70							
Urban								5								1															6							
SURVEY DATE	1978	1976	1976	1976	1974	1975	1978	1975	1975	1978	1978	1978	1974	1978	1978	1978	1978	1978	1978	1978	1978	1978	1978	1978	1978	1978	1978	1978	1978	1978	1978	1978	1978	1978	1978	1978	1978
Moss				1		179		439	70	88		19								18		170															20
Agriculture	16	12	3	3	15	136	25	119	26	41	21	2	3	28	1	7	3	1	102	79	2	36	24	66	10	12	37	7	1	2	81	2	4	14	5	1	88	30
Drained moss						16	14	87		36		3		5		16	15	7	8	13	7	84	109	9							38							
Peat cuttings	34					390		108	106	24						310			123	36		117	25	10	2					2							
Woodland	2					40	14	63	14	10	34	7	6	89		28	2	10	13	28	3	57	16	11	4	11	17		5	8	47		5	1	9		18	113
Forestry																						526	283	297							70							
Urban								5					2			1															6							

Table 6. Solway: summary of land use data for total mire area, and for each of the descriptive groups.

Survey date	Land use	GROUP						TOTAL AREA	
		Wampool		Gretna		Dumfries			
		ha	%	ha	%	ha	%	ha	%
1850 –1866	Moss	2172	100	801	100	2698	100	5671	100
	Total	2172		801		2698		5671	
1893 – 1901	Moss	1956	90	712	88	2310	86	4978	88
	Agriculture	153	7	64	8	282	10	499	9
	Woodland	51	2	35	4	104	4	190	3
	Urban	11	1					11	0
	Total	2171		811		2696		5678	
1946 – 1962	Moss	1034	47	232	28	1128	42	2394	42
	Agriculture	280	13	70	9	371	14	721	13
	Drained moss	141	6	151	18	358	13	650	11
	Peat cuttings	596	27	265	32	527	20	1388	24
	Woodland	108	5	102	12	303	11	513	9
	Urban	29	1			6	0	35	1
	Total	2188		820		2693		5701	
1964 – 1975	Moss	859	39	69	9	376	14	1304	23
	Agriculture	383	17	143	18	496	18	1022	18
	Drained moss	126	6	49	6	437	16	612	11
	Peat cuttings	645	29	367	45	246	9	1258	22
	Woodland	173	8	181	22	352	13	706	12
	Forestry					795	29	795	14
	Urban	5	0	1	0	6	0	12	0
	Total	2191		810		2708		5709	
1974 – 1978	Moss	777	35	19	2	208	8	1004	18
	Agriculture	417	19	147	18	501	19	1065	19
	Drained moss	153	7	54	7	260	10	467	8
	Peat cuttings	662	30	433	53	192	7	1287	23
	Woodland	177	8	155	19	353	13	685	12
	Forestry					1176	44	1176	21
	Urban	5	0	3	0	6	0	14	0
	Total	2191		811		2696		5698	

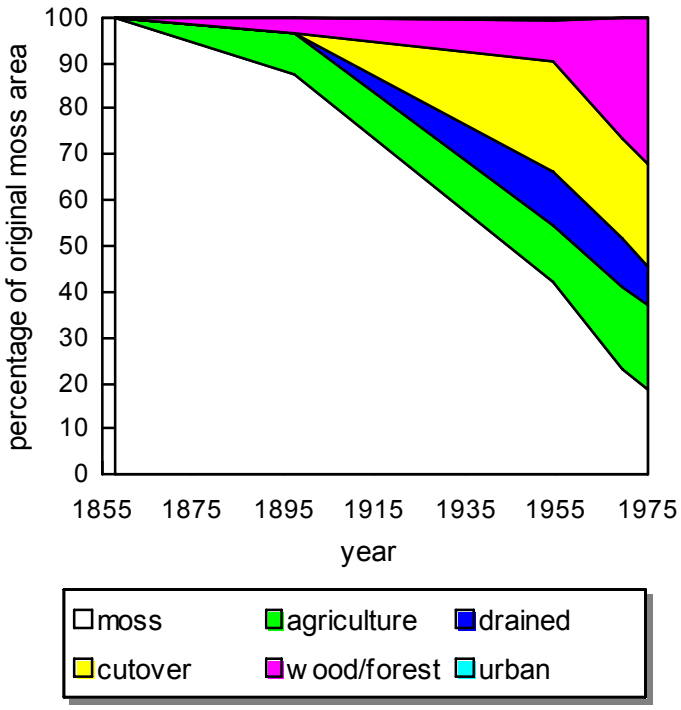
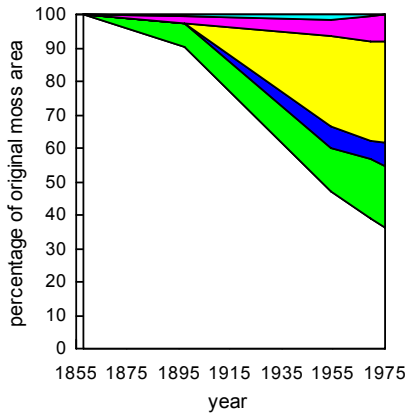


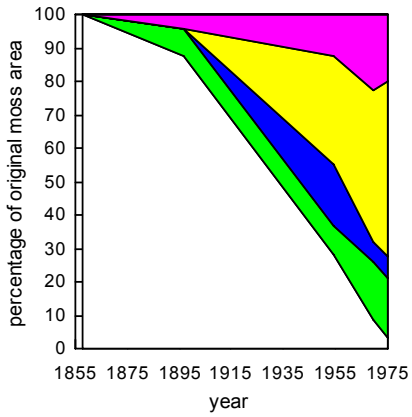
Figure 13. Summary of the sequence of land use changes on raised mires in the Solway study area between the mid-19th century and the 1970s.

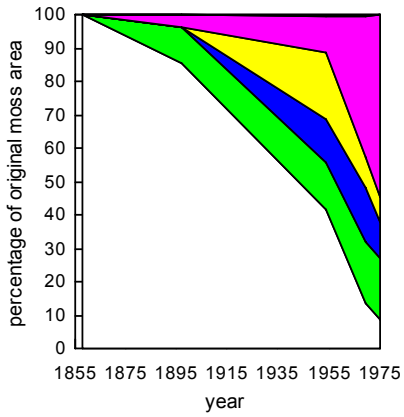
Left: time series of changes, expressed as percentages of the total raised mire area.

Below: time series data for each of the three groups of sites in the Solway study area.

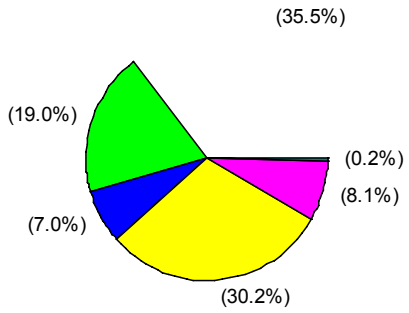
Bottom row: pie charts showing the fraction of the original raised mire area under each land use at the final survey date in the 1970s.

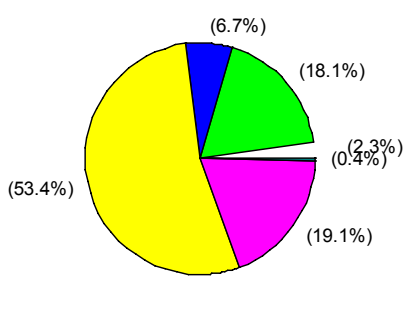


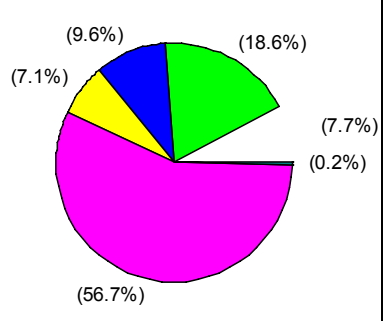




WAMPOOL (2172 ha)	GRETNA (801 ha)	DUMFRIES (2698 ha)







3.3.1 Wampool group

The major areas of peat included in this group are the six sites which flank the River Wampool. Their extent at the beginning of the survey is shown in Figure 14. Also included are five smaller sites (Sites 1–5, total area 86 hectares) which lie to the south of Silloth (Figure 12).

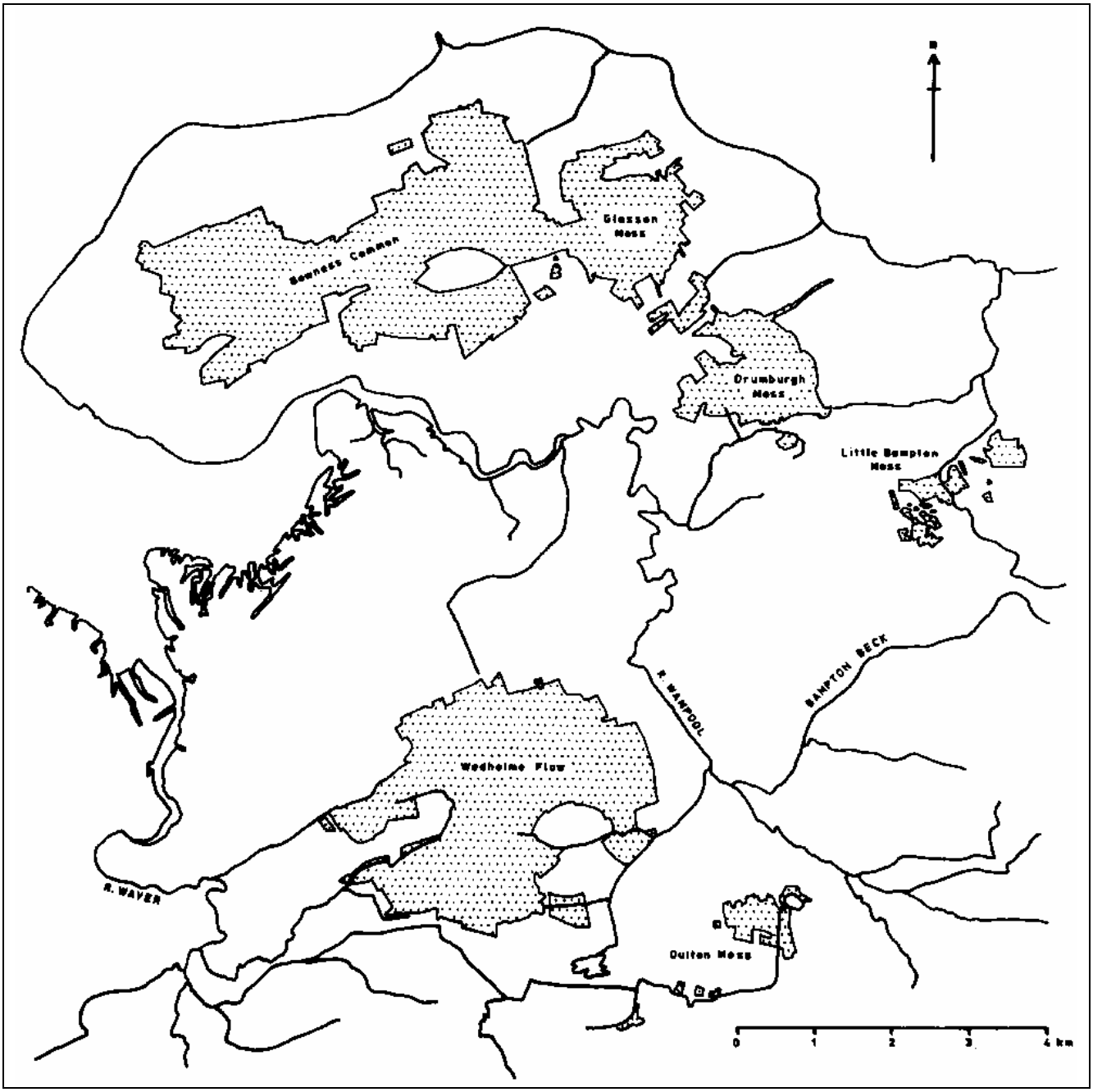


Figure 14. The extent of the six raised mires (Sites 1–6) flanking the River Wampool in 1865–6.

During the latter half of the 19th century, the only land use change recorded on Sites 1–5 was two hectares of reclamation for agriculture on Cockley Moss. Within the area shown in Figure 14, however, new areas of agriculture and woodland appeared on all sites and 11 hectares of Bowness Common were converted to urban use.

By 1950, the area used for agriculture had almost doubled. Reclamation had occurred on all sites except Cowper Bog, and Chapel Moss was completely cultivated. Woodland had expanded, notably on Glasson, Drumburgh and Little Bampton Mosses and Bowness Common, but still had not appeared on any of the five southern sites. The area of 'urban' use on Bowness Common had also increased. The most significant change, however, was the appearance of drains and peat cuttings on approximately one-third of the area. There is documentary evidence (e.g. Marshall 1961) of extensive peat cutting. The margins of many sites were cut, giving them a "stepped" appearance, and 3 feet (approximately 1 metre) of peat was removed from Drumburgh Moss. Moss litter workings were set up between 1948 and 1957 on Glasson Moss, and extended onto Bowness Common. Wedholme Flow was similarly exploited, and the land use data indicate that peat cutting also occurred on Salta and Oulton Mosses.

During the final 20 years of the survey period, the 'urban' area on Bowness Common decreased, but all other land uses continued to expand slowly. By the late 1970s, parts of only five of the eleven sites remained undisturbed, the area of moss totalling 777 hectares, or 35% of the original area.

3.3.2 Gretna group

The eight mosses of the Gretna area are scattered (Figures 12 and 15), and together comprise the smallest of the three Solway groups. Five sites are in England (to the south and east of the River Sark), and the remainder in Scotland.

During the latter half of the 19th century, the pattern of land use changes here was broadly similar to that for the Wampool group. Agriculture and woodland appeared on some sites, but no urban development was recorded.

Subsequently, however, the rate of decline of intact mossland increased. By 1950, agriculture had hardly expanded, but the area of woodland had trebled and drained moss and peat cuttings together accounted for 50% of the area. Woodland was now present on all but one site, whereas the only peat cuttings recorded were on the commercially extracted Solway and Nutberry Mosses.

By the 1970s, the area of drained moss had decreased, but the decline was almost equalled by expansion of agriculture. The spread of woodland had accelerated – Rockcliffe Moss may have been planted with birch and conifers – and one hectare of urban development had appeared on Solway Moss.

The peat cuttings subsequently continued to expand, and by the end of the decade had accounted for the last parts of Solway and Nutberry Mosses.

Thus, at the end of the survey, the major land use was peat cutting (53%). Significant areas of agriculture (18%) and woodland (19%), and a smaller area of drained moss (7%) were also present. Only 19 hectares of White Moss, representing 2% of the original area of the group, remained undisturbed.

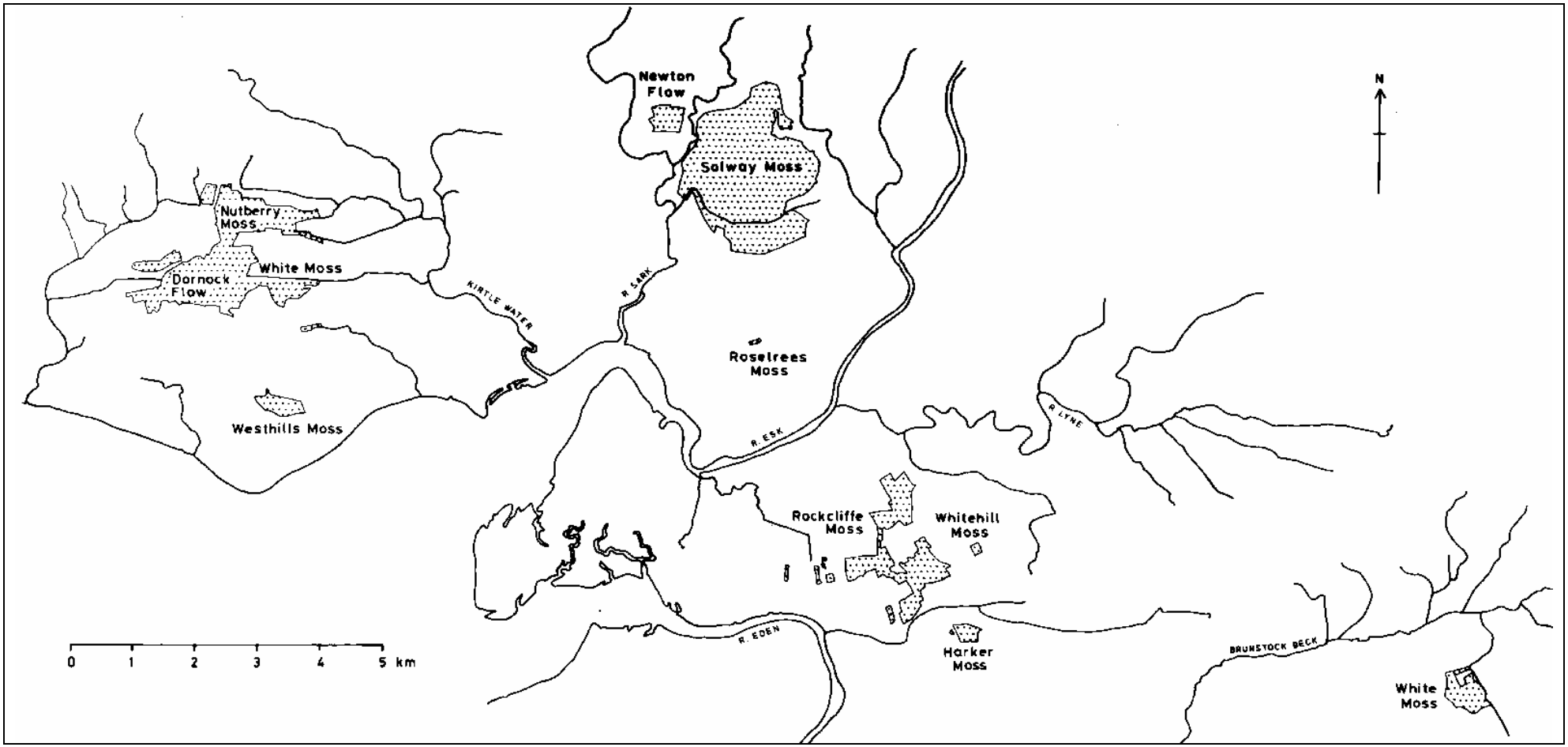


Figure 15. Extent of the Gretna group of raised mires, surveyed 1857–1866.

3.3.3 Dumfries group

The original extent of this group is shown in Figure 16. It is dominated by the Lochar Mosses, a series of raised bogs adjacent to the Lochar Water.

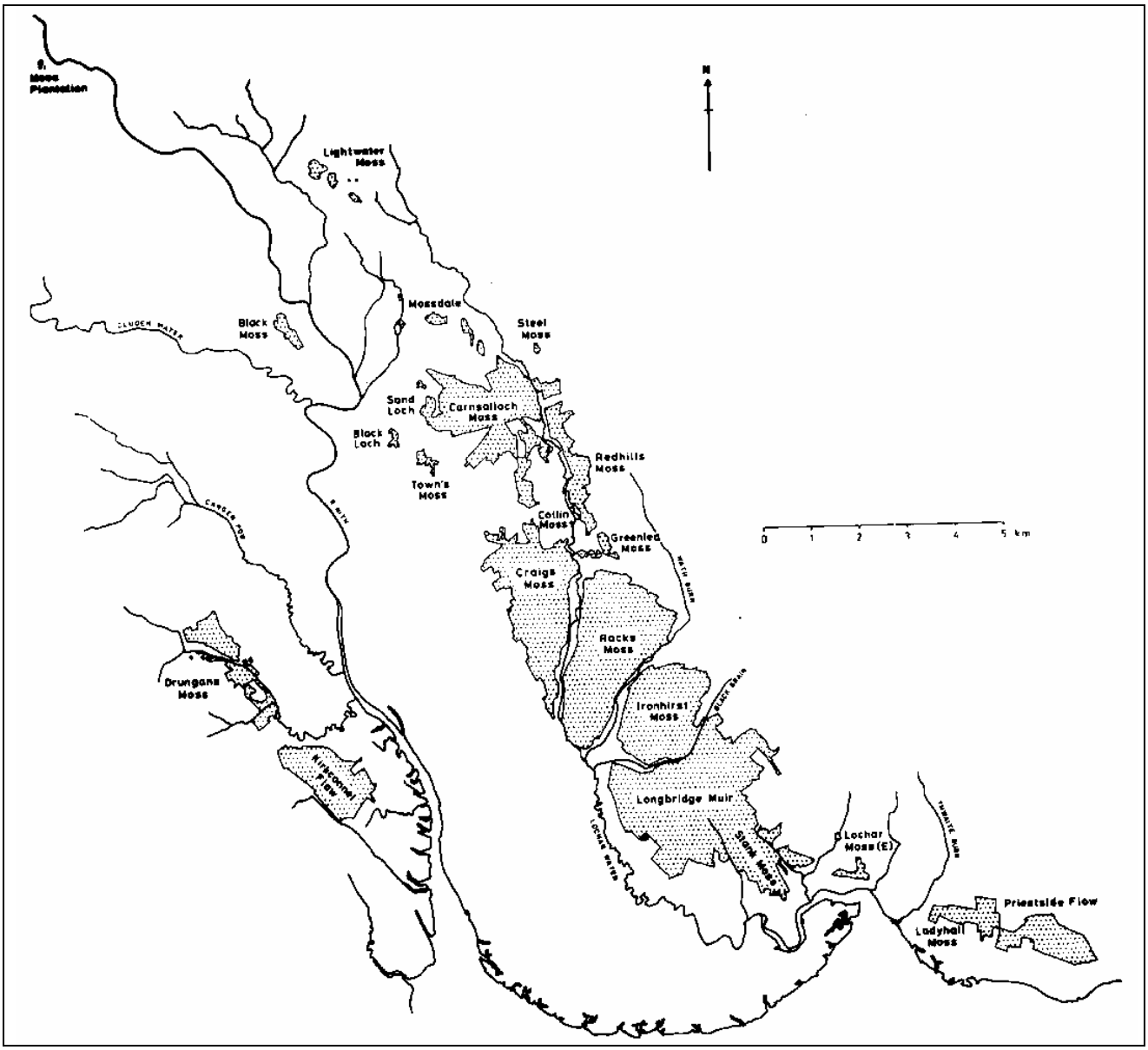


Figure 16. Extent of the Dumfries group of raised mires, surveyed 1850–1856.

There are records of attempts to reclaim some of the Dumfries mires during the early 19th century. More than 250 acres of 'Lochar Moss' were reclaimed between 1800 and 1840, and parts of Priestside Flow before 1942 (Marshall 1961). This continued during the latter half of the century, affecting 15 of the 19 sites, and accounting for 10% of their area by 1900. The limited success of reclamation may be attributed to the fact that the mosses proved to be difficult to drain. In winter, the ditches were flooded and could be used as waterways; between 1900 and 1910 an old shepherd regularly rowed to work across Lochar Moss (Marshall 1961). The only other change recorded during this period was development of woodland on many of the sites. Around 1910, Peco Ltd. began

various experimental operations on Ironhirst and Racks Mosses. Their peat gasifying methods were soon superceded by more economical operations elsewhere; but wet-carbonization was taken up by the Government to produce 'turfcoal' briquettes for use in the trenches during the 1914-18 War, and an 8 ha loch was formed by dredging to supply peat for this process. Between the First and Second World Wars, Peco drained Ironhirst Moss whilst developing techniques for ditching, drying and milling peat; however all of these activities had ceased before 1950 (DAFS 1964).

By the mid-20th century, undisturbed moss amounted to only 42% of the original moss area. Many drained areas were apparent and parts of the five largest sites had been cut. Some expansion of agriculture and, to a greater extent, of woodland, had also occurred; and urban development (6 hectares) was present on Carnsalloch Moss. Nonetheless, substantial parts of the central Lochar Mosses (Craigs and Racks Mosses and Longbridge Muir) remained intact despite their identification in 1957 as "the most suitable peat deposit for exploitation in the south of Scotland and perhaps even in the whole of Scotland" (DAFS 1964). Indeed, these mires were reported to be in largely the same condition as they had been in the 19th century (Marshall 1961). By the 1970s, however, they had been acquired by the Forestry Commission, and large-scale plantations appeared. Reclaimed, drained and cut areas, in addition to previously undisturbed mire, were planted. Thus, forestry took over large parts of four of the sites, and accounted for the last remnants of three of them.

By 1978, forestry was the major land use of the group, accounting for 44% of the peat area. Of the remainder, 19% was devoted to agriculture, 13% was wooded, 10% drained and 7% cut. There were three areas of open moss, on Priestside Flow, Longbridge Muir and Kirkconnell Flow, which amounted in total to 208 hectares.

3.4 Forth Valley

The mosses of the Forth Valley lie on the 'fifty-foot raised beach' which forms a tract of low-lying, flat land, 1–4 miles wide, extending for 30 miles inland from Bo'Ness (Stamp 1946). At the end of the Glacial Period, it lay beneath a "picturesque sea loch", and slowly became covered by silt and clay. As the land began to rise and the sea to retreat, it formed a flat alluvial strath, the Carse of Stirling. Much of this was once densely wooded; when the Romans arrived in the second century A.D., their advance necessitated felling of oak forests in the Vale of Menteith (Cadell 1929), transforming the Carse into "a dreary expanse of peat moss and heather which stretched for some twelve miles up the valley" (Cadell 1913).

Reclamation of the Carse peatlands was instigated by Lord Kames when his wife inherited the Blair Drummond estate in 1766, and continued under the direction of his son George Home Drummond. By the early 1790s, plots of ‘bottomless’ mossland were being allocated to so-called ‘Moss Lairds’ - dispossessed Perthshire Highlanders - whose task was to completely remove the peat. Surface material was cut away and dropped into specially-dug water channels whence it floated off into the River Forth, causing considerable damage to salmon and oyster fisheries in the estuary; whilst the deeper peat was used as fuel. The underlying forest remains were then grubbed up, and agriculture proceeded on the newly exposed "Carse clay". At least 1700 acres (690 hectares) of land in the Vale of Menteith plus additional areas downstream from Stirling had been reclaimed in this way before 1850 (Cadell 1929, Birse 1956).

The locations of the 19 mire sites which remained at the beginning of the survey are shown in Figure 17. Towards the head of the Carse, extensive peat cover remained (Sites 1–14), whilst further downstream, parts of five more mosses (Sites 15–19) persisted. Land use data for individual sites are shown in Table 7.

The sites are conveniently divided into three groups, as follows:

- West Menteith (Sites 1–10), the group of mosses which lie to the west of the area of raised ground known as the Menteith moraine;
- East Menteith (Sites 11–14), four sites lying immediately east of the Menteith moraine, dominated by East Flanders Moss; and
- Lower Carse (Sites 15–19), the rather scattered relict peatlands of the Stirling-Alloa area.

The land use data are summarised for each group and for the whole study area in Table 8 and Figure 18. The extent of the West Menteith and East Menteith raised mires at the beginning of the survey is shown in Figure 19, and that of the Lower Carse sites in Figure 20.

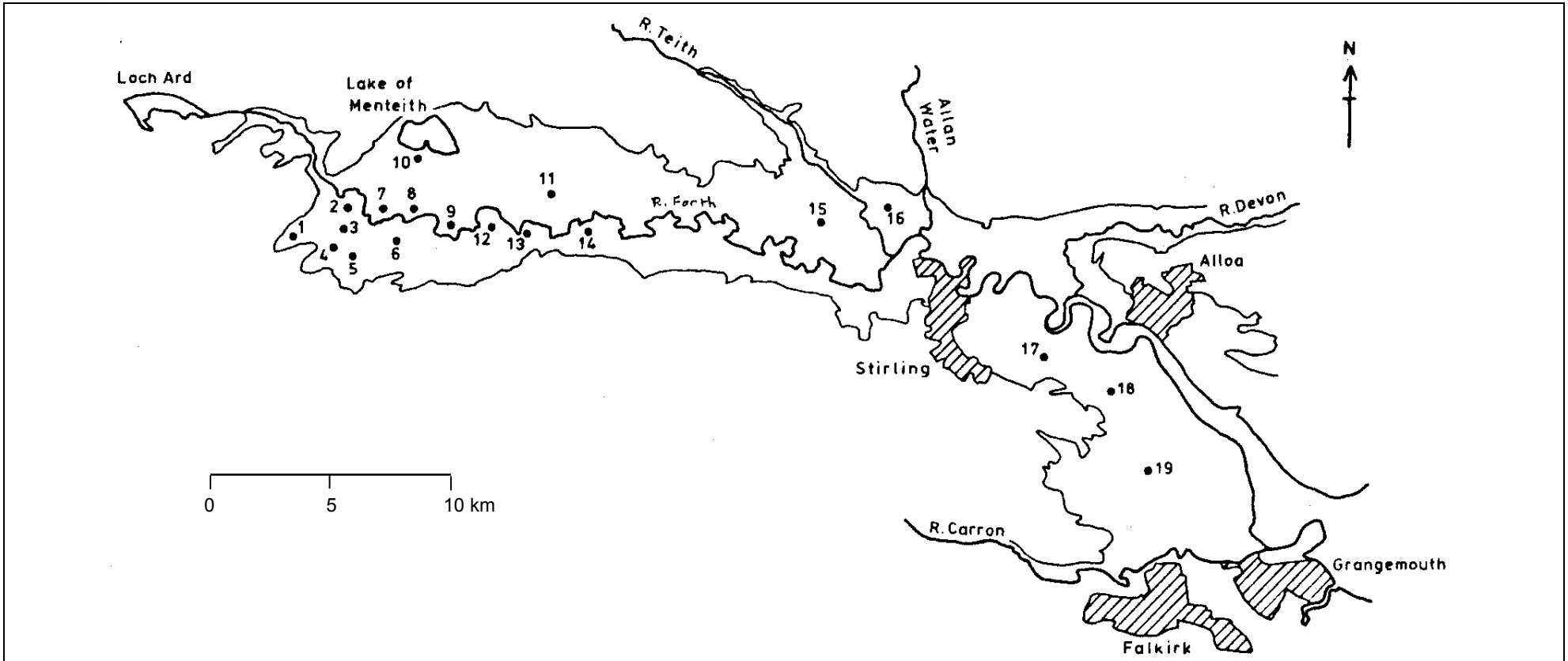


Figure 17. Forth Valley: locations of sites included in the survey. 30 m contour and major urban areas also shown. Key to sites:

1	Claggans Burn Moss	6	West Flanders Moss	11	East Flanders Moss [Poldar Moss]	16	Deafleys Moss
2	Arnochoile Wood Moss	7	Gartrenich Moss	12	Station Wood	17	Wester Moss [Craig Moss]
3	Easterhill Moss	8	Gartur Moss	13	Killorn Moss	18	Dunmore Moss [Easter Moss]
4	Offerance Moss	9	Collymoon Moss	14	Little Kerse Moss	19	Letham Moss
5	Garchell Moss	10	Cardross Moss	15	Ochtertyre Moss		

[names in square parentheses denote mire areas adjacent to the main site, and regarded as part of it in the collation of land use data]

Table 7: Forth Valley: land use areas (ha) for individual sites.

STUDY AREA	FORTH VALLEY																		
GROUP	WEST MENTEITH										EAST MENTEITH				LOWER CARSE				
SITE NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
SITE NAME	Claggans Burn Moss	Arnochoile Wood Moss	Easterhill Moss	Offerance Moss	Garchell Moss	West Flanders Moss	Gartrenich Moss	Gartur Moss	Collymoon Moss	Cardross Moss	East Flanders Moss	Station Wood	Killorn Moss	Little Kerse Moss	Ochtertyre Moss	Deafleys Moss	Wester Moss	Dunmore Moss	Letham Moss
SURVEY DATE	1861	1862	1862	1861	1861	1861	1862	1862	1862	1862	1862	1862	1862	1860	1863	1863	1860	1860	1861
Moss	4	75	18	77	169	399	156	46	69	139	842	10	35	65	94	5	50	182	151
SURVEY DATE	1898	1898	1898	1898	1898	1898	1898	1898	1898	1898	1899	1899	1899	1899	1899	1899	1896	1899	1895
Moss	4	71	14	73	168	384	156	46	65	139	833	7	28	54	89	1	40	164	149
Agriculture			3	4	1	9			3			2		8		4	7	3	
Woodland		1	1			1			1		9	1	7	3	5		3	15	2
Urban		3				5													
SURVEY DATE	1948	1948	1954	1948	1948	1948	1948	1948	1948	1947	1946	1946	1950	1955	1946	1954	1946	1946	1946
Moss			14	16	2	21	69	9	34	31	684	1	28	15	18		19	51	75
Agriculture			4	4	2	7			6	2	19	3		10	6	4	1	5	1
Drained moss	4	71		55	163	316	87	37	7	84	85			36					5
Peat cuttings						35				11	9			3				61	59
Woodland		1		2	1	15			22	11	45	6	7	1	70	1	24	62	11
Urban		3				5											6	1	
SURVEY DATE	1973	1973	1973	1973	1973	1973	1973	1973	1973	1973	1973	1973	1973	1973	1971	1974	1971	1971	1971
Moss			4	28	2	2	4		20		548		22	12			15	24	29
Agriculture	4		14	40	46	7			6	12	23	3		8	7	4	5	18	1
Drained moss				10	119	5	152	1	2	73	166			30				1	5
Peat cuttings						11					39			2				54	100
Woodland		72		1	2	15			41	11	66	7	13	13	87	1	17	87	16
Forestry						354		45		43									
Urban		3				5											13	1	
SURVEY DATE	1978	1978	1978	1978	1978	1978	1978	1978	1978	1978	1978	1978	1978	1978	1978	1978	1978	1978	1978
Moss				28	2	2			13		548		22	12			5		
Agriculture	4		18	40	46	7			6	12	23	3		29	6	4	6	40	1
Drained moss				10	39	5	22	1	2	73	38			9					5
Peat cuttings						11					39			2					129
Woodland		72		1	2	15			48	11	66	7	13	13	88	1	24	141	16
Forestry					80	354	134	45		43	128								
Urban		3				5											13	1	

Table 8: Forth Valley: summary of land use data for the total mire area, and for each of the descriptive groups.

Survey date	Land use	GROUP						TOTAL AREA	
		W. Menteith		E. Menteith		Lower Carse			
		ha	%	ha	%	ha	%	ha	%
1860 – 1863	Moss	1152	100	952	100	482	100	2586	100
	Total	1152		952		482		2586	
1895 – 1899	Moss	1120	97	922	97	443	92	2485	96
	Agriculture	20	2	10	1	14	3	44	2
	Woodland	4	0	20	2	25	5	49	2
	Urban	8	1					8	0
	Total	1152		952		482		2586	
1946 – 1955	Moss	196	17	728	76	163	34	1087	42
	Agriculture	25	2	32	3	17	4	74	3
	Drained moss	824	72	121	13	5	1	950	37
	Peat cuttings	46	4	12	1	120	25	178	7
	Woodland	52	5	59	6	168	35	279	11
	Urban	8	1			7	1	15	1
	Total	1151		952		480		2583	
1971 – 1974	Moss	60	5	582	61	68	14	710	27
	Agriculture	129	11	34	4	35	7	198	8
	Drained moss	362	31	196	21	6	1	564	22
	Peat cuttings	11	1	41	4	154	32	206	8
	Woodland	142	12	99	10	208	43	449	17
	Forestry	442	38					442	17
	Urban	8	1			14	3	22	1
	Total	1154		952		485		2591	
1978	Moss	45	4	582	61	5	1	632	24
	Agriculture	133	12	55	6	57	12	245	9
	Drained moss	152	13	47	5	5	1	204	8
	Peat cuttings	11	1	41	4	129	27	181	7
	Woodland	149	13	99	10	270	56	518	20
	Forestry	656	57	128	13			784	30
	Urban	8	1			14	3	22	1
	Total	1154		952		480		2586	

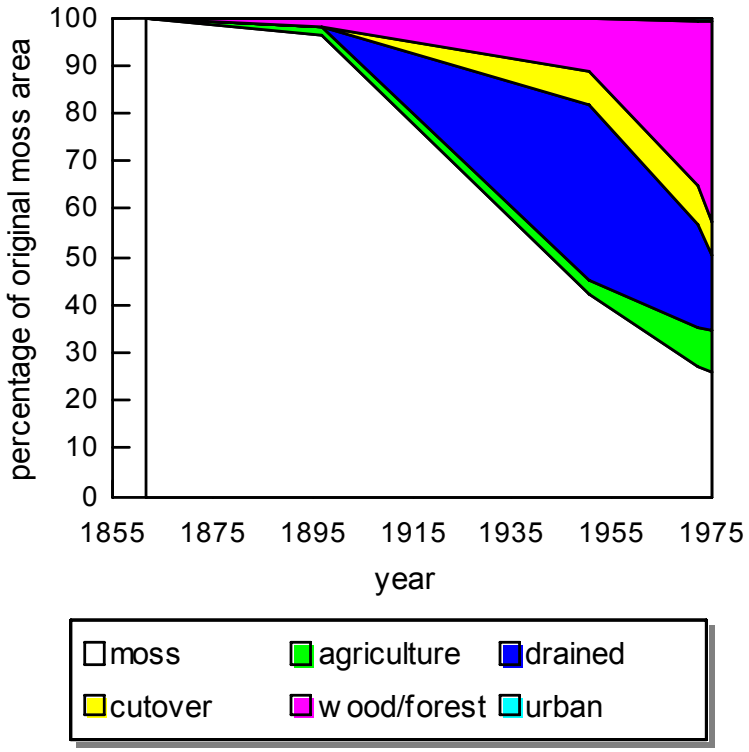
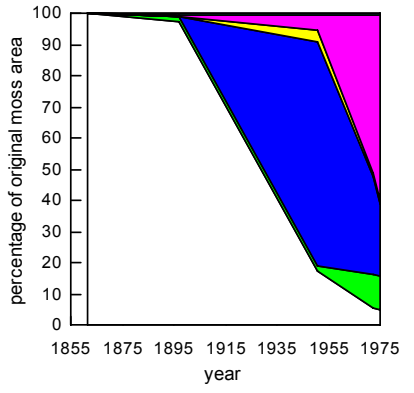


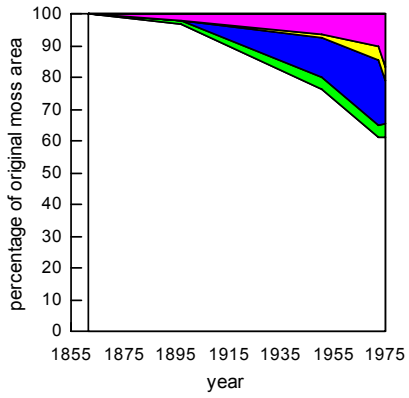
Figure 18. Summary of the sequence of land use changes on raised mires in the Forth Valley study area between the mid-19th century and the 1970s.

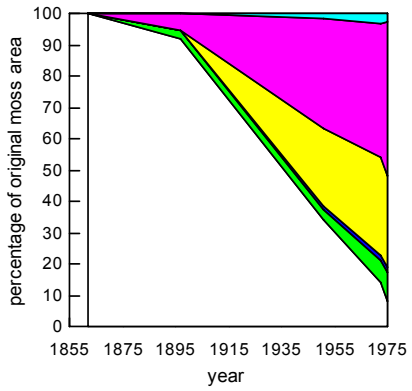
Left: time series of changes, expressed as percentages of the total raised mire area.

Below: time series data for each of the three groups of sites in the Forth Valley.

Bottom row: pie charts showing the fraction of the original raised mire area under each land use at the final survey date in the 1970s.



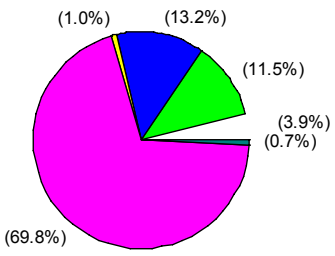


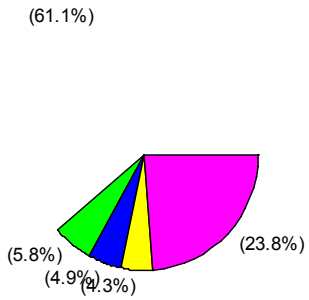


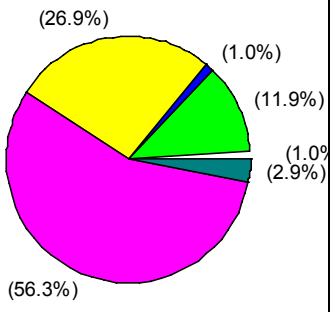
WEST MENTEITH (1152 ha)

EAST MENTEITH (952 ha)

LOWER CARSE (482 ha)







3.4.1 West Menteith

In terms of total area, only small changes occurred during the latter half of the 19th century. However, these affected six of the ten sites. Small parts of five of them had been reclaimed for agriculture, woodland had developed on four sites, and 8 hectares of West Flanders and Arnochoile Wood Mosses had been converted to urban use – possibly by construction of the Aberfoyle branch of the London and North Eastern Railway.

From the 1947-8 air photographs, 72% of the total peat area was identified as 'drained moss'. Every site except Easterhill Moss had been drained - Claggans Burn and Arnochoile Wood Mosses completely - and peat cutting was in progress on Garchell and Cardross Mosses. Woodland had expanded significantly on West Flanders and Collymoon Mosses, and had also appeared on three new sites. 17% of the original moss area remained undisturbed.

During the 1970s, commercial forestry became the major land use. This came to occupy large parts of five of the ten sites; it is possible that their previous drainage was carried out in preparation for planting. Of the remaining sites, Arnochoile Wood and Collymoon Mosses carried mixed woodland, whilst the three westmost sites (Claggans Burn, Offerance and Easterhill Mosses) were largely reclaimed for agriculture.

By the end of the survey, areas of undisturbed moss ranging from 2 to 13 hectares remained on Garchell, West Flanders and Collymoon Mosses, whilst on Offerance Moss 28 hectares, apparently including an area of moss recovering from drainage, persisted. The total area of moss was 45 hectares, or 4% of the original raised mire area.

3.4.2 East Menteith

At the beginning of the survey, the four sites which lie to the east of the Menteith moraine extended to 952 hectares, only 200 hectares less than the area covered by the ten West Menteith sites (Tables 7 and 8). East Flanders Moss comprised almost nine-tenths of this area (Figure 19).

Once again, changes during the latter half of the 19th century were slight; however, the developments of the 20th century had a much smaller effect on this group than was the case for the West Menteith mosses. Woodland developed on significant proportions of Station Wood and Killorn Moss early in the survey, although more than half of Killorn Moss remained open in the late 1970s. During the first part of the 20th century, drainage was restricted to East Flanders and Little Kerse Mosses, and amounted to 13% of the total raised mire area by 1950. On East Flanders Moss, further drainage followed by commercial forestry ensued in the 1970s, and another part of the site was prepared for commercial peat extraction at about the same time. Part of Little Kerse Moss was also cut.

At the end of the survey, 582 hectares of moss (61% of the original area) remained. Most of this was on East Flanders Moss but there were smaller unaltered areas on Killorn and Little Kerse Mosses. A further 55 hectares (6%) were devoted to agriculture, 47 hectares (5%) had been drained, 41 hectares (4%) had been cut, 99 hectares (10%) were wooded, and forestry covered 128 hectares (13%).

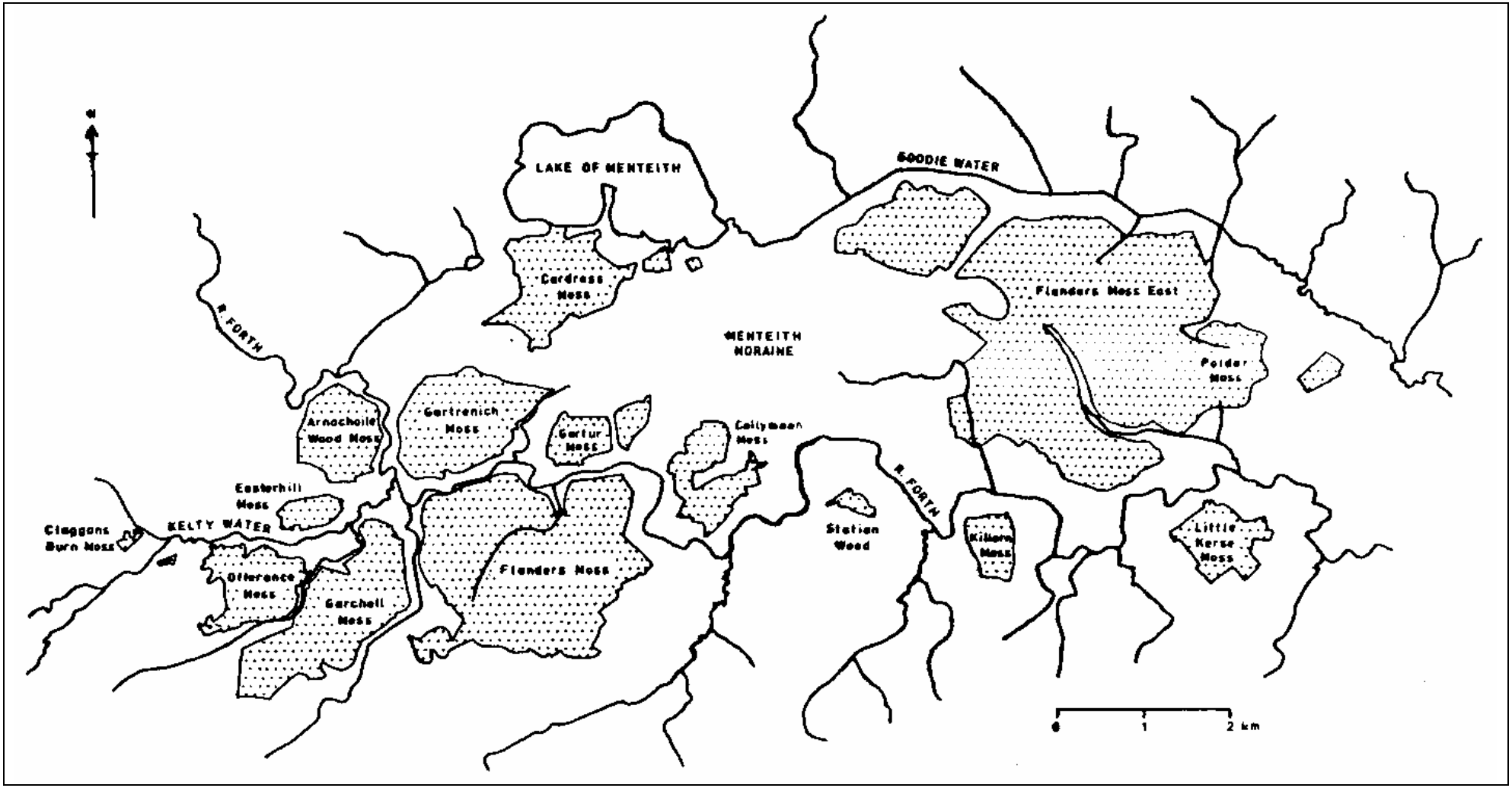


Figure 19. Extent of the Vale of Menteith mosses (West Menteith and East Menteith groups) in 1860–1862.

3.4.3 Lower Carse

The extent of the five Lower Carse sites at the beginning of the survey is shown in Figure 20. These were rather scattered, and their margins showed more evidence of prior reclamation than did those of the sites in the Vale of Menteith.

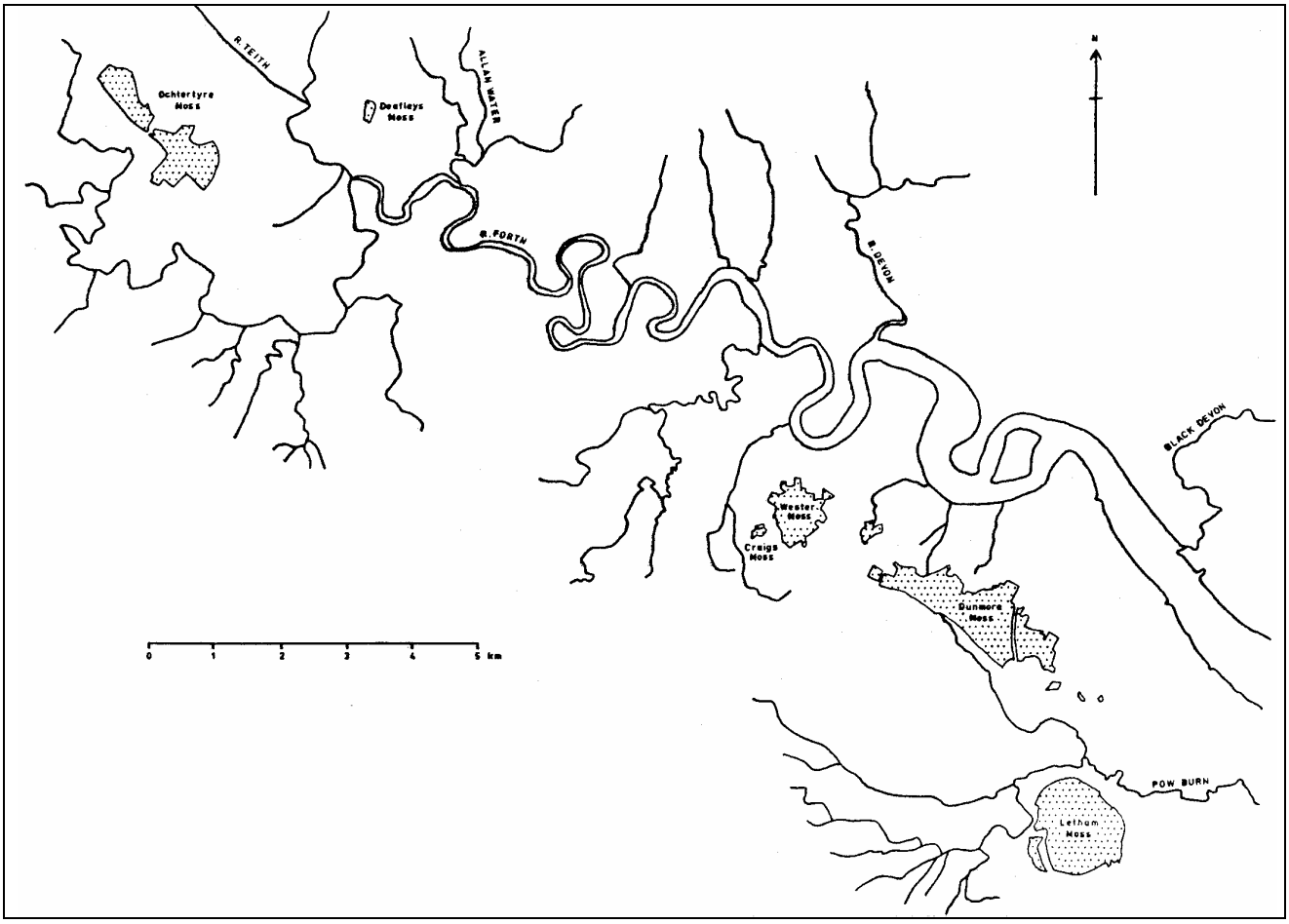


Figure 20. Extent of the Lower Carse mosses in 1861–1863.

Despite the proximity of the industrial centres of the Forth Valley, further reclamation for agriculture was limited; although the smallest site, Deafleys Moss, had been largely brought under the plough by 1900. By the middle of the 20th century, woodland had developed on all sites, and Ochtertyre Moss was almost completely tree-covered. At this time, intensive peat cutting was already in progress on Dunmore and Letham Mosses. The increase in the area of agriculture between 1954 and 1971 is largely attributable to renewed activity on Dunmore Moss, whilst the 'urban development' on Wester Moss may be associated with construction or expansion of the adjacent Polmaise Colliery. Nonetheless, parts of Wester, Dunmore and Letham Mosses survived until 1973. By 1978, however, the last part of Dunmore Moss had been taken into agriculture and peat cutting had expanded onto the remainder of Letham Moss. On Wester Moss, woodland continued to spread.

At the end of the survey, the peat area was dominated by woodland (56%). Peat cuttings and agriculture accounted for 39% of the peatland, a further 3% was devoted to urban use, and 1% had been drained. Only 5 hectares of Wester Moss remained undisturbed, representing 1% of the original peat area.

4. OVERALL TRENDS

The time series diagrams for the twelve site groups described in Section 3 and included in Figures 3, 8, 13 and 18 are presented together in Figure 21 to allow comparison.

During the latter half of the 19th century, the principal land use that encroached onto peatland was agriculture, accompanied in most cases by some expansion of woodland. There is a clear south-to-north trend in the fraction of peatland that was altered during this period; in Lancashire it was 73% (range across the three groups 58–87%), in South Cumbria 20% (17–25%), and for the Solway and Forth study areas 9% (7–10%) and 2% (1–3%) respectively. In general, the area taken into agriculture at this time was retained, but expanded little further during the 20th century.

After 1900, drainage and peat cutting expanded dramatically in all the study areas. The cutover area reflects the combined effects of domestic-scale activity through two World Wars and commercial operations on a few large sites, leaving a variety of patterns of evidence on the ground but probably always involving drainage. As it is suspected that some reciprocal mis-identification occurred between cut and drained moss within the survey (see especially the account for the Mersey Mosses in Section 3.1.1), their relative proportions may not be highly significant and they are considered together here. In contrast to agriculture, the extent of these land uses increased from south to north; by the mid-20th century they accounted for only 13% (2–24%) of the original moss area in Lancashire, whereas the corresponding statistics for the other study areas were: South Cumbria 36% (34–37%), Solway 35% (33–50%) and Forth Valley 44% (14–76%). Land availability appears to be the most significant factor in determining this pattern; since most of the Lancashire mosses were already in 'productive' agricultural use, limited areas were available to the new moss litter companies whose attention consequently focused on the more extensive mosslands that remained further north.

Up to the mid-20th century, there was a general but very gradual increase in the area of woodland in all of the study areas. To the Forestry Commission, founded in 1919 with a remit to establish a strategic timber resource for wartime security, lowland raised mire was only marginally plantable even after invention of the Cuthbertson plough in the 1930s, but with the advent of the 'humpy' plough in the 1960s, forestry on deep peat became practical. The influence on land use within the four study areas is clear. Once more, the impact was principally on areas that had not already been taken into other uses (although some of the drainage recorded at the 1946–62 survey date may have been preparatory work for forestry rather than for peat cutting), so that whereas only 9% (3–40%) of the Lancashire mosses were wooded by the end of the survey, the corresponding data for the South Cumbria, Solway and Forth Valley study areas were 45% (16–68%), 33% (8–57%) and 50% (23–70%) respectively. Forestry does not account for all of this change however; the rate of expansion of unplanted woodland also increased at this stage.

As the data were analysed, it became apparent that they indicated somewhat divergent trends for England and Scotland, and it was decided to repeat the analysis using a national division (Tables 9–11). Summary diagrams for England and Scotland are shown in Figure 22, and for the whole dataset in Figure 23. The distribution of unconverted moss between groups, study areas and countries at the end of the survey is shown in Table 12. For the sites surveyed in England, the rate of decline of moss area was most rapid during the latter half of the 19th century so that its progress through the full survey period followed a concave curve; whereas the decline in Scotland began gradually and accelerated during the 20th century, resulting in a convex curve. Although the total area of peatland originally identified within the study areas in England was 3139 hectares more than (and around 1.6 times) that in Scotland, the difference at the end of the survey was only 77 hectares, with 53% of the remaining mossland in England and 47% in Scotland. Overall, the rate of loss is linear ($R^2 = 0.996$), with 12.5% of the original mossland remaining at the 1973–1978 survey date and trending towards an extinction date during 1989.

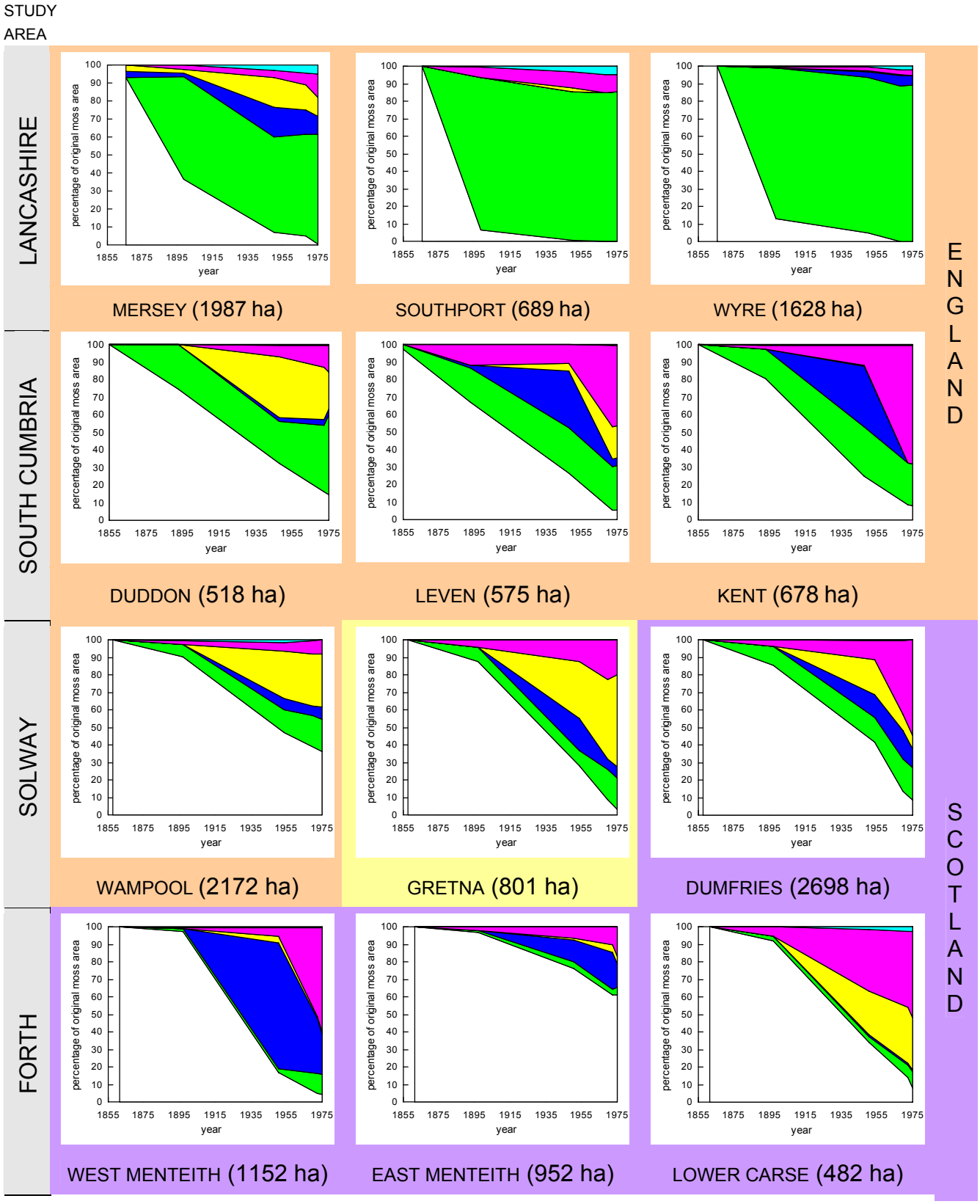


Figure 21. Composite of time series diagrams for all 12 study groups. Coloured backgrounds indicate the national (England/Scotland) division; the Gretna group straddles the border.

Table 9. Overall trends : England.

Survey date	Land use	Lancashire		South Cumbria		Solway (England)	
		ha	%	ha	%	ha	%
1844 – 1866	Moss	4229	98	1771	99	2698	100
	Drained moss			16	1		
	Peat cuttings	75	2				
	Total	4304		1787		2698	
1893 – 1901	Moss	1005	23	1328	74	2434	90
	Agriculture	3146	73	363	20	166	6
	Drained moss			7	0		
	Peat cuttings	40	1				
	Woodland	100	2	87	5	86	3
	Urban	14	0	3	0	11	0
	Total	4305		1788		2697	
1946 – 1962	Moss	247	6	494	28	1174	43
	Agriculture	3173	74	468	26	311	11
	Drained moss	178	4	435	24	169	6
	Peat cuttings	382	9	207	12	838	31
	Woodland	181	4	177	10	192	7
	Urban	103	2	5	0	29	1
	Total	4264		1786		2713	
1964 – 1975	Moss	106	2	175	10	909	33
	Agriculture	3241	75	503	28	420	15
	Drained moss	231	5	41	2	145	5
	Peat cuttings	301	7	263	15	909	33
	Woodland	253	6	541	30	329	12
	Forestry			255	14		
	Urban	172	4	5	0	6	0
	Total	4304		1783		2718	
1974 – 1978	Moss	11	0	156	9	796	29
	Agriculture	3297	76	566	32	458	17
	Drained moss	228	5	43	2	177	7
	Peat cuttings	207	5	202	11	972	36
	Woodland	395	9	555	31	307	11
	Forestry			255	14		
	Urban	178	4	5	0	8	0
	Total	4316		1782		2718	

Table 10. Overall trends : Scotland.

Survey date	Land use	Solway (Scotland)		Forth Valley	
		ha	%	ha	%
1850 – 1863	Moss	2973	100	2586	100
	Total	2973		2586	
1893 – 1901	Moss	2544	85	2485	96
	Agriculture	333	11	44	2
	Woodland	104	3	49	2
	Urban			8	0
	Total	2981		2586	
1946 - 1962	Moss	1220	41	1087	42
	Agriculture	410	14	74	3
	Drained moss	481	16	950	37
	Peat cuttings	550	18	178	7
	Woodland	321	11	279	11
	Urban	6	0	15	1
	Total	2988		2583	
1964 – 1975	Moss	395	13	710	27
	Agriculture	602	20	198	8
	Drained moss	467	16	564	22
	Peat cuttings	349	12	206	8
	Woodland	377	13	449	17
	Forestry	795	27	442	17
	Urban	6	0	22	1
	Total	2991		2591	
1974 – 1978	Moss	208	7	632	24
	Agriculture	607	20	245	9
	Drained moss	290	10	204	8
	Peat cuttings	315	11	181	7
	Woodland	378	13	518	20
	Forestry	1176	39	784	30
	Urban	6	0	22	1
	Total	2980		2586	

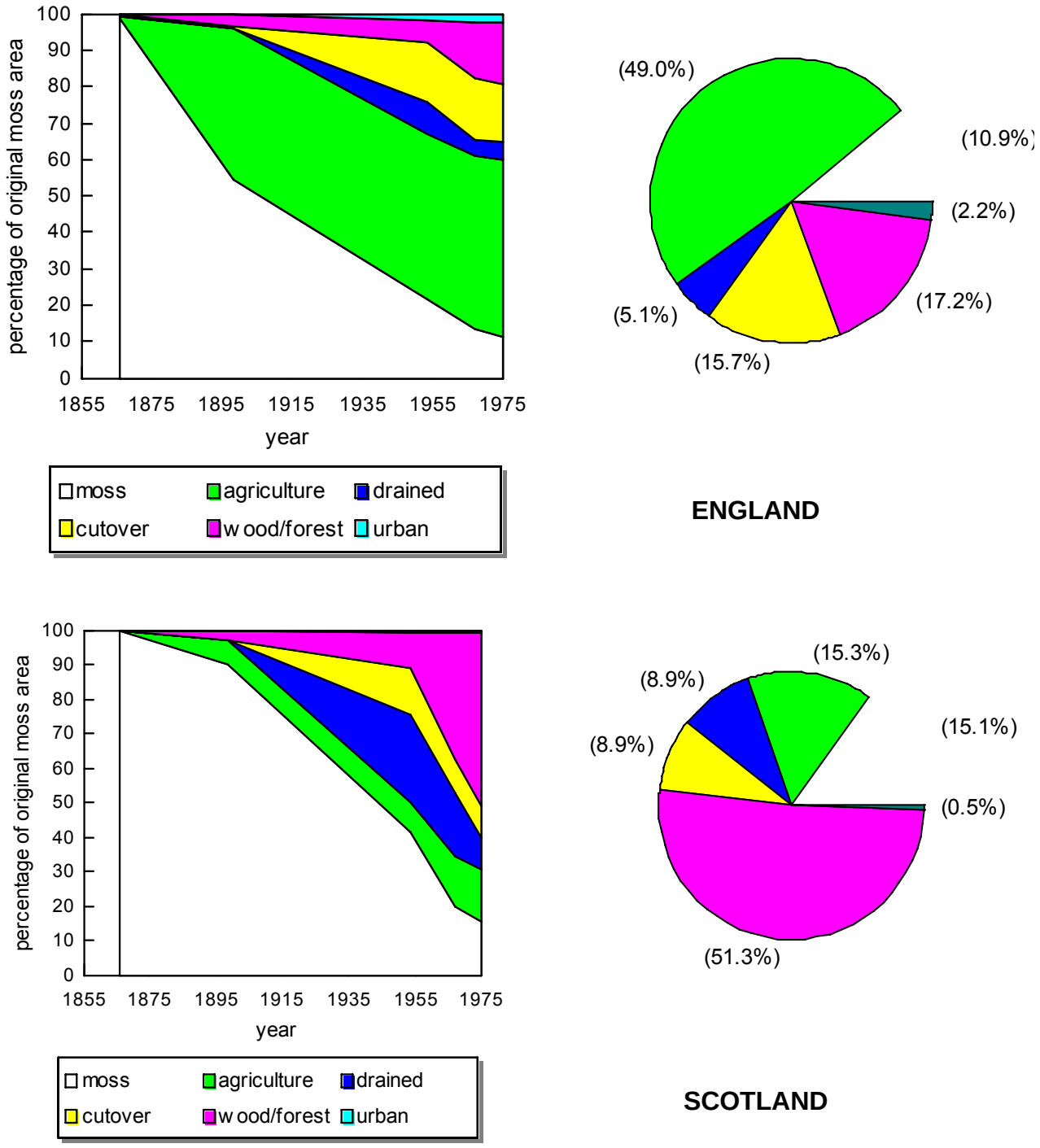
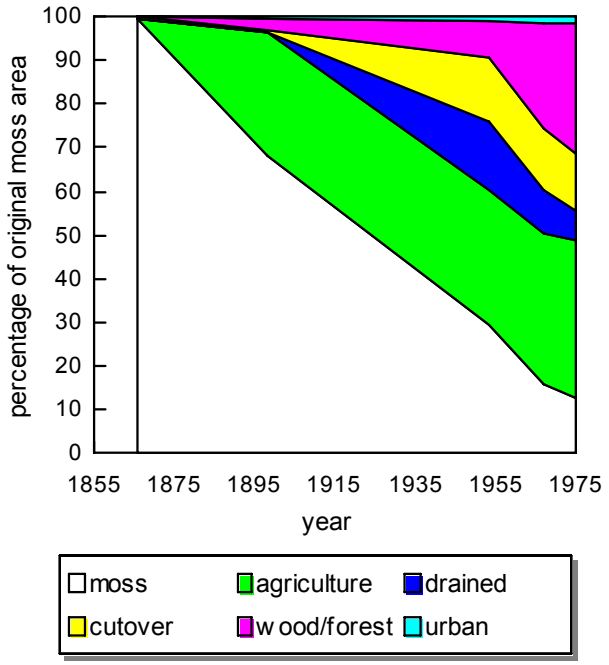


Figure 22. Summary diagrams for England and Scotland

Table 11. Overall trends: England and Scotland.

Survey	Country	England		Scotland		Total	
date	Land use	ha	%	ha	%	ha	%
1850 –1866	Moss	8698	99	5559	100	14257	99
	Drained moss	16	0			16	0
	Peat cuttings	75	1			75	1
	Total	8798		5559		14348	
1893 – 1901	Moss	4767	54	5029	90	9796	68
	Agriculture	3675	42	377	7	4052	28
	Drained moss	7	0			7	0
	Peat cuttings	40	1			40	0
	Woodland	273	3	153	3	426	3
	Urban	28	0	8	0	36	0
	Total	8790		5567		14357	
1946 – 1962	Moss	1915	22	2307	41	4222	29
	Agriculture	3952	45	484	9	4436	31
	Drained moss	782	9	1431	26	2213	15
	Peat cuttings	1427	16	728	13	2155	15
	Woodland	550	6	600	11	1150	8
	Urban	137	2	21	0	158	1
	Total	8763		5571		14334	
1964 – 1975	Moss	1190	14	1105	20	2295	16
	Agriculture	4164	47	800	14	4964	35
	Drained moss	417	5	1031	18	1448	10
	Peat cuttings	1473	17	555	10	2028	14
	Woodland	1123	13	826	15	1949	14
	Forestry	255	3	1237	22	1492	10
	Urban	183	2	28	1	211	1
	Total	8805		5582		14387	
1974 – 1978	Moss	963	11	840	15	1803	13
	Agriculture	4321	49	852	15	5173	36
	Drained moss	448	5	494	9	942	7
	Peat cuttings	1381	16	496	9	1877	13
	Woodland	1257	14	896	16	2153	15
	Forestry	255	3	1960	35	2215	15
	Urban	191	2	28	1	219	2
	Total	8816		5566		14382	



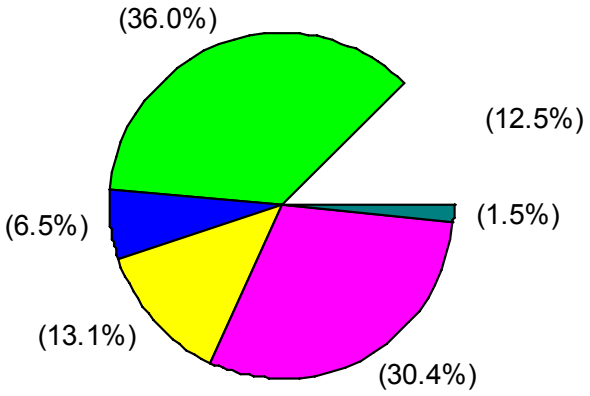


Figure 23. Summary diagrams for total peat area

Table 12. Distribution of the remaining mossland in the area surveyed, expressed as area (ha) and % of TOTAL, according to GROUP, study AREA and COUNTRY.

COUNTRY		ENGLAND									SCOTLAND		
AREA		Lancashire Lowlands			South Cumbria			Solway			Forth Valley		
GROUP		Mersey	Southport	Wyre	Duddon	Leven	Kent	Wampool	Gretna	Dumfries	West Menteith	East Menteith	Lower Carse
GROUP	ha	5	0	6	72	31	53	777	19	208	45	582	5
	%	0	0	0	4	2	3	43	1	12	2	32	0
AREA	ha	11			156			1004			632		
	%	0			9			56			35		
COUNTRY	ha	963									840		
	%	53									47		
TOTAL	ha	1803											

5. CURRENT STATUS OF THE REMAINING MOSSLAND AREAS

5.1 Introduction

The overall results of the land use survey (Section 4) indicate that, of the 14,348 hectares of mossland identified within the study areas in the mid-19th century, 1,803 hectares remained unexploited in 1978. Of this area, 43% (777 ha) was in the Wampool group, 32% (582 ha) in the East Menteith group and 12% (208 ha) in the Dumfries group. The other nine groups retained total moss areas of only 0–72 ha (Table 12) and together accounted for 13% of the remaining mossland, which was scattered across the four study areas. These data are shown graphically in Figure 24.

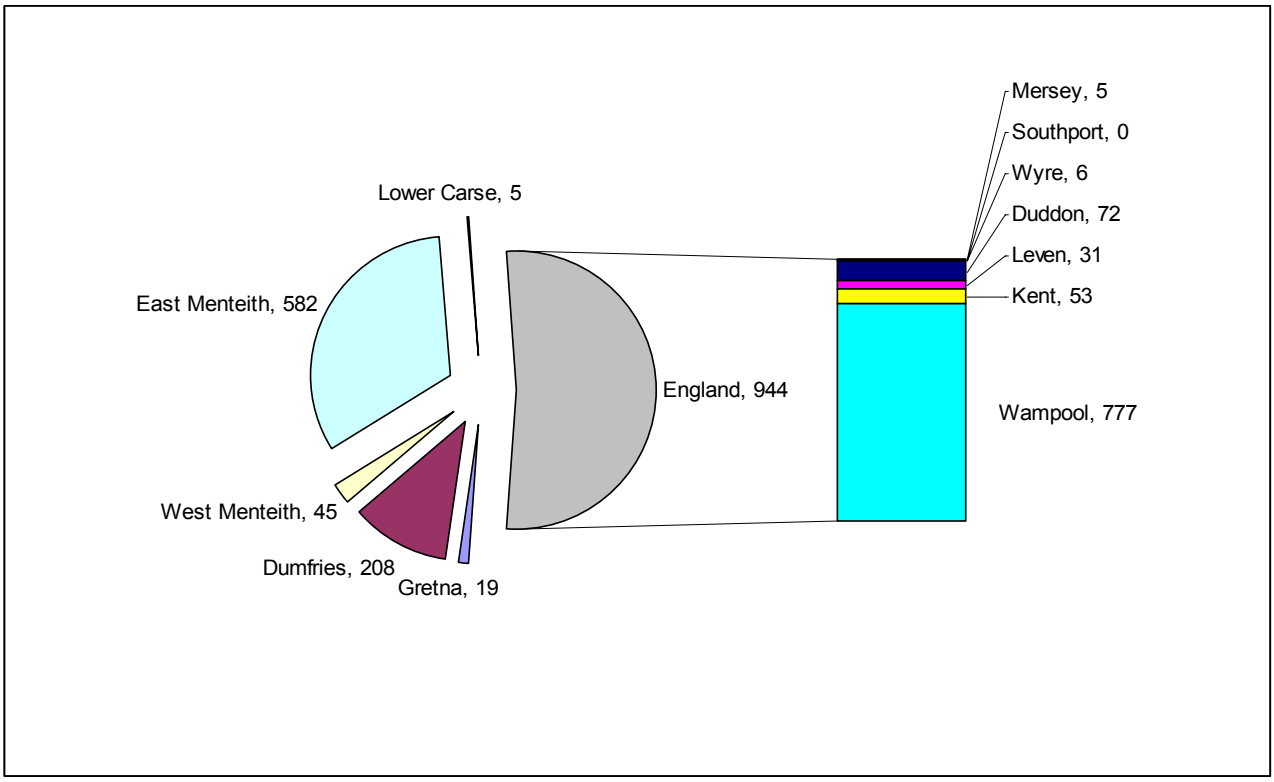


Figure 24. Mossland areas (ha) remaining at the end of the survey within each of the 12 site groups.

The data provide no information on the condition of the surviving moss areas. For the most part, these are small fragments of what were once much larger mire units, persisting as small islands of relict mossland in large seas of reclaimed peat. Thus it seems probable, firstly, that the hydrological integrity of the mire units in which the relict areas developed has been destroyed, and secondly that improved access has increased the likelihood of damage through grazing, trampling, burning and spraydrift (Section 1). Thus we cannot assume that these areas, although apparently still unexploited, actually retain the surface characteristics of truly undisturbed mossland. For this reason, all of these sites except those for which recent survey data were known to be available, were visited.

5.2 Vegetation

The vegetation of remaining mire areas was examined during the 1978 field survey (Section 2). On most sites, the extent of burning and encroachment by trees was estimated, and where a substantial area of open bog remained, quadrat data were collected. The quadrat area was 1 m^2, and the number of quadrats *per* site ranged from 5 to 55. In each case, all species present were recorded and the percentage cover of *Sphagnum* species was estimated. The data were then subjected to "objective assessment" using a scoring system devised by D.A. Goode and described in detail by Greig (1975). Essentially, site quality is assessed on the basis of three criteria:

i. extent of *Sphagnum* cover;
ii. number and cover of indicator species; and
iii. number and cover of intrusive species.

For *Sphagnum* and each indicator species, % cover is converted to a score in the range 1–5 as follows:

% cover	score
0 – 20	1
21 – 40	2
41 – 60	3
61 – 80	4
81 – 100	5

Each intrusive species scores -1 at cover up to 50%, and -2 if cover exceeds 50%. The site score is derived by summation of the *Sphagnum* score and all indicator/intrusive species scores. Sites which score 20 or more are considered to be of high quality.

Data for the ten sites investigated in this way are summarised in Tables 13 and 14. Data for eight more of the sites were extracted from survey reports by Greig (1975) and Lindsay (1978). Both of these authors distinguished a number of plant communities at each site, including those occurring on disturbed areas. Quality scores for the communities occupying apparently undisturbed moss areas only are shown in Table 15.

Tables 16 and 17 summarise the condition of each of the moss areas that remained at the end of the survey within England and Scotland respectively. In cases where no quality data were recorded, the 'remaining moss' area is entered as an area of unknown quality. Where estimates of 'burnt area' and 'area of scattered trees' only are available, any area of moss not affected by these impacts is again entered as an area of unknown quality. Quadrat data from the 1978 field survey are assumed to apply to any part of the moss area not flagged as burnt or carrying scattered trees. For some of the data obtained from Greig (1975) and Lindsay (1978), the actual extents of the areas referred to were accessible. In these cases, the mean score for high-quality areas (scoring 20 or more) is quoted, and the presence of areas of lower quality is also indicated.

The data were summed over study areas (Table 18) and for England and Scotland (Table 19). This exercise showed that 26% of the remaining moss areas in both England and Scotland fell within the highest (score 20+) quality class and a further 24% of the total within the next (score 10–20) class, although almost all of this was in Scotland. Moss scoring <10 and burnt areas were present only in England whereas the area of scattered trees in Scotland was more than twice that in England. Overall, 50% of the resource attained a score of 10 or more, with a most optimistic estimate of 65% assuming that the ‘unknown quality’ category would all fall into this quality class. Similarly, 36–50% of the resource was of low quality (score <10), had scattered trees or was burnt (Table 19, Figure 25).

Table 13. Indicator/intrusive species analysis for sites included in the 1978 field survey.

STUDY AREA	LANCASHIRE LOWLANDS	SOUTH CUMBRIA	SOLWAY (DUMFRIES AND GALLOWAY)			FORTH VALLEY						
SITE NUMBER	21	27	22			4	9	11	13	14	15	17
SITE NAME	Cockerham Moss [Gull Moss]	Meathop Moss	Longbridge Muir			Offerance Moss	Collymoon Moss	East Flanders Moss	Killorn Moss	Little Kerse Moss	Ochtertyre Moss	Wester Moss
			Stank Moss	marginal area	central area							
No. of quadrats	10	5	34	9	26	15	25	55	25	31	25	17
Mean % *Sphagnum* cover	8	81–100	69	21	72	70	31	27	48	52	88	47
Indicator species												
Rhyncospora alba			53	11	50	40	12	5		13		
Vaccinium oxycoccos	70	100			4	87	40	60	84	87	100	12
Drosera spp.	70	80	76	11	77	100	48	47	68	77	88	41
Narthecium ossifragum		20	76	22	50	100	68	33	8	48		
Sphagnum pulchrum					4			2	4		32	6
Sphagnum rubellum		100	21		27	100	56	44	60	61		
Cladonia impexa	10		56	100	42	7	92	69	64	29		
Cladonia uncialis			32			7	68	15				
Cladonia arbuscula					4		12	5				
Intrusive species												
Campylopus sp.	50		9		4	7		5	8	10		18
Polytrichum commune		20						7	4	3		12
Polytrichum agg.		20	9					35	64	48	4	76
Molinia caerulea	20					7	4	2				
Trichophorum cespitosum			44	22	4	80	4	9	8	6		
Cladonia agg.	30		12	11	4		12	24	16	3		

Table 14. Objective assessment of sites surveyed within the current project, derived by applying the scoring system described in the text to the data in Table 13.

Site		*Sphagnum* score	Indicator species		Intrusive species		Total score
			number	score	number	score	
Cockerham Moss		0	3	9	3	-3	6
Meathop Moss		20	4	15	2	-2	33
Longbridge Muir:	Stank Moss	15	6	18	4	-4	29
	marginal area	5	4	9	2	-2	12
	central area	15	8	18	3	-3	30
Offerance Moss		15	7	24	3	-4	35
Collymoon Moss		5	8	23	3	-3	25
Flanders Moss (east)		5	9	19	6	-6	18
Killorn Moss		10	6	18	5	-6	22
Little Kerse Moss		10	6	19	5	-5	24
Ochtertyre Moss		20	3	12	1	-1	31
Wester Moss		10	3	5	3	-4	11

Table 15. Quality data for sites surveyed by Greig (1975) and Lindsay (1978).

Study area	Site No.	Site name	Mean quality score	Location and extent (where available) of area studied	Source
SOUTH CUMBRIA	4	Shaw Moss	17	Arnaby Moss, community 8	Lindsay (1978)
	6	Wreaks Moss	21	Bank End Moss, community 1	
			20	Little White Moss, community 1	
	7	White Moss	16	community 1	
	9	Heathwaite Moss	-4	community 4	
SOLWAY (CUMBRIA)	6	Wedholme Flow	27	community I, 32.0 ha	Greig (1975)
			27	community III, 11.0 ha	
			26	community L, 33.5 ha	
			25	community J, 20.0 ha	
			24	community II, 8.0 ha	
			21	community C, 12.5 ha	
			3	community A	
	8	Bowness Common	34	community I, 12.0 ha	
			26	community F, 16.5 ha	
			23	community L, 38.5 ha	
			10-19	communities II-VIII, X, XI, XIII-XV, A-C	
			<10	communities IX, XII, J, K, M	
			<10	community XIVb	
	9	Glasson Moss	46	community I, 2 ha	
			33	community II, 2 ha	
			20	community III, 21.5 ha	
			12	community V	
			3	community IV	
	10	Drumbrugh Moss	9	two transects across bog	

Table 16. Quality of remaining moss areas in England (+: <1%).

		AREA (ha)						
Study area	Site	Moss	Score 20+	Score 10-20	Score <10	Burnt	Scattered trees	Unknown quality
LANCS. LOW-LANDS	1. Chat Moss	5						5
	21. Cockerham Moss	2			1.6		0.4	
	22. Heysham Moss	4				4		
SOUTH CUMBRIA	1. The Mosses	3						3
	2. Arrow Moss	3						3
	4. Shaw Moss	12		12				
	6. Wreaks Moss	29	29					
	7. White Moss	8		8				
	9. Heathwaite Moss	13			13			
	12. Leece Mosses	4						4
	13. Newland Moss	5						5
	14. Stribers Moss	16					16	
	15. Deer Dike Moss	10					10	
	26. Nichols Moss	31					31	
	27. Meathop Moss	10	10					
	28. Foulshaw Moss	10					4	6
	33. Savinhill Moss	2					2	
SOLWAY	4. Cowper Bog	1						1
	6. Wedholme Flow	179	117		+	35		27
	8. Bowness Common	439	67	+	+	183		189
	9. Glasson Moss	70	25.5	+	+	44.5		
	10. Drumburgh Moss	88			88			
	12. White Moss	19					19	

Table 17. Quality of remaining moss areas in Scotland (+: <1%).

		AREA (ha)						
Study area	Site	Moss	Score 20+	Score 10-20	Score <10	Burnt	Scattered trees	Unknown quality
SOLWAY	20. Priestside Flow	18						18
	22. Longbridge Muir	170	170	+				
	38. Kirkconnell Flow	20					18	2
FORTH VALLEY	4. Offerance Moss	28	15				13	
	5. Garchell Moss	2						2
	6. West Flanders Moss	2						2
	9. Collymoon Moss	13	13					
	11. East Flanders Moss	548		411			137	
	13. Killorn Moss	22	12				10	
	14. Little Kerse Moss	12	11				1	
	17. Wester Moss	5		3			2	

Table 18. Distribution and quality of remaining moss areas (by study area).

STUDY AREA	LANCASHIRE LOWLANDS		SOUTH CUMBRIA		SOLWAY (CUMBRIA)		SOLWAY (DUMFRIES AND GALLOWAY)		FORTH VALLEY	
Status	ha	%	ha	%	ha	%	ha	%	ha	%
Score 20+			39	25	209.5	26	170	82	51	8
Score 10-20			20	13					414	66
Score <10	1.6	5	13	8	88	11				
Burnt	4	36			262.5	33				
Scattered trees	0.4	4	63	40	19	2	18	9	163	26
Unknown quality	5	45	21	13	217	27	20	10	4	0.6
Totals	11	1	156	9	796	44	208	12	632	35

Table 19. Quality summary of remaining moss areas.

	ENGLAND		SCOTLAND		TOTAL	
Status	ha	%	ha	%	ha	%
Score 20+	248.5	26	221	26	469.5	26
Score 10-20	20	2	414	49	434	24
Score <10	102.6	11			102.6	6
Burnt	266.5	28			266.5	15
Scattered trees	82.4	9	181	22	263.4	15
Unknown quality	243	25	24	3	267	15
TOTAL	963		840		1803	

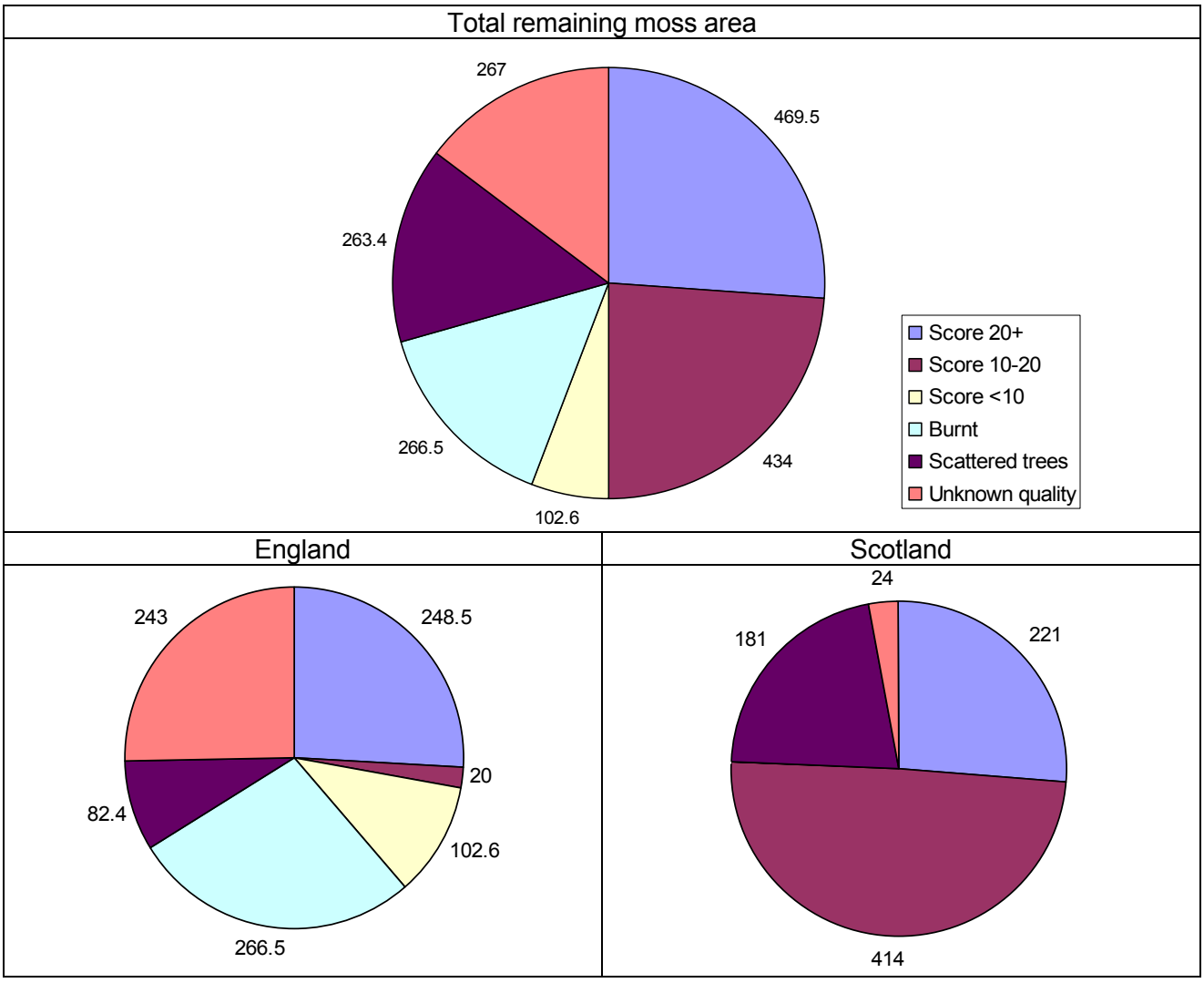


Figure 25. Graphical representation of the quality of the total moss area remaining at the end of the survey (upper diagram), and of the breakdown of these data between England (lower left) and Scotland (lower right).

5.3 Existing conservation measures for remaining sites

The sites retaining 10 ha or more of moss are listed in descending order of size in Table 20, and those with smaller areas of moss in Table 21. Conservation measures currently in force are indicated.

Table 20. List of sites that retained 10 ha or more of unaltered moss at the end of the survey, arranged in descending order of the area of moss recorded and indicating any statutory (SSSI, NNR) and voluntary sector protection currently in place. Unprotected sites marked with double asterisks have confirmed high-quality moss (Score 10+, Tables 16 and 17) and those marked with single asterisks retain unconverted areas with unknown vegetation quality.

Site number	Site	Area of moss remaining (ha)	SSSI	NNR	Trust reserve
FOR 11	East Flanders Moss	548	√	p	√
SOL 8	Bowness Common	439	√	p	
SOL 6	Wedholme Flow	179	√	p	
SOL 22	Longbridge Muir**	170			
SOL 10	Drumburgh Moss	88	√		p
SOL 9	Glasson Moss	70		√	
SCUM 26	Nichols Moss	31	√		
SCUM 6	Wreaks Moss**	29			
FOR 4	Offerance Moss	28	√		
FOR 13	Killorn Moss	22	√		
SOL 38	Kirkconnell Flow	20		√	
SOL 12	White Moss	19			p
SOL 20	Priestside Flow*	18			
SCUM 14	Stribers Moss	16		√	
SCUM 9	Heathwaite Moss	13			
FOR 9	Collymoon Moss**	13			
SCUM 4	Shaw Moss**	12			
FOR 14	Little Kerse Moss	12	√		
SCUM 15	Deer Dike Moss	10		√	
SCUM 27	Meathop Moss	10	√		√
SCUM 28	Foulshaw Moss*	10			

Table 21. List of sites that retained less than 10 ha of unaltered moss at the end of the survey, arranged in order of the area of moss recorded and indicating any statutory (SSSI, NNR) and voluntary sector protection currently in place. Unprotected sites marked with double asterisks have confirmed high-quality moss (Score 10+, Tables 16 and 17) and those marked with single asterisks retain unconverted areas with unknown vegetation quality..

Site number	Site	Area of moss remaining (ha)	SSSI	NNR	Trust reserve
SCUM 7	White Moss	8	√		
LANCS 1	Chat Moss*	5			
SCUM 13	Newland Moss*	5			
FOR 17	Wester Moss**	5			
LANCS 22	Heysham Moss	4			
SCUM 12	Leece Mosses*	4			
SCUM 1	The Mosses*	3			
SCUM 2	Arrow Moss*	3			
LANCS 21	Cockerham Moss	2	√		
SCUM 33	Savinhill Moss	2			
FOR 5	Garchell Moss*	2			
FOR 6	West Flanders Moss*	2			
SOL 4	Cowper Bog*	1			

Of the 21 sites in Table 20, 13 have statutory protection; four are National Nature Reserves (NNR) and nine are scheduled as Sites of Special Scientific Interest (SSSI) including three proposed NNRs. Two of the smaller (<10 ha) sites - White Moss (part of the Broughton Mosses) and Cockerham Moss, the only scheduled site in the Lancashire Lowlands - are also designated as SSSI. At least parts of three of the protected sites are also existing or proposed local trust reserves, and one Trust reserve is proposed for an otherwise unprotected site (White Moss).

The most notable unprotected sites are Longbridge Muir and Wreaks Moss, with 170 ha and 29 ha of high-quality unaltered moss respectively. Unprotected sites with 5–13 ha of high-quality moss are Collymoon Moss (de-scheduled SSSI), Shaw Moss and Wester Moss. Eight of the ten sites with 'unknown quality' moss have less than 10 ha of this land cover type, and the largest 'unknown quality' areas are on Priestside Flow (18 ha) and Shaw Moss (12 ha).

6. CONCLUSIONS

1. The 14,257 ha of lowland raised mire (116 sites) selected as the focus of this study have suffered substantial land use change since the mid-19th century as a result of successive expansions of agriculture, drainage and/or peat extraction, and finally afforestation. Built (urban) development has encroached almost negligibly onto the mossland, but there has been a tendency for woodland to spread onto any mire surface that remained otherwise unconverted.

2. Patterns of change have varied geographically, but overall the area of moss has declined linearly by 87% over a period of *ca*. 120 years. If the trend is projected into the future, total extinction of the habitat is predicted for the year 1989, which is only five years from the date of this report.

3. Half of the 1803 ha of moss that remains has been confirmed to be in fair or good condition (quality score 10+); 35% is degraded through burning or invasion by trees, or simply has low-quality vegetation; and it has not been possible to ascertain the condition of the other 15%.

4. A maximum of 1437 ha of the remaining moss area has statutory protection. This represents 82.3% of the remaining resource but only 10.4% of the moss area that existed in the mid-19th century.

5. Of the 34 sites that still have unconverted surface, only 15 have statutory protection and one further site is proposed as a Local Trust reserve. The 18 unprotected sites include three with vegetation of the highest (score 20+) quality extending to a total area of 212 ha, including the site with the fourth largest expanse of unconverted moss identified (Longbridge Muir); two with areas of fair-quality (score 10–20) vegetation extending to 15 ha; and 10 whose condition has not been ascertained (53 ha). All of these sites remain available for conversion to other uses.

6. Six of the protected sites are degraded, indicating that statutory protection of a site does not necessarily mean that its mossland characteristics, especially vegetation, will be preserved.

7. REFERENCES

Birse, E.L. (1956) Reclamation of Scottish Peat Land. *Town and Country Planning*, March 1956.

Cadell, H.M. (1913) *The Story of the Forth*. James Maclehose & Sons, Glasgow.

Cadell, H.M. (1929) Land reclamation in the Forth Valley. *Scottish Geographical Magazine*, 45, 7–22.

Charnley, J.R. (1904) Cockerham Moss: Being a short account of a Lancashire Guller. Extract from NCC files without full reference details seen.

DAFS (1964) *Scottish Peat Surveys, Volume 1, South West Scotland*. Department of Agriculture and Fisheries for Scotland / HMSO, Edinburgh.

Davis, H. (1975) *George Stephenson: the Remarkable Life of the Founder of the Railways*. Weidenfeld and Nicolson.

Fraser, A. (1969) *Mary Queen of Scots*. Book Club Associates, London.

Gorham, E. (1953) Some early ideas concerning the nature, origin and development of peat lands. *Journal of Ecology*, 41(2), 257–274.

Greig, D.A. (1975) *Raised Bogs in north-west Cumbria*. Report commissioned by the Nature Conservancy Council, 94 pp.

Hall, B.R. & Pollard, C.J. (1970) *Soils of Lancashire*. Harpenden.

Lindsay, R.A. (1978) *The Peatlands of the Duddon Valley*. Report for the Nature Conservancy Council, 81 pp.

MAFF (1958) *A Survey of the Uncultivated Lowland Moss Areas of Lancashire*. Ministry of Agriculture, Fisheries and Food /ALS Technical Report No. 3.

McCarthy, J. (1964) The growth and regeneration of Scots pine on Rusland Moss National Nature Reserve. Report to the Nature Conservancy Council.

Marshall, J.R. (1961) Investigations into some aspects of the physiography of the upper Solway marshes and mosses. Extract from NCC files without full reference details seen.

Oldfield, F. (1956) *The Mosses and Marshes of North Lancashire*. B.A. Geography thesis, Liverpool University.

Stamp, L.D. (1943a) *The Land of Britain*, *Part 49: Cumberland.* Report of the First Land Use Survey.

Stamp, L.D. (1943b) *The Land of Britain*, *Part 50: Westmorland*. Report of the First Land Use Survey.

Stamp, L.D. (1946) *The Land of Britain, Part 23: Stirlingshire*. Report of the First Land Use Survey.

Taylor, J.A. & Alexander, T.W.M. (1954) The peat industry in Somerset and Lancashire. *Proceedings of the International Peat Symposium, Dublin, July 1954*. Bord na Mona.

Tew, J.F.B. (1956) *The Development of Land Use Patterns on Some Lowland Lancashire Mosses*. MA thesis, Reading University.

Thomas, J. (1972) A study of the mosslands of southern Lakeland and a preliminary survey of their Coleoptera. Extract from NCC files without full reference details seen.

Walker, J. (1772) Account of the irruption of Solway Moss on December 16, 1772. *Philosophical Transactions of the Royal Society*, 62, 123–127.

APPENDIX

Preliminary reports on the Historical Survey of Lowland Raised Mires, Great Britain.

COUNCIL OF EUROPE/CONSEIL DE L'EUROPE
European Committee for the Conservation of Nature and Natural Resources
Group of Consultants – peatlands

Study of Impacts on Lowland Raised Mires

by Dr D A Goode (UK), December 1978

Résumé

Une influence croissante de l'agriculture, de la génie forestière et du drainage sur la productivité des bas pays, brittanniques a changé l'aspect de ces régions avec le résultat que les habitats qui autrefois taient considerés pauvres possèdent maintenant la pour les marais ombrogènes. Cet habitat diminue d'une façon accé1erée parce que les nouvelles techniques de drainage, rendant plus rentable l'amélioration des terrains.

Une étude est en train pour établir, la perte pendant la période l84O–l978 et pour évaluer la perte causée par l'agriculture, la génie forestière et la tourbage. Quatre sites ont été choisies – Lancashire, South Cumbria, the Solway et Forth Valley, et les limites des tourbières au-dessous de 30 mètres étaient dessinées sur une carte, utilisant des sources très variées: des cartes topographiques (Ordnance Survey) datant de 1840-1860, 1883-1900, des cartes sur l'utilisation du terrain de 1930 et de 1960, des photographies aériennes de 1940-1950 et de 1970 et des cartes géologiques.

Une fois les cartes terminées, la perte peut être calcu1ée en comparant les superficies de marais ombrogènes intervalles determinées depuis 130 ans. Des chiffres provisories pour une site – the Solway – indiquent que la perte entre 1860 et 1970 était d'environs 70% cela superficie originelle.

Introduction

The increasing pressure from agriculture, forestry, horticulture and drainage authorities to improve the utilization of lowland Britain has meant that many habitats which were once considered marginal land are now looked upon as potentially productive areas. This trend has important implications for the conservation of lowland raised mires. This habitat is now vanishing rapidly as new drainage and planting techniques make the job of reclamation feasible. The difficulty of obtaining medium or low–grade agricultural land for planting has led the Forestry Commission to become dependant on peat deposits for lowland planting in many parts of Britain. In addition the raised mires have formed the only source of peat for horticultural and garden/domestic use, although much is also imported from Ireland and Finland. The Water Authorities continue to promote extensive drainage of such areas to improve land drainage for agriculture, and the availability of improvement grants has encouraged many farmers to tackle the reclamation of peatlands within their holdings as a long-term investment.

A thorough assessment of these trends is essential if a comprehensive approach to the conservation of this habitat is to be formulated. The Nature Conservancy Council commenced a detailed study of this kind in 1976 and the following is a brief summary of this work.

Methods

To determine the rate and extent of land use changes, it was necessary to obtain figures for the extent of peatland habitat at a definite date, then at a number of subsequent dates. For each interval the total area of mire lost to each form of exploitation was assessed. This revealed in quantitative terms the various threats to this habitat over an extended period, and their change in relative significance during this time.

An initial desk study of peatlands below 30m in Scotland, Wales and Western England was carried out to identify the general distribution of raised mire habitat. From this inventory four major concentrations – the Solway Firth, the South Cumbria River Valleys, the Forth Valley and the Lancashire Lowlands - were selected as study areas. These were chosen to demonstrate detailed changes of land use, and to highlight any Regional variation in the form of exploitation.

Although a considerable body of information relating to the Study Areas exists, extending as far back as the "tithe maps" of the late 18th Century (and for a number of individual sites much earlier still), for the purposes of this study it was essential that detailed and comparable information should be available for all sites for a specific period to establish an overall baseline for the study.

The first standardized description including all the Study Areas and carried out within a relatively short period is the 1st Edition 6" scale Ordnance Survey, begun in 1840 and completed in 1865. This therefore formed the basis for the initial assessment of raised mire habitat. Certain problems were encountered in defining the peatland boundaries due to the simplified system of map symbols used in this Edition, but such difficulties were largely overcome by reference to the 6" Geological Survey Maps, surveyed in the 1920s.

Having established the total extent of raised mire for the period 1840-1865, the process was repeated for a number of defined periods:—

1) 1883-1900 : 6" Ordnance Survey, Second Edition

2) l930—1939 : First Land Use Survey of Great Britain

3) l945—1949 : Aerial photography

4) l968—1972 : Aerial photography

5) 1978 : actual field survey

The field survey of 1978 was designed to do more than simply define the latest extent of raised mire habitat; where open moss was still found to exist, botanical information was obtained in order to determine the actual state of the mire surface. This is particularly important when considering the nature conservation value of these sites, as a number have retained open mire surfaces but are now so modified by peripheral drainage, burning or grazing that they no longer support an active raised mire vegetation association. The final assessment therefore summarises the total surviving areas of <u>active</u> raised mire as a proportion of the original extent in 1840-1865.

Preliminary Results

Losses up to 1900 consist almost entirely of agricultural reclamation and peat extraction, either commercially or for domestic purposes. Massive reclamation schemes which began during the 18th Century continued to show benefits well into the 1 9th Century, and much mossland was thus lost in the latter half of the 1900s. At the same time commercial peat extraction began to supply an increasing demand for peat from the horticultural industry.

In the late 1800s railway lines were built across relatively unproductive areas of the coastal plains, and several mire systems were divided into smaller units by this process. Perhaps of more significance from a nature conservation viewpoint is that all surviving examples of the ecological gradient from raised mire to estuarine salt marsh were lost from the Study Areas at the same time.

The next fundamental change in land use followed the establishment in 1919 of the Forestry Commission. In its search for plantable land the Forestry Commission has in the last 20 or 30 years come to look upon lowland raised mires as an increasingly attractive prospect, combining low agricultural value with the better lowland climate. The result is that afforestation now represents the largest single threat to the survival of remaining raised mire habitat.

Finally all these forms of exploitation have been considerably helped by the efforts of the Water Authorities in improving the drainage systems associated with lowland Britain.

Table 1 presents the detailed changes in land use on the Solway Firth for the period 1860-1970 as an example of the nature and extent of change encountered for the four Study Areas.

Examination of the individual Study Areas does reveal significant regional variation in the methods of exploitation. Lancashire shows perhaps the most dramatic change, as the 20,250 ha of raised mire which once dominated the Lancashire coastal plain have now been reduced to one small site, totalling 8 ha, although even this has suffered a massive fire and its survival is in grave doubt. Agricultural reclamation has been the major cause, together with a small amount of commercial peat extraction. The same forms of exploitation continue to fragment the mires of South Cumbria, although here peat extraction tends to be for domestic purposes. One block of forestry has been established on a particularly large mire to the east of the Study Area, but to the west extensive areas of open raised mire still survive. The south side of the Solway supports perhaps the largest concentration of relatively undisturbed lowland raised mires in Britain. Commercial peat extraction is the major threat, affecting a number of sites. However the north side is almost entirely devoted to Forestry Commission plantation. Certain sites have been partially reclaimed for agriculture, and others exploited for peat, but the massive inroads of the Forestry Commission have destroyed almost all the remaining mire sites. The Forth Valley has suffered two phases of exploitation; an initial phase of reclamation before the turn of the century, and then a recent enormous increase in the rate of afforestation. Nevertheless a number of important sites continue to survive.

TABLE 1. Total area (ha) lost to exploitation, or surviving in some form, between the period l860—l970 for the Solway Firth Raised Mires.

Site	Forestry and Agriculture (1)	Peat cutting (2)	Raised Mire (3)
S Solway			
Wedholme Flow	220	387	235
Drumburgh Moss	88	-	96
Newton Flow/Oulton Mosses	28	8	26
Rockcliffe/Harker Mosses	105	8	4
White Moss	27	41	12
Bowness Common/Glasson Moss	354	98	655
Total (ha)	822	542 •	1028
(Original total of moss in 1860:	2392 ha)		
% of original total	34%	23%	43%
N Solway			
Lochar Mosses	932	199	235
Cockpool Mosses	249	276	222
Solway Moss	86	297	-
Lightwater/Hassock Mosses	10	3	-
Drungens Moss	65	14	18
Kirkconnel Flow	121	14	32
Little Bampton Moss	38	14	11
Hangingshaw/Chapel Moss/Cowper Bog	5	14	2
Priestside Flow/Ladyhall Moss	98	91	-
Redhills Moss	239	79	50
Dornock Flow/Nutberry/Westhills and White Mosses	160	95	35
Total (ha)	2003	1096	605
(Original total of moss in 1860:	3704 ha)		
% of original total	54%	30%	16%
% Total of whole Solway Group	46%	27%	27%

Note (1) “Forestry and Agriculture” includes agriculture, forestry plantation, woodlands, buildings etc.

Note (2) “Peat cuttings” includes peat cutting, drainage and other gross modifications which retain an open peat surface which may regenerate.

Note (3) Mire” represents uncut mossland, still with the original raised mire surface, although this may be severely modified by burning, grazing or drying out.

Implications for Nature Conservation

This study has revealed for the first time the full scale of the problem for conservation, both in terms of total loss of lowland raised mire habitat and the rate at which it continues to be lost to various forms of exploitation. The situation has already been reached where any surviving examples of relatively undisturbed raised mire are of importance for nature conservation, but this inevitably brings the aims of nature conservation into direct conflict with those of other land uses. Indeed the fewer the sites which remain, the more desirable they become for all forms of land use, and nature conservation, offering no direct financial return, is often in danger of being relegated to a minor position when decisions affecting the future of these sites are made. Fortunately, however, the conservation movement has been able to identify all the significant remaining areas and provide some form of protection for the vast majority of these. Table 2 summarizes all remaining areas of active raised mire in the four Study Areas, together with their conservation status.

TABLE 2 Conservation status of surviving raised mire areas.

National Nature Reserves (including proposed)	6
Local Trust Reserves	3
Sites of Special Scientific Interest(SSSI)	9
Proposed SSSI	9
No conservation status	3
Total number of sites	30

NEWS RELEASE

The NCC has recently completed a historical review of land use changes since 1850 affecting lowland “raised-bogs”. Such bogs were once commonplace in low-lying districts where they developed by the gradual accumulation of peat over 5,000 years. In the north of England they are known as Mosses, and in many places the name “Moss-side” is now the only clue to the former presence of a raised bog. The study included 120 different bogs and was based on four regions in Scotland and northern England where such bogs are extensively developed. Changes in land use were determined from the First and Second Edition Ordnance Survey maps (approximately 1850 and 1900) and from successive aerial photographs during the past thirty years.

The decline in mossland over this period has been dramatic. By 1978, 87% of the original area had been utilised in one way or another. Only 34 areas of bog remained, half of which were reduced to fragments of less than 10 ha. All the remaining bogs were affected by fragmentation and piecemeal reclamation around their margins. In the Lancashire Lowlands, 99.5% of the mossland has been reclaimed, and none of the other study areas has more than 20% remaining.

Agriculture, forestry and commercial peat extraction were the main causes of this reduction in bog habitat. Most of the agricultural reclamation took place prior to 1900, the main change during this century resulting from afforestation. Conversion to agriculture accounts for 36% and forestry 37.5% of the original mossland, but the past thirty years have also seen the development of a horticultural peat industry which has competed for the remaining areas of bog and 11% of the original mossland has been developed for this purpose.

Apart from small fragments, virtually all the remaining areas of raised bog are notified as SSSIs, yet even on these there is continuing pressure for new developments. There have been several new applications for peat winning within SSSIs during 1980 and the scarcity of peat has reached the point when even recently afforested bogs are being seriously considered for acquisition by the horticultural peat industry. Some of the remaining bogs are still being converted to agriculture, but an important precedent was established last year when grant aid for agricultural improvement on part of Bowness Common SSSI was refused because of its importance for nature conservation. Unfortunately the rarity of such bogs as a wildlife resource is not always appreciated. A District Council in Wales recently proposed to use the local raised bog, again an SSSI, for domestic refuse disposal. The NCC has objected and the matter will shortly be the subject of a Public Inquiry.

D.A. Goode
07 January 1981.