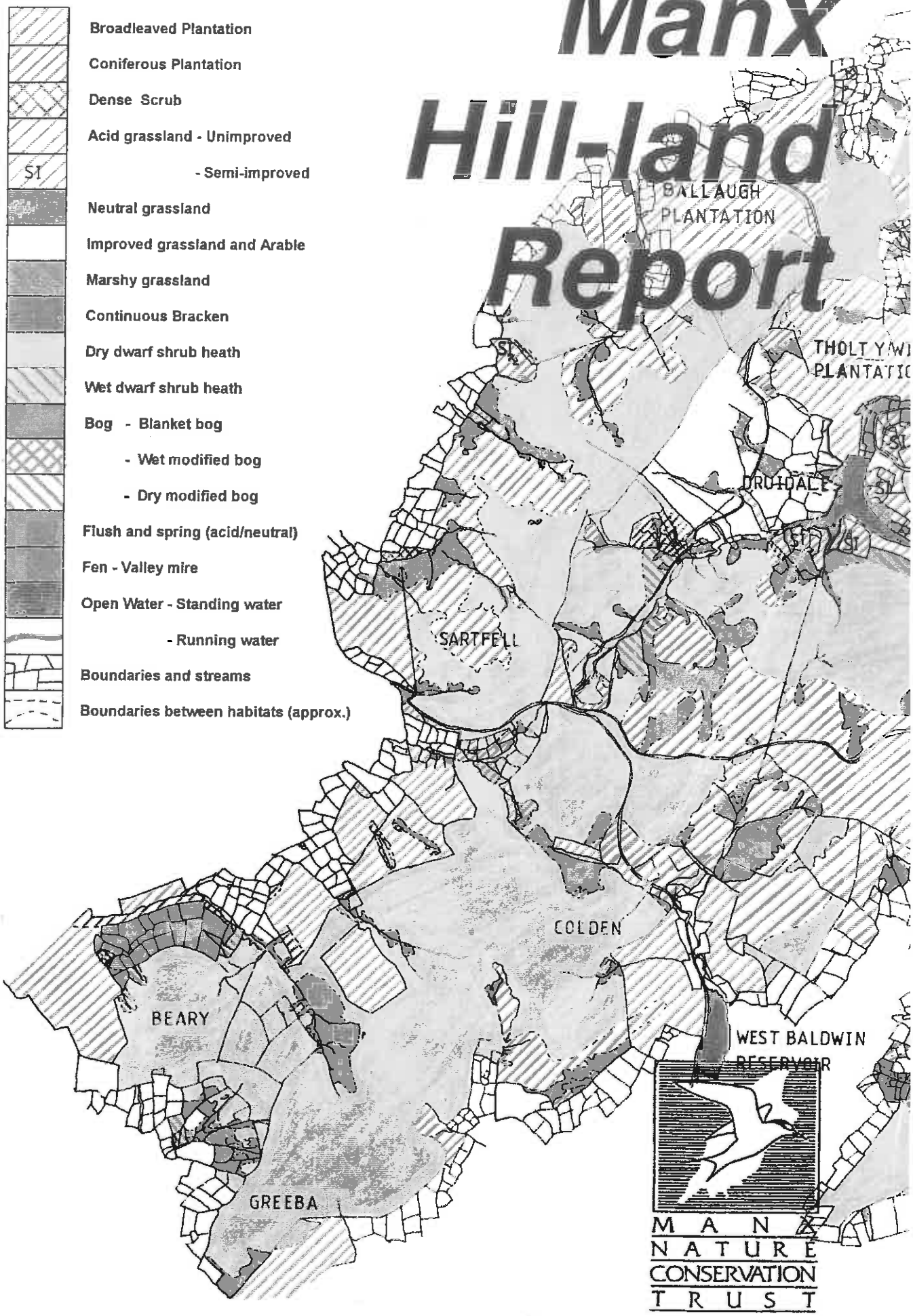
Manx Hill-land Report



Manx Hill-land Report

Edited by

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(Manx Nature Conservation Trust)

Putting *wildlife* on the map

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This report is dedicated to the memory of Robin, Earl of Northesk, of Springwaters, Ballamodha, Isle of Man, a long-standing member of the Manx Nature Conservation Trust. Robin had a particular interest in the Island's hill-lands, taking a keen interest in heather moorland and its management for the benefit of the red grouse. He was involved from the beginning in the hill-land initiative under the auspices of the MNCT until his untimely death at the beginning of 1994. We deeply regret that Robin did not witness the production of this report, hence it is dedicated to his memory. We all miss him.

The editors wish to thank all those who contributed to this report, particularly Dr Paul Bregazzi for his help with editing the text.

CONTENTS

1.1 ORIGINS OF THE HILL-LAND REPORT AND SEMINAR

Numerous letters and articles expressing concern at the afforestation programme were published in the Manx papers between October 1991 and the end of 1994. In 1993, the Manx Nature Conservation Trust (MNCT) was invited by the late Earl of Northesk to examine the possibility of changing Government policy towards the hill-lands. The Trust's Conservation Officer was asked to progress this matter and a meeting of concerned parties (the late Earl of Northesk, Allen Moore of the Manx Ornithological Society and Bruce Walker of the Game Preservation Society with John Lamb, the MNCT Conservation Officer) was held on 26 July 1993. It was decided that a consortium should be formed which would recommend to the Department of Agriculture, Fisheries and Forestry that certain areas of the hill-land merited designation as Areas of Special Scientific Interest (ASSI's) through the Wildlife Act 1990 and that a detailed report on all aspects of the hill-land should be prepared.

Meetings with Major Crellin, the Earl of Northesk and the MNCT Conservation Officer were held on 2 and 17 August 1993 to discuss how best to increase public awareness and present a case to Government. In order to measure the degree of interest in and concern for the Manx uplands, it was agreed that a questionnaire should be made widely available to the public.

The questionnaire and an accompanying letter asking for support in presenting a case to the Manx Government for the protection and proper management of the Manx hills was sent to all hill-land shooting and grazing tenants, MHK's, Commissioners, and Manx and UK conservation organisations. Though the Department of Agriculture, Fisheries and Forestry felt unable to supply a list of tenants information was provided by the shooting tenants.

The Isle of Man Examiner printed the questionnaire and letter on 14 September 1993. By the beginning of November a total of 77 hill-land questionnaires had been returned to the MNCT together with 28 letters (not including letters of acknowledgement) several of which answered the questions. The results are presented below:

Of the 81 responses to the question; "Are you aware of the recent depletion of the Manx Red Grouse population ?"

58 replied YES (71.6%) and 23 NO (28.4%).

Of the 79 responses to the question; "Do you agree that some areas of hill-land should be designated as ASSI's in order to conserve the habitats and their characteristic flora and fauna ?"

75 replied YES (94.9%) and 4 NO (5.1%).

Of the 82 responses to the question; "Do you agree that the establishment of a Hill-land Working Party to discuss the Manx hills and their management is a good idea ?"

78 replied YES (95.1%) and 4 NO (4.9%).

Of the 70 responses to the question; "Would you like to make an input into the production of the report to be presented to Government ?"

46 replied YES (65.7%) and 24 NO (34.3%).

Preliminary results of the hill-land questionnaire, were published in the Courier together with a further copy of the questionnaire on 4 November 1993.

Support for the designation of Areas of Special Scientific Interest (ASSI) and the formation of a Hill-land Working Party was received from a wide variety of persons and organisations on the Island and from the UK, including farmers and conservationists who are united in their concern over the afforestation programme. All those wishing to contribute to the report were consulted and their views have been incorporated into this publication, where appropriate.

The consortium met again on 22 November 1993 and a draft contents page for the report was approved. Authors for the various sections were identified. An article was written for the Winter 1993/94 *Newsletter* of the MNCT and articles were published in the *Natural World* and *Field* magazines.

Following an offer from the Executive of the Heather Trust to carry out a survey of the heather moorland on the Island for no charge other than travel expenses, a visit was arranged for 20-22 December. The Executive of the Heather Trust was shown around the Southern Hills on 20 December and the Northern Hills on 21 December 1993. His observations and discussions with shooting tenants and other concerned individuals during the visit formed the basis of a report to the MNCT on the condition of Manx heather moorland.

It is of interest to note that in November 1993, the Department of Agriculture, Fisheries & Forestry announced revised consultation procedures. From 1994 the Water Authority, Manx National Heritage, DLGE, Local Authorities, DHPP, MNCT and MOS will receive information including maps and outline planting proposals for the successive year. In the past people had often complained that the creation of new plantations was not publicly announced, with the result that members of the public were often shocked to come across a new plantation. Whilst the above is an improvement in public relations there is still widespread concern that the afforestation programme and hill-land management are conducted with little consideration for public opinion.

The consortium suggested that the organisation of a Hill-land Seminar would be an appropriate means of drawing attention to the value of the hills, the pressures upon them and provide an opportunity to discuss possible options for their future management. The MNCT agreed to take on the responsibility of organising such a seminar which will take place on the 11-13 April 1995 at King Williams College, Castletown, Isle of Man.

1.2 SUPPORTERS

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and the late

Robin Northesk
W.K. Quirk, M.L.C., C.P.

Manx organisations:

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Arbory Parish Commissioners
Ballaugh Parish Commissioners
Bride Parish Commissioners
British Horse Society (IoM Branch)
Celtic League
Centre for Manx Studies
German Parish Commissioners
Isle of Man Natural History and Antiquarian Society
Isle of Man Friends of the Earth
Jurby Parish Commissioners
Manx Airlines Project 2000, Ballasalla
Manx Game Preservation Society
Manx National Farmers Union
Manx Wind Energy Services,
Maughold Parish Commissioners
Mec Vannin
Onchan District Commissioners
Santon Parish Commissioners
Society for the Preservation of the Manx Countryside & Environment

UK-based organisations:

Botanical Society of the British Isles,
British Association for Shooting & Conservation, Wrexham
British Lichen Society, Leicester
British Trust for Ornithology, Norfolk
Hawk and Owl Trust, London
Heather Trust, Stirlingshire
Plantlife, London
The Wildlife Trusts (Royal Society for Nature Conservation), Lincoln
World Wide Fund for Nature, Surrey, Godalming

1.3 THE MNCT AND THE WILDLIFE TRUSTS

The Manx Nature Conservation Trust, founded in March 1973, aims to protect Manx wildlife by preventing habitat destruction and by the careful management of sites. It is a registered charity and a member of The Wildlife Trusts (see below).

The MNCT is run mainly by volunteers and now has over 700 members. With headquarters in St Johns, it owns and manages 12 nature reserves, totalling over 120 acres, and operates two visitor centres, The Ayres and Scarlett. These provide detailed information to the public on local natural history and both have nature trails and education packs.

The Wildlife Trusts are an association of 47 Wildlife Trusts which work to protect wildlife in town and country over much of the British Isles including England, Wales, Scotland, Ulster and Guernsey as well as the Isle of Man. Sharing the goal and making a vital contribution to its attainment are the junior branch, Wildlife Watch, and 48 Urban Wildlife Groups established in towns and cities.

Through their care of over 2,000 nature reserves, The Wildlife Trusts are working towards the goal of a countryside richer in wildlife, managed on sustainable principles. With specialist skills in conservation and education, The Wildlife Trusts seek to gain recognition from the public that a countryside where wildlife thrives is essential to a healthy environment and continued human wellbeing.

1995 has been designated European Nature Conservation Year (ENCY) to celebrate 25 years of conservation effort since the first European Conservation Year in 1970. It was in that year that the Manx Conservation Council was formed. One aim of the MCC was the establishment of a Wildlife Trust on the Island, a goal achieved three years later when with the Council's help, the Manx Nature Conservation Trust was founded.

The Isle of Man is fortunate in retaining much semi-natural vegetation in attractive countryside, including several sites of international importance. Sadly, however, the Manx government lags many years behind the United Kingdom and its European neighbours in recognising the importance of our natural heritage. Government funding for wildlife conservation is negligible and much legislation, already working elsewhere, is lacking on the Island. It is considered to be particularly important that the Manx Nature Conservation Trust is involved in European Nature Conservation Year 1995. We hope that media attention to Conservation Year events will help increase public awareness of our rich wildlife heritage so that the need to preserve it *now* for the benefit of future generations will be obvious to all.

1.4 SUMMARY

Public opposition to the continued planting of large-scale conifer plantations on Manx hill-lands has increased in the 1990s. In July 1993 the Manx Nature Conservation Trust set up a hill-land initiative which led to the production of this report and the organisation of the Hill-land Seminar held on 11-13 April 1995.

The post-glacial history of the vegetation cover of the Island is discussed and the climate is described briefly.

An account is provided of the geology. The uplands are chiefly formed of Manx slates.

The hill-lands comprise the largest areas of semi-natural habitat on the Isle of Man. The categories of habitat are described, their status discussed, full-colour habitat maps presented and threats highlighted.

Manx heather moorland is considered in the light of the recent decline of this habitat in the British Isles and elsewhere. Losses due to afforestation, reclamation for agriculture and heavy grazing are noted. Changes in hill-land management have resulted in the spread of bracken and gorse and the replacement of heather by grasses and rushes.

Afforestation is identified as the most important threat to heather moorland. Present Government plans for afforestation will lead to a loss of 64% of heather moorland on plantable Government-owned land by the year 2010. Additional losses have resulted from heavy grazing, encroachment by bracken and agricultural reclamation.

Habitat loss is further exacerbated by fragmentation of remaining habitats leading to reductions in the breeding and foraging ranges of animals and birds. The importance of maintaining the integrity of habitats which serve as connections between areas of semi-natural vegetation and provide for the movement of flora and fauna is stressed.

The Manx hills support internationally important populations of chough, hen harrier and curlew and are also important for the red grouse, merlin, raven and owls. Since 1977, the Manx population of hen harrier has built up to one of the largest in any area of the British Isles. The Island supports over 22% of the British and Manx population of Chough and the hill-lands are crucial as a feeding area for this bird.

The role of non-avian vertebrates in the hill-lands is discussed. Mountain hares, indigenous brown trout and, in the southern hills, brown hares are considered to be most at risk from development.

The status of the red grouse is considered in detail. The species is confined to heather moorland and afforestation on the most productive areas for grouse has caused a decline in grouse numbers in recent decades due to habitat loss and fragmentation.

The occurrence of invertebrates in the hill-lands and in forest plantations is discussed. Results from a recent survey of spiders on an upland hillside show that the fauna is comparable to similar sites in northern England.

The effects of afforestation on upland fauna is discussed at length. Afforestation may bring benefits to a few common species including fungus flies and booklice but much of the hill-land fauna, including rarer species and those which depend on open country are excluded.

It is noted that although higher plants and birds are well documented in upland habitats, survey work is urgently needed to increase our knowledge of other groups.

Upland management is discussed and shortcomings are identified. In particular the heather moorland, which requires careful management, often fails to receive proper care. The Island is of such a size that a positive management programme could be successfully initiated, funded and implemented through cooperation between landowners, tenants, Government, ecologists and archaeologists.

A brief history of afforestation on the Island is provided. By 1985 approximately 2,000ha of conifer plantation had been established. The Afforestation Programme approved by Tynwald in 1985 aimed to plant a further 2,000ha by the year 2000 but his figure has since been amended to an extra 1,300ha by 2005.

Locally-produced timber is low in quality and quantity and it is believed that timber products can be imported more cheaply than they can be produced on the Island. Financial aspects of the Afforestation Programme are questioned and the need for a detailed analysis of costs and benefits is stressed.

Upland hydrology is discussed and the need for a base-line study of water and water courses is emphasised.

The question of acidification in soil and water in catchments where conifer afforestation has taken place is discussed. The need for research on the Island to ascertain if such effects occur here is stressed.

The Isle of Man has outstanding upland landscape which can easily be altered by afforestation and other changes in land use.

The hills contain the richest source of well preserved archaeological remains and evidence in the Island. Primary survey work is urgently required to document sites.

The cover of blanket peat on the hills preserves a record of the history of the Manx vegetation, environmental changes and the impact of human activities.

Afforestation is most likely to occur at lower altitudes which are the very areas in which most archaeological evidence is concentrated. Ground preparations prior to planting can easily destroy structural evidence.

The hills represent a major leisure resource for Manx residents and increasingly for tourists. This resource is under-exploited and is being damaged by land use policies. At relatively low cost a great deal more could be made of the resource in terms of literature, events, walks, training courses and on-site interpretation. Other activities are discussed including peat digging, bilberry picking and landscape painting.

Future options for the hill-lands are discussed. These include designation of statutory and non-statutory sites of ecological importance; protection through Town and Country Planning controls; the establishment of a hill-land working group; provision of management grants and training courses. A possible future for afforestation on the Isle of Man is presented, together with opportunities for enhancing existing plantations and the restoration of degraded habitats.

The lack of adequate planning controls over afforestation and the construction of access roads across open moorland is highlighted.

It is noted that large areas of hill-land would qualify for ASSI status under the Wildlife Act 1990, but that a lack of commitment on the part of Government to act in this matter is evident.

The need for the establishment of an independent government agency to administer wildlife legislation and promote nature conservation is stressed.

2 HISTORICAL BACKGROUND

2.1 A history of vegetation development on the hills (After Garrad 1972 and Allen 1984)

The present day native flora descends from that which colonised the Island as the ice withdrew at the close of the last glaciation. One or two arctic plants such as the least willow (*Salix herbacea*) and the liverwort (*Lepidozia pinnata*), which survive on Snaefell, have persisted through at least some of the glacial periods, but these are very few and are special cases. For all practical purposes, the Island was swept clean and recolonisation had to begin afresh.

It is thought that the land connection with England was broken around 9,000 years ago (Allen 1978).

As the ice retreated, large pieces of ice were left behind buried in the debris. When this ice melted, a depression was left which often became a dub (pond) known as "kettle holes" which are important because study of the silt and peat which accumulated in the holes can reveal a lot about the development of vegetation. Under peaty conditions, pollen shed by flowering plants, may survive for thousands of years and it is possible to determine what plants grew in and around the area and thus what the weather was like. Changes in the groups of plants suggest that some deposits started forming before the last cold period. This is a further indication that the Isle of Man was not completely covered by ice.

The post-glacial development of vegetation on the Isle of Man parallels that in Britain and Ireland since the connecting land bridge was not yet severed. After the ice retreated, tundra gave way to grassland with flowering herbs and scattered birch copses in sheltered places. At about 8800-8300 BC the climate became colder and grasses decreased but the odd cold spell was short-lived and willows and birches spread rapidly, followed by hazel. The hazel remained a constituent of the understorey in a mixed forest with sessile oak and small-leaved lime and common alder on the wetter areas. Scots Pine was also common and birch persisted. This dense woodland covered most of the Island so the campsites of the first detectable human visitors are found near the coasts and in areas where thin, shallow soils would have produced sparser tree cover. The arrival of neolithic settlers about 2500BC was probably marked, as shown elsewhere by pollen analysis, by the clearance of woodland for agricultural use, the clearing being subsequently maintained by grazing domestic animals. There was then a steady attrition of woodland. Timber was used for building houses and boats and later for smelting metals.

Despite this exploitation there were a few trees to shelter the army before the battle of Sky Hill in 1079. Historical observers were unanimous in their description of the Island's treeless landscape. The near complete deforestation must have greatly affected the wildlife and probably caused the extinction of many species of animal and plant, including the wild cat and the red fox. It is likely that red and roe deer, pine marten, red squirrel and the wolf were once present (Garrad 1972). Woodland birds now absent include the jay, hawfinch and, except for rare visitors, woodpeckers.

Isolated groups of oaks still survive on several coastal cliffs and in a few steep glens. Occasionally they are accompanied by hazel but in the Bloc Eary valley, Sulby Glen, there is also rowan, holly and birch. Secondary growth from older stools indicates that they pre-date the main period of reforestation in the 18th Century.

As the ice retreated cold-loving plants were replaced by open grassland accompanied by birch which probably grew in scattered groups. Another cold spell then allowed willow to be more common than birch but when the climate warmed again many of the arctic plants died out and birch woodland again became dominant. During the succeeding boreal, when summers were longer and warmer than today, pine and hazel appeared and were joined by oak before the land bridge was severed by rising sea levels forming the Irish Sea.

The subsequent destruction of the natural woodland was through human activity, but fluctuations in the climate may have hastened the decline of the woodlands. Whatever the causes, 17th and 18th Century writers were unanimous in their description of a treeless landscape and most of the modern plantations and glens date from the 19th Century or later.

The first forests were dominated by birch, but the reign was comparatively short, as the all-prevailing tree of colder northern climates, the Scots Pine (*Pinus sylvestris*), replaced the birch which withdrew northwards and higher up the hills as a terminating fringe. Probable descendents of these original birches still linger on the hills, as the clearly native race *Betula pubescens* ssp. *tortuosa*. The Scots Pine was the only native coniferous tree on the Isle of Man (not including the native coniferous shrub, the Juniper) but has been extinct for some centuries (Allen 1984). Sub-fossil examples have been unearthed from the hill peat - up to 1,000 feet on Mount Karrin.

As the climate became warmer, the pine in turn gave way to broadleaved deciduous trees. By 7,000 years ago, the principal component of the "mixed oak forest" were oak itself, hazel, wych elm and alder. This oak-dominated forest survived until its eventual destruction by humankind.

Woodland clearance began with the arrival of Mesolithic people, some 9, 000 years ago, even before an island existed perhaps (Allen 1984). Mesolithic people initiated the clearance in order to hunt more easily but inadvertently initiated the soil changes which led to the formation of blanket bog (as opposed to climatic deterioration as formerly thought).

Seemingly relic oak-hazel woods occur in lower Glen Maye and upper Glen Auldyn and at numerous localities on the east coast cliffs from Traie ny Halsall to Santon Gorge.

As late as the 11th Century documentary records suggest that there were still considerable woods. But by 1500, if not earlier, all the trees of any size appeared to have gone (Allen 1984).

As elsewhere in the British Isles, Bracken is spreading despite attempts at its control and it now covers 3.5 % of the Island's land surface (Phase 1 habitat survey, DAFF in press, pers. comm.). It is especially concentrated on foothills and on the western sea coast (see Figures 2 and 3).

The untilled land, particularly the hills, was treated as common land on which livestock were pastured and turf (peat) cut for fuel. From an early date, enclosures licenced by the Lord and known as "intack" were made from the `waste' (Garrad 1972).

The upper limit of arable land is about 600ft (183m) above which there is often a band of rough grazing which was more intensively farmed in the past when climatic or agricultural conditions were more favourable. In some areas, it has proved possible to greatly improve the quality of grazing by ploughing, fertilising and reseeding but the rate of leaching in the wetter areas makes this unprofitable (Garrad 1972).

2.2 Woodland history in the 19th and 20th centuries

The main period of reforestation was initiated by bishops and private landowners in the 18th century. Planting continued in the 19th century particularly in the creation of pleasure gardens, for example, Injebreck (Garrad 1972).

The first major plantation was at Archallaghan (SC300790) in 1883 with 371 acres (150ha) planted by 1894 on land retained by the Crown at the time of the Disafforestation Act of 1886, as were those at South Barrule (SC2776) with 265 acres (107ha) planted in 1884-94 and the 156 acre King's Forest or Greeba Plantation (SC320810). The Isle of Man Arboricultural Society was formed in 1897 and planted 48, 300 trees, mainly European larch, on Slieau Whallian (SC276811) around 1906. Unfortunately, the area available for planting was such that, as with the King's Forest, the edge of the plantation runs in a sharp line at right angles to the contour and complaints of damage to the view were justified (Garrad 1972) and still are. Their work at Tholt-y-Will (SC3789) in Sulby Glen was more aesthetically pleasing and laid the foundation for the attractive mixed planting. Planting continued into the 1914-18 war, which made heavy inroads into the Island's meagre timber stocks (Garrad 1972).

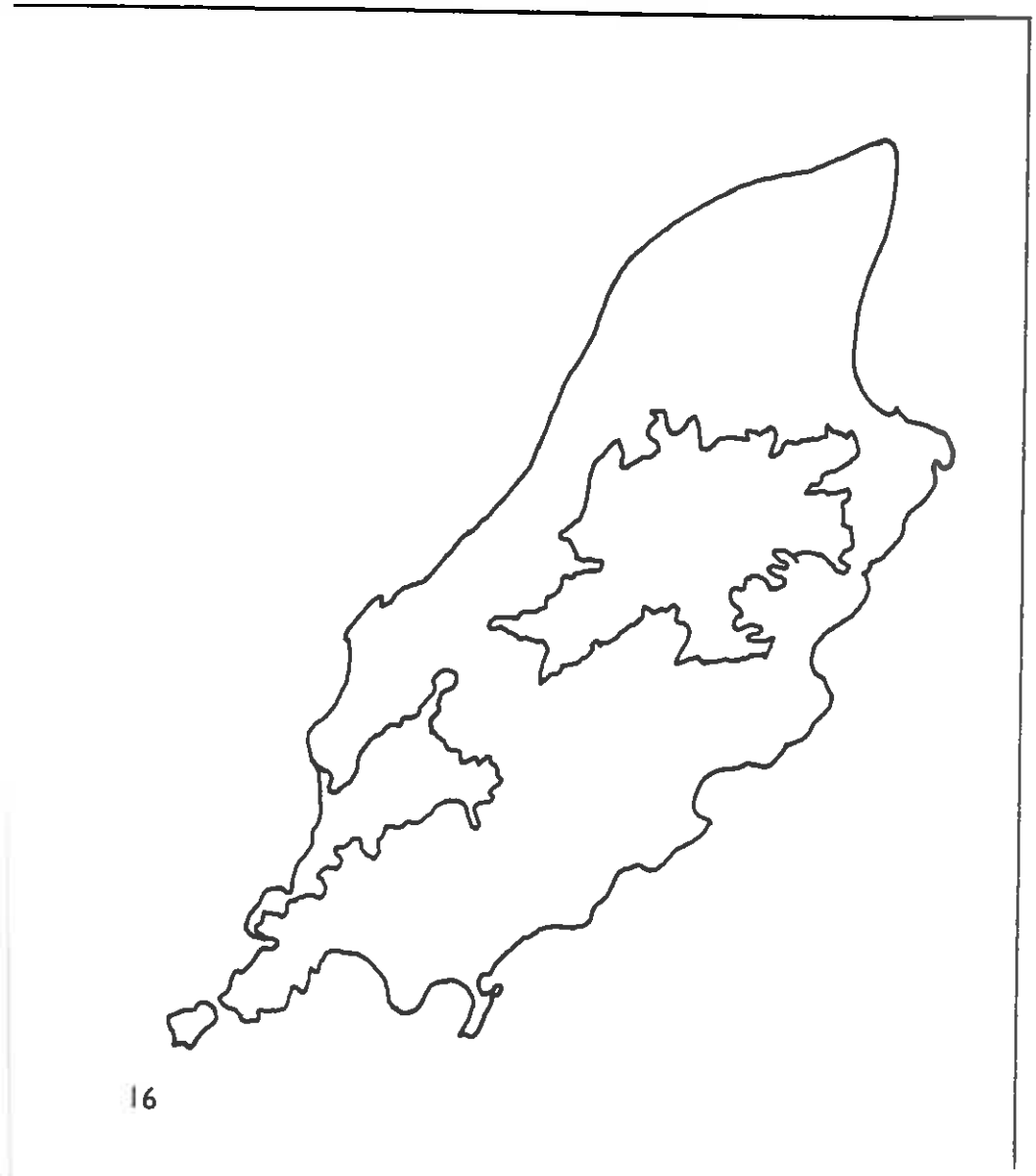
There was some planting in the 1930's but mainly of rather small areas. There was again much wartime felling between 1939-45 and the main period of replanting came after 1950 when the Isle of Man Forestry, Mines and Lands Board was set up. The Board planted conifers including Sitka and Norway spruce, Douglas fir, Scots and Corsican pine, Japanese and European larch. Some hardwoods were included, notably at Colden (SC355840) and Tholt-y-Will, and plantations were fringed with ornamentals and hardwoods (Garrad 1972).

An outstanding broadleaved plantation is present at Montpelier (SC354881) which was first enclosed about 1763 from hill pasture. The beech trees subsequently planted are 750-800ft (229-244m) above sea level and the trees are about 75ft tall. It supports a considerable fungus flora which is almost without equal in the Isle of Man. The plantation should be managed so as to ensure its regeneration and thus the survival of this very interesting woodland (Garrad 1972).

During the 20th Century, some 5,930 acres (2,400ha) have been planted with conifers in some 50 plantations. Plans approved by Tynwald in 1985 proposed doubling the area of conifer plantation by planting a further 7000 acres (2,833 ha) by the year 2000. In 1987 the target was reduced to 5000 acres (2024 ha) over 15-20 years, accompanied by re-planting of failed plantations and improvements to hill-lands to compensate the agricultural tenants for land lost to forestry.

Further information on the plantations and the Afforestation Programme is presented in section 3.8.

Figure 1 Location map of the Isle of Man



3 AN EVALUATION OF THE MANX HILLS

3.1 Introduction - climate and topography

The Isle of Man is approximately 30 miles (48km) long by 10 miles (16km) broad covering an area of approximately 227 square miles (58,793ha or 145,275 acres). Agricultural habitats account for 86% of the area, urban 7%, forest and woodland 5% and non-agricultural habitats 2% (NCC/ITE 1975). The resident population is estimated to be 71,114 and it is assumed that the population will increase to 75,000 by the year 2000 (IoM Government 1994).

The hills are aligned north-east/south-west and fall into two distinct blocks: the southern hills culminating at 1585 feet (483m) on South Barrule; and the northern hills which include Snaefell at 2036 feet (621m) as their central and highest point and a further 19 peaks over 400m in altitude. The two hill groups are separated by a narrow central valley extending from Douglas and Peel. At their northern edge the hills drop away steeply to the northern plain. The southern hills generally slope gradually to the lowlands, but in the south-west they slope abruptly to the sea.

The Gulf stream produces a winter sea temperature several degrees warmer than Liverpool Bay or the Irish Coast (Colman 1953). As a result the climate is decidedly 'Atlantic' with normally mild winters and cool summers, a comparitively high rainfall and very slight frosts. The flora and fauna display a predominantly western aspect in their composition.

No part of the Island is more than six miles from the sea, which consequently exerts a strong influence on temperature conditions on the land. The main effect is that variations are reduced so that the Island has an especially equable temperature distribution, both seasonally and daily (Birch 1960).

Rainfall, by contrast, varies markedly between parts of the Island, making it the most important factor influencing the pattern of plant distribution. Mean annual rainfall is in the region of 60 inches (1500mm). Unlike the temperature, long-term fluctuations in the Island's rainfall are quite sizeable.

The hills, as would be expected, receive much higher rainfall than the lowlands and experience generally the worst climatic conditions. Only on the hills is fog common and only there, in normal years, does snow persist. Wind speeds are also highest in the hills. High winds are mostly westerlies, but easterly gales also occur, especially in the spring.

The high level of salt in the gales which sweep the west coast in particular, is likely add to the affect of wind on the distribution of flora and fauna. The great differences in wind exposure from one location to another suggest that this must play a major role, together with temperature and rainfall, in influencing distribution patterns. There is much, however, to be learned about the Island's microclimate.

The hill-land are the most extensive of the semi-natural ecosystems on the Isle of Man (DAFF, in press, pers.comm), and indeed in the British Isles as a whole (Ratcliffe 1977). With the exception of the truly montane areas in Scotland, these upland habitats are dominated by heather moorland and acidic grasslands.

3.2 Geology
by Eva Wilson

3.2.1. Solid geology (After Dackombe, 1990)
Although a casual glance at the geological map of the Isle of Man reveals that it is dominated by slates, there are a variety of geological features packed into a remarkably small area. The long coastline provides easy access to striking sections of rocks ranging from slates and greywackes of Cambro-Ordovician age, through Devonian fluviatile sandstone and conglomerates, Carboniferous limestones and volcanics to some of the finest Quaternary glacial sections in the British Isles.

The Isle of Man is an inlier of Lower Palaeozoic greywackes, the Manx Group, in the centre of the northern basin of the Irish Sea. It forms part of the Caledonian orogenic belt and can be related to similar rocks in the English Lake District and south-east Ireland. During the Caledonian orogeny the Manx Group suffered mild metamorphism, faulting and intense folding and was intruded by two late- orogenic granites. The Island forms an upstanding massif which protrudes through the younger cover of Carboniferous and Permo-Triassic sediment which extends eastwards into the Solway, Lancashire and Cheshire Lowlands and west into eastern Ireland around Dublin.

The Carboniferous rocks extend on to the Isle of Man in the south-east around Castletown where a basal conglomerate succeeded by limestones and extrusive, basic volcanics lie unconformably upon the Manx Group. On the west coast, around Peel, younger sediments consisting of red sandstones and conglomerates of Devonian age are downfaulted into the Manx Slates. The northern plain of the Island is thickly manteled with glacial deposits and the solid rocks are buried at least 40m below sea level. Despite this, the lure of an extension of the West Cumberland Coalfield on to the Island has led to a number of exploratory borings being sunk through the glacial drift. These have proved a sequence of Lower Carboniferous limestone and shales overlain unconformably by Permo- Triassic sandstones shales and saliferous marls.

The Manx Slates are host to a range of intrusive igneous rocks including, as well as many dykes, two granites (the Foxdale and Dhoon), a compound acidic/basic/ultrabasic intrusion (the Oatland Complex) and a diabase or grabbro (Poortown).

3.2.2 The upland massifs (After Dackombe and McCarroll, 1990).
Although the total area of the Isle of Man is only about 590 km sq., the diversity of scenery and landforms is such that eight broad physiographic regions may be defined. The Island is dominated by two upland massifs which are separated by the central valley, running from Douglas to Peel. The broadly triangular northern plain, composed entirely of glacial drift, lies beyond a steep northern escarpment, whilst fringing the uplands to the east and less prominently to the west are the rolling coastal plateaux. In the south of the Island, the eastern coastal plateau gives way gradually to the low, relatively flat plain of Malew which is overlooked in the south west by Mull Hill (Meayl Hill) and the Calf of Man.

The northern and southern upland massifs are dominated by two high slate-cored ridges, guided by the dominant north-north-east to south-south-west Caledonide structural trend, which also accounts for the elongated shape of the Island. The western and lower of the two ridges runs from Mount Karrin in the north, through Slieau Dhoo, Slieau Freoghane and Beary Mountain. It is incised by the central valley at St Johns and continues through the southern massif via Slieau Whallian and Dalby Mountains to the steep slope of the coast at Gob yn Ushtey. The eastern ridge can be traced

from North Barrule through Clagh Ouyr to Snaefell, the highest point of the Island at 621m, and on to Greeba Mountain overlooking the central valley. It continues via South Barrule (483m), the highest peak in the southern massif, and abuts the coast at Cronk ny Irree Laa.

In the northern massif, above about 200m and excluding the main ridges, the terraine forms a series of shallow upland basins and dissected high plateaux. Over most of the area drift, comprised exclusively of local lithologies, blankets the landscape resulting in a smoothly undulating topography. Although occasionally bare rock surfaces can be found which display convincing striae, the northern uplands are conspicuously lacking in classical glacial landforms, and only one valley, Laxey Glen, shows any semblance of a typical 'U' shape. Hill peats are well developed in the centre of the northern uplands, particularly around Mullagh Ouyr and Beinn y Phott.

The southern upland massif is generally similar to that in the north, though the closeness of the two main slate ridges reduces the amount of high plateau. Also, the western ridge is much more subdued than its northern counterpart, with only Slieau Whallian exceding 300m in height.

Through the upland areas the rivers and streams are deeply incised into what appear to be preglacial valleys and are bordered by distinct terraces, the higher being the remnants of former solifluction features and the lower aggradational alluvial terraces.

The highest parts of the main ridges, particularly on the flanks of Snaefell and along the North Barrule-Clagh Ouyr ridge are notable for the relatively high proportion of solid rock exposed. Altiplanation terraces, blockfields, boulder runs and tor-like features all attest to the severity of conditions on these maritime highlands.

Temple (1956) mapped a series of terraces and associated slope breaks around the margins of the upland massifs and interpreted them as representing no less than nine Plio-Pleistocene strandlines ranging in height between 15 and 207m. It is difficult to establish to what extent these fetaures reflect structural or lithological control, however, and this, taken together with their presence in areas of very restricted fetch, such as along the central valley, suggests that they might be more reasonably attributed to periglacial processes.

3.2.3 Mines and mining (After Ford, 1993)

The Isle of Man has a long history of metal mining with the earliest records being in the 13th century. Stone hammers found on Bradda Head suggest even earlier, probably Bronze Age, mining. The three main groups of mines are at Laxey with the nearby Snaefell mine, at Foxdale with the associated Glen Rushen Mines, and at Bradda Head near Port Erin (Cowin and Scarffe c.1991, Lamplugh 1903, Carruthers and Strahan 1923, Skelton 1956). There are over a hundred smaller mines, trials and optimistic adits. The main ores were sulphides of lead, zinc and copper; small amounts of silver were obtained and traces of gold. Iron ore was mined at Stack Mooar and near Maughold Head in the northeast. The host rock for the veins was the Manx Group, particularly the Maughold Banded formation and associated granites. Recorded production between 1845 and 1938 was 268,000 tons of lead concentrates, 256,000 tons of zinc concentrates, 14,000 tons of copper concentrates, 25,000 tons of iron ore and substantial amounts of silver, making the Manx mines some of the most productive in Britian. Foxdale ore was predominently galena, mostly argentiferous, whilst at Laxey sphalerite was the chief ore. The Manx output amounted to a fifth of all the zinc ever produced in the British Isles, and perhaps as much as 5 % of the lead. Small quantities of antimony, manganese, titanium, nickel and molybdenum ores have been found.

The success of the Manx mining industry in Victorian times has led the Manx Government into wishful thinking that it could be revived, and comprehensive surveys were commissioned in the 1950s to no avail. Indeed the widespread occurrence of mines and trials and the use of waste materials for roads and tracks throughout the island has led to so much contamination that stream sediment geochemical surveys were of little value. The host rocks for the mineral veins is the Manx Group or the intrusive granites though the ores are much younger: no veins of any significance have been found in the Carboniferous rocks, which might suggest a pre-Carboniferous age for mineralization, though there has also been speculation that there was a cover of Carboniferous Limestone at the time of mineralization. Ineson and Mitchell (1979) have determined K-Ar dates on some 30 clay gouges in veins or from altered wall-rocks. The dates indicate several episodes of mineralization at 310-320 Ma, 285 Ma, 250Ma and 220Ma with a possible Tertiary remobilization. These are mid-and late Carboniferous, Permian and Triassic, comparable with the dates obtained for similar mineral deposits in the Lake District. Mobilization of ore-fluids during periods of tectonic stress associated with the Armorican earth movements may have generated the ore deposists in the Isle of Man as in other parts of Britain.

3.2.4 Slate and building stone (After Ford, 1993)

As noted above, much of the Manx "Slate" Group is not true slate, but one subdivision, the Barrule Slates, has been quarried for (roof) slate and is still quarried for building stone on South Barrule. Old "slate" quarries occur near the Round Table, and in Glen Rushen. The slates could not be split as thinly and evenly as those of North Wales and their use died out when bulk transport of the latter became possible. However, slabs for building walls could be obtained, and some of the South Barrule quarries are still yielding these. Flaggy beds of Lonan Flags have similarly yielded building blocks, chiefly from the old quarries on Douglas Head. The flat-bedded massive sandstones in the Lonan and Niarbyl Flags have been quarried in various parts of the Island, notably around Peel, where they were used for building the massive walls of Peel Castle. On Spanish Head a particular form of the slate yielded long and strong stone 'beams' which were used in Castle Rushen as floor boards, for example, and as lintels all over the Island. The red Peel Sandstone was quarried on Creg Malin headland north of Peel Bay.

The Carboniferous Limestone was quarried, particularly from the foreshore along the south coast. Three quarries near Ballasalla and Castletown are still producing limestone, mainly for aggregate and agricultural purposes. Roadmetal is at present produced from the gabbro at the governments quarries at Poortown.

3.3 Upland flora - plants and plant communities
by John Lamb

3.3.1 Habitats

The Manx hill-land were recently surveyed following the standard methodology of Phase 1 habitat survey (see *Phase 1 handbook*, NCC 1990), a system developed by the Nature Conservancy Council and used initially in Scotland, Cumbria and Yorkshire. Field work on the government owned hill-land of the Isle of Man, a total of 23,632 acres (9,571ha) was carried out by two ecological surveyors (Ms Tricia Sayle and Mr John Lamb) on contract to the Department of Agriculture, Fisheries and Forestry in summer/autumn 1991 as part of a Phase 1 survey of the whole Island. Preliminary results, on which the present accounts are based, were presented to the Isle of Man Farming and Wildlife Advisory Group on 14 April 1992.

Ten major Phase 1 categories of habitat are represented in the Manx hill-land:

A Woodland and scrub
B Grassland and marsh
C Tall herb and fern
D Heathland
E Mire - bog
- flush and spring
- fen
F Swamp, marginal and inundation
G Open water
H Coastland
I Rock exposure and waste
J Miscellaneous

In the accounts which follow, the Phase 1 definition for each habitat category is given in a separate panel, followed by a discussion of its status in the Manx hills. Threats to the major habitat categories are highlighted at the end of each section. Survey maps showing the distribution of the habitats are presented in Figures 2 and 3, and an analysis of the data by area is given in Tables 1 and 3.

A standard system of Phase 2 survey for woodland and scrub, mire and heath, grassland and montane communities has recently been published (Rodwell 1991a, 1991b and 1993) as part of the National Vegetation Classification which should be applied to the ecologically interesting areas on the Isle of Man. A Phase 2 survey of those areas identified as being of ecological importance in the Phase 1 habitat survey is currently being undertaken by two ecological surveyors employed by the Department of Agriculture, Fisheries and Forestry. This survey is more comprehensive than Phase 1 and involves production of more detailed site maps, a more exhaustive species list and the assignment of abundance ratings to those species recorded. Whilst the survey is including semi-natural woodlands, it is not intending to survey the Manx hill-land. Although the Phase 2 survey currently being carried out on the Isle of Man does not follow the National Vegetation Classification, the results can be assigned to a NVC habitat type coding.

A Woodland and scrub

A1 Woodland

Phase 1 definition: Woodland is defined as vegetation dominated by trees more than 5m high when mature, forming a distinct, although sometimes open, canopy. The habitat divisions are:

A1 Woodland
- A1.1 Broadleaved
  - A1.1.1 semi-natural
  - A1.1.2 plantation
- A1.2 Coniferous
  - A1.2.1 semi-natural
  - A1.2.2 plantation
- A1.3 Mixed
  - A1.3.1 semi-natural
  - A1.3.2 plantation

Phase 1 definitions of the main categories are:

A1.1 Broadleaved woodland: 10% or less conifer in the canopy

A1.2 Coniferous woodland: 10% or less broadleaved in the canopy

A1.3 Mixed woodland: 10-90% of either broadleaved or conifer in the canopy

If the cover of trees is less than 30% the area is referred to as having scattered trees

A2 Scrub

A3 Parkland and scattered trees

A4 Recently felled woodland

Semi-natural woodland

Phase 1 definition: Semi-natural woodland comprises all stands which do not obviously originate from planting. The distribution of species will generally reflect natural variations in the site and its soil. Both ancient (pre-1600) and more recent stands are included. In the Phase 1 habitat survey the following are included in the semi-natural category:

Woods with planted standard trees in semi-natural coppice

Mature plantations (more than about 120 years old) of native species growing on sites where those species are native and where there are semi-natural woodland ground flora and shrub communities

Self-sown secondary stands of exotic species (for example, sycamore and pine)

Alder carr and willow carr (Manx = curragh) where the willows are more than 5m tall (although *Salix cinerea* should always be classified as scrub)

Well-established sweet-chestnut coppice (that is, over 25 years old)

Woods which have been completely underplanted, but where the planted trees do not yet contribute to the canopy

Stands of young trees or coppice regrowth, even when less than 5m

Plantation woodland

Phase 1 definition: All obviously planted woodland of any age, with the exception of those types mentioned above, and including ornamental tree gardens and arboreta.

Table 1 Analysis of the Phase 1 habitat data for the Government-owned hill-lands for 1991 (northern and southern hills combined)

	Phase 1 survey code	Total area (ha)	%	No of units	Mean area (ha)	SD	Largest area (ha)	Smallest area (ha)
Semi natural habitats:								
Broadleaved woodland	A.1.1.1	1.48	0.02	2	0.74	0.14	0.88	0.60
Dense scrub	A2	3.20	0.03	6	0.53	0.31	1.08	0.12
Unimproved acid grassland	B1.1	2398.06	25.05	72	33.31	232.27	1984.64	0.12
Semi-improved acid grassland	B1.2	102.84	1.07	29	3.55	6.96	37.28	0.12
Unimproved neutral grassland	B2.1	0.92	0.01	1	-	-	0.92	0.92
Semi-improved neutral grassland	B2.2	5.24	0.05	5	1.05	0.88	2.56	0.20
Marshy grassland	B5	96.60	1.01	36	2.68	5.74	32.48	0.16
Continuous bracken	C1	336.32	3.51	125	2.69	6.41	42.96	0.12
Tall ruderal	C3.1	0.36	0.01	2	0.18	0.02	0.20	0.16
Dry heath	D1	4100.56	42.84	48	85.43	313.89	1807.28	0.12
Wet heath	D2	171.82	1.80	66	2.60	3.68	17.76	0.12
Blanket bog	E1.6.1	99.24	1.04	23	4.31	4.97	15.48	0.20
Wet modified bog	E1.7	4.76	0.05	3	1.59	0.87	2.32	0.36
Dry modified bog	E1.8	67.32	0.70	8	8.42	15.13	47.00	0.64
Flush	E2	305.20	3.19	179	1.71	3.71	34.04	0.12
Valley mire	E3.1	13.56	0.14	6	2.26	2.34	7.00	0.16
Standing water	G1	1.36	0.01	8	0.17	0.05	0.28	0.12
Hard cliff	H8.1	1.28	0.01	4	0.32	0.12	0.52	0.24
Coastal heath	H8.5	3.76	0.04	1	-	-	3.76	3.76
Total natural habitats		**7713.88**	**80.59**					
Artificial habitats:								
Planted broadleaved woodland	A1.1.2	4.08	0.04	5	0.82	0.74	1.96	0.16
Planted conifer woodland	A1.2.2	1094.44	11.43	24	45.60	48.45	168.72	0.40
Planted mixed woodland	A1.3.2	1.92	0.02	2	0.96	0.56	1.52	0.40
Improved/arable	J1.1	75.28	0.79	13	5.79	14.18	54.76	0.36
Poor semi-improved grassland	B6	35.56	0.37	12	2.96	7.13	26.52	0.12
Quarry and spoil	I2.1-2	20.28	0.21	15	1.35	2.04	6.28	0.12
Amenity grassland	J1.2	0.32	0.01	2	0.16	0.01	0.16	0.16
Bare ground	J4	16.64	0.17	9	1.85	3.09	9.88	0.12
Planted broadleaves on dry heath	A1.1.2/D1	10.04	0.10	8	1.26	1.05	3.36	0.40
Planted broadleaves on semi-improved grassland	A1.1.1/D1	0.16	0.01	1	-	-	0.16	
Planted conifers on dry heath	A1.2.2/D1	575.28	6.01	11	52.30	27.96	94.68	4.04
Planted conifers on wet heath	A1.2.2/D2	19.24	0.20	1	-	-	19.24	19.24
Planted mixed wood on dry heath	A1.3.2/D1	4.08	0.04	2	2.04	0.68	2.72	1.36
Total artificial habitats		**1857.32**	**19.41**					
Total all habitats		**9571.20**		**729**				

Table 2 Analysis of the Phase 1 habitat data for the Government-owned hill-lands for 1991 (northern hills)

	Phase 1 survey code	Total area (ha)	%	No of units	Mean area (ha)	SD	Largest area (ha)	Smallest area (ha)
Semi natural habitat:								
Broadleaved woodland	A.1.1.1	0.60	0.01	1	-	-	0.60	0.60
Dense scrub	A2	1.20	0.02	2	0.6	0.48	1.08	0.12
Unimproved acid grassland	B1.1	2395.26	34.01	66	36.29	242.37	1984.64	0.12
Semi-improved acid grassland	B1.2	91.56	1.30	21	4.36	7.98	37.28	0.12
Unimproved neutral grassland	B2.1	-	-	-	-	-	-	-
Semi-improved neutral grassland	B2.2	-	-	-	-	-	-	-
Marshy grassland	B5	92.00	1.31	28	3.29	6.37	32.48	0.24
Continuous bracken	C1	246.32	3.50	90	2.74	6.92	42.16	0.12
Tall ruderal	C3.1	-	-	-	-	-	-	-
Dry heath	D1	2856.08	40.56	29	98.49	344.69	1807.28	0.12
Wet heath	D2	84.02	1.19	44	1.91	2.64	12.92	0.12
Blanket bog	E1.6.1	99.24	1.41	23	4.31	4.97	15.48	0.20
Wet modified bog	E1.7	4.76	0.07	3	1.59	0.87	2.32	0.36
Dry modified bog	E1.8	67.32	0.96	8	8.42	15.13	47.00	0.64
Flush	E2	286.12	4.06	162	1.77	3.88	34.04	0.12
Valley mire	E3.1	13.56	0.19	6	2.26	2.34	7.00	0.16
Standing water	G1	0.12	0.01	1	-	-	0.12	0.12
Hard cliff	H8	-	-	-	-	-	-	-
Coastal heath	H8.5	-	-	-	-	-	-	-
Total natural habitats		**6238.16**	**88.58**					
Artificial habitats:								
Planted broadleaved woodland	A1.1.2	4.08	0.06	5	0.82	0.74	1.96	0.16
Planted conifer woodland	A1.2.2	478.20	6.79	14	34.16	48.77	168.72	0.40
Planted mixed woodland	A1.3.2	1.52	0.02	1	-	-	1.52	1.52
Improved/arable	J1.1	12.28	0.17	6	2.05	1.54	4.84	0.36
Poor semi-improved grassland	B6	3.40	0.05	3	1.13	0.62	2.00	0.56
Quarry and spoil	I2.1-2	3.00	0.04	4	0.75	0.42	1.36	0.20
Amenity grassland	J1.2	-	-	-	-	-	-	-
Bare ground	J4	12.32	0.17	7	1.76	3.34	9.88	0.12
Planted broadleaves on dry heath	A1.1.2/D1	6.84	0.97	4	1.71	1.30	3.36	0.40
Planted broadleaves on semi-improved grassland	A1.1.1/D1	-	-	-	-	-	-	-
Planted conifers on dry heath	A1.2.2/D1	280.88	3.99	5	56.18	15.89	74.16	33.36
Planted conifers on wet heath	A1.2.2/D2	-	-	-	-	-	-	-
Planted mixed wood on dry heath	A1.3.2/D1	1.36	0.02	1	-	-	1.36	1.36
Total artificial habitats		**803.88**	**11.42**					
Total all habitats		**7042.04**		**534**				

Table 3 Analysis of the Phase 1 habitat data for the Government-owned hill-lands for 1991 (southern hills)

	Phase 1 survey code	Total area (ha)	%	No of units	Mean area (ha)	SD	Largest area (ha)	Smallest area (ha)
Semi natural habitats:								
Broadleaved woodland	A.1.1.1	0.88	0.03	1	-	-	0.88	0.88
Dense scrub	A2	2.00	0.08	4	0.50	0.17	0.72	0.24
Unimproved acid grassland	B1.1	2.80	0.11	6	0.47	0.33	1.12	0.12
Semi-improved acid grassland	B1.2	11.28	0.45	8	1.41	1.50	5.32	0.52
Unimproved neutral grassland	B2.1	0.92	0.04	1	-	-	0.92	0.92
Semi-improved neutral grassland	B2.2	5.24	0.21	5	1.05	0.88	2.56	0.20
Marshy grassland	B5	4.60	0.18	8	0.58	0.52	1.52	0.16
Continuous bracken	C1	90.00	3.56	35	2.57	4.87	20.20	0.12
Tall ruderal	C3.1	0.36	0.01	2	0.18	0.02	0.20	0.16
Dry heath	D1	1244.48	49.21	19	65.50	258.67	1161.60	0.12
Wet heath	D2	87.80	3.47	22	3.99	4.87	17.76	0.28
Blanket bog		-	-	-	-	-	-	-
Wet modified bog		-	-	-	-	-	-	-
Dry modified bog		-	-	-	-	-	-	-
Flush	E2	19.08	0.75	17	1.12	1.06	3.12	0.12
Valley mire	E3.1	-	-	-	-	-	-	-
Standing water	G1	1.24	0.05	7	0.18	0.05	0.28	0.12
Hard cliff	H8	1.28	0.05	4	0.32	0.12	0.52	0.24
Coastal heath		3.76	0.15	1	-	-	3.76	3.76
Total natural habitats		**1475.72**	**58.35**					
Artificial habitats:								
Planted broadleaved woodland	A1.1.2	-	-	-	-	-	-	-
Planted conifer woodland	A1.2.2	616.24	24.37	10	61.62	43.18	123.80	0.48
Planted mixed woodland	A1.3.2	0.40	0.02	1	-	-	0.40	0.40
Improved/arable	J1.1	63.00	2.49	7	9.00	18.69	54.76	1.00
Poor semi-improved grassland	B6	32.16	1.27	9	3.57	8.14	26.52	0.12
Quarry and spoil	I2.1-2	17.28	0.68	11	1.57	2.33	6.28	0.12
Amenity grassland	J1.2	0.32	0.01	2	0.16	0.01	0.16	0.16
Bare ground	J4	4.32	0.17	2	2.16	1.96	4.12	0.20
Planted broadleaves on dry heath	A1.1.2/D1	3.20	0.13	4	0.80	0.35	1.36	0.40
Planted broadleaves on semi-improved grass	A1.1.1/D1	0.16	0.01	1	-	-	0.16	0.16
Planted conifers on dry heath	A1.2.2/D1	294.40	11.64	6	49.07	34.64	94.68	4.04
Planted conifers on wet heath	A1.2.2/D2	19.24	0.76	1	-	-	19.24	19.24
Planted mixed wood on dry heath	A1.3.2/D1	2.72	0.11	1	-	-	2.72	2.72
Total artificial habitats		**1053.44**	**41.65**					
Total all habitats		**2529.16**		**195**				

Woodland is valuable for a number of reasons including the provision of landscape features, shelter, noise/pollution filters, recreation and wildlife. Woodland is an important habitat for wildlife, in particular birds, bryophytes, lichens, fungi, wood-boring beetles and bats. The presence of glades and open areas provides structural diversity and shelter, with a mixture of woodland and other habitat communities. Mature trees can support valuable and often rare communities of bryophytes (mosses and liverworts) on their trunks and branches. Dead wood, both standing and fallen, when present is often colonised by a range of fungi and invertebrates, especially wood-boring beetles. The value of dead wood and the importance of leaving dead wood in situ, whether standing or fallen, wet or dry, cannot be over-emphasised.

The Isle of Man has precious little (0.3%, Phase 1 habitat survey, DAFF, in press, pers. comm.) semi-natural woodland and hence all woods of this type are of some importance. Most woodlands are noted for their displays of common plants which are certainly appreciated and noticed by many people. Familiar woodland plants include bluebell, primrose, wild garlic, lesser celandine, pignut, red campion, violet, wood avens, yellow pimpernel and various ferns. Most woodland plants flower in the spring taking advantage of the available light before trees and shrubs produce their leaves and create a woodland canopy which shades the ground.

Woodlands provide nesting sites for breeding birds, shelter and feeding for birds and bats, and support a diverse range of invertebrates. Very little is known, however, about the invertebrates on the Manx hills or on the Island at large. There is a clear need for further survey work to be carried out.

The understorey increases the structural and species diversity in a woodland and provides cover and shelter to the benefit of people and animal life.

The Phase 1 survey of government owned hill-land recorded only 3.7 acres (1.48ha) of semi-natural broadleaved woodland (Table 1), with 2.2 acres (0.88ha) on the southern hills, within Kerroodhoo Plantation (SC2276), and 1.5 acres (0.6ha) on the northern hills at Glen Dhoo, Ballaugh Glen (SC350910).

Plantations can be coniferous, broadleaved or mixed. The Manx government has planted chiefly conifers (spruce, larch and pine) on unenclosed dry heathland and enclosed semi-improved acid grassland. The original heathland or grassland vegetation persists along rides where present and among the trees until the canopy closes. Allen (1984) states that the conifer plantations, which then covered about 3% of the Island, appear to be devoid of interest floristically. This view, however, is considered extreme by the MNCT.

The following conifers have been widely planted in the Government plantations: Douglas fir, Norway and Sitka spruce, Silver fir, European larch, Japanese and hybrid larch, Scots pine, Corsican pine, beech pine and lodgepole pine. Scots pine *(Pinus sylvestris)* was formerly a native tree to the Isle of Man but has been extinct for some centuries. Sub-fossil examples have been found under hill peat and up to 1,000 ft on Mount Karrin (SC3791, Allen 1984).

A2 Scrub

Phase 1 definition: Scrub is seral or climax vegetation dominated by locally native shrubs, usually less than 5m tall, occasionally with a few scattered trees, and including the following:

European gorse, broom and juniper scrub

stands of bramble and dog rose

montane scrub

stands of mature hawthorn, blackthorn or grey willow, even if more than 5m tall

all willow carr less than 5m tall; all grey willow carr

The following are not included in this category:

very low least willow, creeping willow or bog myrtle

western gorse

hedges (see boundaries, J2)

stands of young trees or stump regrowth less than 5m high, where these represent more than 50% of the immature canopy cover

stands of introduced shrub species

Scrub can be composed of native or introduced/naturalised species and forms dense/continuous stands or scattered individuals or clumps. Native scrub normally supports a greater number of invertebrates (see Table 4) which in turn provide food for birds and mammals. Scrub can be important in providing height and structural diversity to otherwise low habitats such as grassland and heathland.

The Phase 1 habitat survey of government owned hill-land recorded only 7.9 acres (3.2ha) of dense scrub (Table 1), with 4.9 acres (2ha) on the southern hills and 3 acres (1.2ha) on the northern hills. The majority of the dense scrub recorded is European gorse.

European gorse was introduced to the Isle of Man. Its introduction is confirmed by its Manx (and Welsh) name of "French gorse": Aittin Frangagh or Conney Frangagh. It was extensively used in farm rotations in the west of the British Isles being the main source of winter fodder together with western gorse (Manx = Aittin). When the introduction of turnips around 1780 began to undermine its value as a crop, it took off as a substitute for hawthorn in hedging. Forty years later it formed most of the fences throughout the Island (Allen 1984) as it does today.

Before the introduction of European gorse, Manx peasants depended largely on the native western gorse for fuel and winter fodder. Special gorse mills, sometimes powered by water, on which the gorse was crushed in wooden troughs, were at one time frequent and continued in use until around 1840. Horses, especially, thrived on western gorse which was highly esteemed medicinally in particular for ridding animals of worms (Allen 1984).

Table 4 Numbers of insect and mite species associated with trees and shrubs (after Kennedy and Southwood 1986)

Tree/shrub	Scientific name	Manx name	No. of species
Willows	*Salix* (5 species)	Shellag	450
Oak	*Quercus robur & petraea*	Darrag	423
Birch	*Betula* (2 species)	Beih	334
Hawthorn	*Crataegus monogyna*	Drine	209
Poplars	*Populus* (4 species)	Pobbyl	189
Scots Pine	*Pinus sylvestris*	Juys	172
Sloe	*Prunus spinosa*	Drine Airn	153
Alder	*Alnus glutinosa*	Farney	141
Elms	*Ulmus* (2 species)	Lhiouan	124
Crab apple	*Malus sylvestris*		118
Hazel	*Corylus avellana*	Couyll	106
Beech*	*Fagus sylvatica*	Faih	98
Norway Spruce*	*Picea abies*		70
Ash	*Fraxinus excelsior*	Unjin	68
Mountain ash	*Sorbus aucuparia*	Cuirn	58
Lime	*Tilia* (2 species)		57
Hornbeam*	*Carpinus betulus*		51
Field maple	*Acer campestre*	Malpys	51
Sycamore*	*Acer pseudoplatanus*	Shykey	43
European Larch*	*Larix decidua*		38
Juniper	*Juniperus communis*		32
Sweet chestnut*	*Castanea sativa*	Castan Spaainagh	11
Holly	*Ilex aquifolium*	Cullyn, Hollin	10
Horse chestnut*	*Aesculus hippocastanum*	Castan	9
Walnut*	*Juglans regia*		7
Yew*	*Taxus baccata*	Euar	6
Holm oak*	*Quercus ilex*		5
False acacia*	*Robinia pseudoacacia*		2

Non-native trees to the Isle of Man are marked *

A3 Parkland and scattered trees

Phase 1 definition: Areas with less than 30% tree cover including scattered trees over pasture (as in parkland), or over heath, bog etc and lines of trees forming windbreaks or avenues.

Threats to woodland and scrub: Some woodlands are subject to heavy grazing by livestock which can reduce the diversity of the ground flora and in eating tree seedlings, over-grazing can prevent natural regeneration, produce a reduced understorey and an unbalanced age distribution of trees.

A possible threat to woodlands on the Island is the potential proliferation of a virulent strain of Dutch Elm Disease which was first recorded on the Island in the 1990s. The outbreak was centred on Ramsey where the disease may have entered the town's harbour on a ship. Diseased Elm trees have been felled at the Grove Museum and at Glen Auldyn, Ramsey.

Trees and woodlands on the Isle of Man are protected by the Tree Preservation Act 1993 through which a felling licence is required to fell any tree greater than 8cm in diameter (at 1.3m above ground-level), or 15cm for coppice. Fines of up to £2000 per tree can be imposed for illegal tree felling. In addition, woodland areas are included in the Isle of Man Development Plan (Isle of Man Local Government Board 1982) and as such are protected through the planning process.

B Grassland and marsh

Phase 1 definition: This category includes both areas of herbaceous vegetation dominated by grasses, and certain wet communities dominated by rushes (*Juncus* species), sedges (*Carex* species), meadowsweet (*Filipendula ulmaria*) or by other marsh herbs.

Six main types of grassland are included in the Phase 1 classification:

1 Acid grassland
- 1.1 unimproved
- 1.2 semi-improved

2 Neutral grassland
- 2.1 unimproved
- 2.2 semi-improved

3 Calcareous grassland
- 3.1 unimproved
- 3.2 semi-improved

4 Improved grassland
5 Marsh/marshy grassland
6 Poor semi-improved grassland

Most grasslands have been subjected to some degree of agricultural improvement by repeated grazing, mowing, fertilising, drainage or herbicide treatment. It is important to try to distinguish unimproved and semi-improved from improved grasslands. However, these grassland types form a continuum, so that it is not possible to define each with precision, especially as species critical for their definition are often only observable for a short season in the year.

Agricultural improvement usually results in a decrease in the floristic diversity of the sward and dominance by a few quick-growing grasses such as rye-grass, Yorkshire fog and red fescue. The resulting sward composition is likely to vary with intensity of treatment and with the composition of the original sward.

Grassy roadside verges, railway cuttings and embankments which generally escape agricultural management may be very important reservoirs of native flora , especially in intensively-farmed areas.

Phase 1 definitions for the two levels of improvement are:

Unimproved grassland
Unimproved grasslands are rare, especially in the lowlands. They may be rank and neglected, mown or grazed. They may have been treated with low levels of farmyard manure, but should not have had sufficient applications of fertiliser or herbicide, or have been so intensively grazed or drained, as to alter the sward composition significantly. Species diversity is often high, with species characteristic of the area and the soils and with a very low percentage of agricultural species.

Semi-improved grassland
Semi-improved grassland is a transition category made up of grasslands which have been modified by artificial fertilisers, slurry, intensive grazing, herbicides or drainage, and consequently have a range of species which is less diverse and natural than unimproved grasslands. Such grasslands are still of conservation value. Semi-improved grassland may originate from partial improvement of acid, neutral or calcareous grassland. However, it should be noted that improvement reduces the acid or calcareous character of the grassland so that it is not always easy to distinguish in the field. Species diversity will generally be lower than in unimproved grassland in the same area.

B1 Acid grassland

Phase 1 definition: Grassland in this category is often unenclosed, as on hill-grazing land, and occurs on a range of acid soils (pH less than 5.5). It is generally species-poor, and often grades into heathland, although it must always have less than 25% heather cover. Pioneer annual-rich calcifuge (avoiding Calcium) communities on dry sandy soils are included in this category, as are wet acidic grasslands typified by species such as heath rush (but see marsh/marshy grassland, B5).

The following plants are indicative of acidic conditions when frequent or abundant:

Mat-grass (*Nardus stricta*)
Wavy hair-grass (*Deschampsia flexuosa*)
Heath rush (*Juncus squarrosus*)
Heath bedstraw (*Galium saxatile*)
Sheep's sorrel (*Rumex acetosella*)

Other plants often present include tormentil *(Potentilla erecta)*, heath-grass (*Danthonia decumbens*), sweet vernal grass (*Anthoxanthum odoratum*) and heath milkwort (*Polygala serpyllifolia*).

Acid grassland can be *unimproved* or *semi-improved*:

B1.1 Unimproved acid grassland

On the Isle of Man, unimproved acid grassland is virtually confined to the northern hills and dominates several peaks including Beinn y Phott, Mullagh Ouyr, Snaefell, Clagh Ouyr and North Barrule covering nearly 5,930 acres (2,400 ha) of government owned hill-land. The Phase 1 habitat survey recorded a total of 7,791 (3,153 ha) of unimproved acid grassland on the whole Island, comprising just over 19% of the Island's semi-natural vegetation (DAFF, in press, pers. comm.).

Less than seven acres (2.8ha) of unimproved acid grassland was recorded on the southern hills in government ownership (Table 1).

B1.2 Semi-improved acid grassland

Grassland which is generally enclosed and part of the marginal hill-land. Partial "improvement" through the agency of fertilisers, slurry, intensive grazing, herbicides or drainage has occurred, and consequently the species range is less diverse and/or less natural than in unimproved grassland.

Plants showing signs of improvement include white clover (*Trifolium repens), crested* dog's-tail (*Cynosurus cristatus*), daisy (*Bellis perennis*) and selfheal (*Prunella vulgaris*). Stands of dock (*Rumex* species), common nettle (*Urtica dioica*) and thistles (*Cirsium* species) indicate local soil enrichment by grazing animals.

The majority of the semi-improved acid grassland is recorded on the government owned northern hills (227 acres, 92 ha, Table 2), with a further 27 acres (11 ha) on the southern hills (Table 3). However, the Phase 1 habitat survey of the entire Island recorded a total of 2,478 acres (1,003 ha, over 6% of the Island's semi-natural vegetation, DAFF, in press, pers. comm.), the majority of which is in private ownership.

Note that there is a transition between the grassland types according to the degree of improvement.

B2 Neutral grassland

Phase 1 definition: Typically enclosed and usually more intensively managed than acid or calcareous grassland (except on roadside verges), this category encompasses a wide range of communities occurring on neutral soils (pH 5.5 - 7.0). Hay meadows will usually fall within this category.

The following are indicative of neutral conditions when frequent or abundant:

Meadow fox-tail (*Alopecurus pratensis*)
False oat-grass (*Arrhenatherum elatius*)
Crested dog's-tail (*Cynosurus cristatus*)
Cock's-foot (*Dactylis glomerata*)
Tufted hair-grass (*Deschampsia cespitosa*)
Tall and meadow fescue (*Festuca arundinacea* and *F. pratensis*

Rye-grass (*Lolium perenne*) may be present, but when abundant it is indicative of improved grassland (see B4).

Included in neutral grassland is a range of grasslands which are inundated periodically, permanently moist, or even water-logged (but see marsh/marshy grassland, B5). Examples are:

inundated grassland with abundant flote-grass, marsh foxtail, rough meadow-grass and waterpepper

water meadows and alluvial meadows

species-poor tufted hair-grass grasslands and grazed soft rush/hard rush - Yorkshire fog/tufted hair-grass grasslands

wet meadows or pastures where grasses are dominant in the sward (cf. marsh/marshy grassland, B5) but with species such as marsh marigold, meadowsweet, valerian species or rushes present.

Neutral grassland can be unimproved or semi-improved.

Although extensive areas of unimproved (but modified) acid grassland are present on the northern hills, unimproved neutral grassland is very rare on the Isle of Man, with only 11 hectares recorded by the Phase 1 habitat survey (DAFF, in press, pers. comm.). Most fields have been partially improved or intensively improved.

The Phase 1 habitat survey of government owned hill-land recorded 2.3 acres (0.92ha) of unimproved neutral grassland, at Fleshwick (SC202713, Figure 3), and 12.9 acres (5.24ha) of semi-improved neutral grassland, all of which is present on the southern hills (Table 3 and Figure 3).

B4 Improved grassland

Phase 1 definition: Improved grasslands are those meadows and pastures which have been so affected by heavy grazing, drainage, or the application of herbicides, inorganic fertilisers, slurry or high doses of manure that they have lost many of the species which one would expect to find in an unimproved sward.

They have only a very limited range of grasses and a few common herbaceous plants, mainly those demanding of nutrients and resistant to grazing. Rye-grass, crested dog's-tail, white clover, common sorrel, dandelion, daisy, meadow buttercup and bulbous buttercup are typical of improved grassland, while stands of dock, common nettle and thistles indicate local enrichment of the soil by grazing animals.

continued

The following signs usually indicate substantial improvement:

bright green, lush and even sward, dominated by grasses (though poaching causes unevenness)

low diversity of herbaceous plants

more than 50% rye-grass, white clover and other agricultural species

Fields which have been reseeded in the past and have since become somewhat more diverse florally are included in this category, but recently reseeded monoculture grassland such as rye-grass leys, with or without clover, are classified as cultivated land (arable, J1).

Whilst the botanical diversity of improved grassland is low, such fields still have some interest, for example, in providing an invertebrate food source for birds including blackbird, thrushes, redwing, fieldfares, rooks, jackdaws and crows.

The Phase 1 survey of government owned hill-land recorded 186 acres (75.3ha) of improved grassland and arable combined (Table 1), with 155.5 acres (63ha) in the southern hills, for example adjacent to Arrasy plantation at SC2578 and the upper reaches of Glen Rushen (Figure 3), with 30.4 acres (12.3ha) on the northern hills.

B5 Marshy grassland.

Phase 1 definition: This is a diffuse category covering certain purple moor-grass (*Molinia caerulea*) grasslands, grassland with a high proportion of rushes, sedges or meadowsweet, and wet meadows and pastures supporting communities of species such as marsh marigold or valerian species, where broadleaved herbs rather than grasses, predominate. The category differs from swamp (F1) in that the latter has a water-table distinctly above the substratum for much of the year and is dominated by reed grasses or large sedges. Unlike marginal vegetation (F2), marsh/marshy grassland occurs on more-or-less level areas, rather than on the banks of watercourses. It differs from flush (E2) in that Bryophytes (mosses) are not a conspicuous component of the vegetation, also flushes always have a flow or seepage of water through them.

The following are included in marsh/marshy grassland:

vegetation with a greater than 25% cover of purple moor-grass, on less than 0.5m of peat

vegetation with less than 25% dwarf shrub cover on peat less than 0.5m deep

vegetation with greater than 25% cover of rushes (soft-rush, *Juncus effusus* and sharp-flowered rush, *Juncus acutiflorus*), or meadowsweet, except for grazed soft rush-Yorkshire fog/tufted-hair grass grasslands, which are classified under neutral grassland (B2)

wet meadows and pastures where grasses are subordinate to herbs (cf. wet neutral grassland, B2) - such communities are often rich in plants such as marsh marigold, meadowsweet, valerian species, orchid species, hemp-agrimony, rushes and sedges.

The majority of the marshy grassland on the government owned hill-land is found on the northern hills where 227 acres (92 ha) were recorded (Table 2) with a further 11.4 acres (4.6 ha) on the southern hills (Table 3).

Examples of *Molinia*-dominated marshy grassland are found on the valley side opposite Lhergyrhenny above the Sulby Reservoir (SC380880) and along the Agneash valley, above Laxey (SC4286).

Due to the presence of water and additional plant species, areas of marsh/marshy grassland may provide good feeding for birds, including waders and also support rich communities of invertebrates.

Wetlands are among the most important wildlife habitats, yet they are under threat throughout the world. The urgent need to conserve wetlands of international importance has been recognised through the Ramsar Convention, Iran 1971, to which the Isle of Man is a signatory. These important sites can be designated as *Ramsar sites* but only Ballaugh Curragh is likely to qualify on the Isle of Man. However, the conservation of wetlands of national and local importance should still be a priority.

B6 Poor semi-improved grassland

> Phase 1 definition: Good semi-improved grassland will have a reasonable diversity of herbaceous species, at least in parts of the sward, and is clearly recognisable as acid, neutral or calcareous in origin. Poor semi-improved grassland has a much more restricted list of species and, being more improved, is more likely to resemble a species-poor neutral grassland irrespective of its origin.

Semi-improved grassland is characteristic of abandoned fields of improved grassland which become rank and dominated by tall tussock-forming grasses which can shade out or out-compete other grasses and many flowering plants. However, the structural diversity of such grassland can be attractive to invertebrates and the tussocks can provide over-wintering sites for invertebrates and habitat for mammals including hares and field mice.

The Phase 1 survey of government owned hill-land recorded 87.9 acres (35.6ha) of poor semi-improved grassland, with 79.5 acres (32.2ha) on the southern hills and 8.4 acres (3.4ha) on the northern hills.

Threats to grassland: All native grasslands are potentially threatened by agricultural improvement, development, inappropriate management and neglect. It is particularly important that the threats to unimproved, semi-improved and marshy grasslands are reduced as far as practicable and positive steps taken to ensure their conservation.

Further agricultural improvement by the application of fertilisers and herbicides, drainage, ploughing and reseeding will inevitably lead to habitat loss. Over-grazing tends to damage vegetation and encourages the spread of nutrient-demanding "weed" species such as docks, nettles, thistles and cushag (ragwort). The effects of pasture improvement on the ground beetles and spider communities of upland grassland can be dramatic. In particular, improvement procedures involving excessive sward disturbances are destructive and reduce the ecological and conservation interest of the grassland to that of an intensively-managed lowland temporary ley (Rushton, Luff and Eyre 1989).

Although vulnerable to further agricultural improvements, if managed appropriately for conservation, semi-improved neutral grassland may have the potential to revert back towards unimproved grassland and at the same time yield profitable crops of hay.

The main threat to marsh/marshy grassland is drainage and agricultural improvements. Other threats include localised trampling, over-grazing, planting with trees, tipping and eutrophication by run-off from fertiliser application on adjacent land.

The species diversity of semi-improved grassland can also be reduced by lack of management, ie, neglect. In the absence of management, most grasslands will become dominated by rank vegetation and scrub will invade and ultimately develop into recent semi-natural woodland which can be good wildlife habitat but results in the loss of the grassland. An appropriate management involving a suitable grazing or mowing regime is required to conserve the wildlife value of grasslands.

C Tall herb and fern

C1 Bracken

Phase 1 definition: Areas dominated by bracken, or with scattered patches of bracken.

Bracken can invade and smother plant communities, including heathland and grassland. The species is very successful covering large areas of the Isle of Man and other parts of the British Isles, particularly in the hill-land of the north and west. It is generally regarded as an invasive "weed" reducing the value of the land for agriculture, conservation, sport and recreation. However, it can have positive effects (see below) and in some areas bracken provides visually attractive autumn colours in the landscape, for example in Sulby Glen.

Bracken can be invasive and replace plant communities that have greater conservation value. Habitats particularly at risk include lowland heaths, moorland and upland grassland. It can be a problem for two reasons: the underground rhizomes and the dense frond canopy. The rhizomes are full of food reserves and produce buds from which new fronds are produced. The fronds reduce light penetration to the ground in summer. Colonisation by other plants is prevented by dense stands which produce a large amount of "litter" and by the chemical substances which may be in both the fronds and litter (Marrs & Pakeman 1993).

However, there is increasing evidence that bracken sometimes supports a valuable wildlife community. Bracken can act as a substitute tree canopy for woodland plants such as bluebell, wood sorrel, pignut, lesser celandine, primrose etc, its fronds providing shelter and the plants surviving beneath the canopy of bracken as if underneath a woodland canopy. This rich flora can support a variety of invertebrates, notably in the UK the threatened high brown fritillary butterfly and the declining pearl-bordered fritillary (Warren 1993). Bluebells growing on open hillsides and coastal brooghs, where later in the season bracken flourishes, are a familiar site on the Isle of Man.

Bracken is a food-plant to 40 insects, 11 of them feeding on nothing else, but other much more scarce invertebrates may be associated with bracken habitats. Bracken can also protect plants from heavy grazing. It is an important habitat for declining birds such as the whinchat and the nightjar in the UK, and provides cover for many other birds and mammals (Warren 1993).

The Phase 1 habitat survey of the government owned hill-land recorded 608 acres (246 ha, Table 2) on the northern hills with a further 222 acres (90 ha, Table 3) on the southern hills. The survey of the whole Island recorded 4,880 acres (1,975 ha), 3.5% of the land area or 12 % of the Island's semi-natural vegetation (DAFF, in press, pers. comm.). This compares with the estimated 5,930 acres

(2,400 ha), 4% of the land surface in the ecological survey (NCC/ITE 1975) and contrasts with the estimated 1.5% cover in Great Britain (DOE 1993).

Bracken is distributed in the zone between the lowlands and uplands where management is less intensive and where the slopes provide suitable dry conditions. Examples include the slopes of Mount Karrin, Sulby Glen and in the Agneash and Corrany valleys. It is also prevalent on the exposed western coast, where similar conditions prevail (see Figure 3).

It is almost universally accepted that bracken has increased in recent decades, In many areas, such as Wales as well as the Isle of Man, much of the spread has not been so much on the moorland itself but on the slopes below, which were once meadow or pasture but have been less-intensively managed or abandoned. The change from cattle to sheep grazing has also been implicated in the spread of bracken, for example in Scotland (Darling 1955), because sheep hardly eat it and do not trample it the same as cattle, which can help keep it under control.

C3 Other tall herb and fern

C3.1 Tall ruderal

Phase 1 definition: This category comprises stands of tall perennial vegetation or biennial dicotyledons, usually more than 25 cm high, of species such as rose-bay willow-herb, common nettle and Japanese knotweed

Tall ruderal vegetation can be valuable for wildlife especially invertebrates and birds. Common nettle is the larval foodplant for the red admiral, small tortoiseshell and peacock butterflies, hence nettle beds are very important for these butterflies. Other ruderal plants provide colourful floral displays which are also rich in nectar, for example, rose-bay willow-herb and thistles. Common hogweed provides an important nectar source for a range of insects including soldier beetles. The seeds of thistles are an important food source for seed-eating birds and the hollow stems of this and similar plants provide over-wintering sites for invertebrates.

The Phase 1 habitat survey of government owned hill-land recorded 0.9 acres (0.36ha) of tall ruderal vegetation on the southern hills (Table 3) located on roadside verges.

C3.2 Non-ruderal

Phase 1 definition: Non-wooded stands of species such as lemon-scented fern, lady-fern, buckler ferns or greater woodrush.

The Phase 1 habitat survey of the Isle of Man did not map and record areas of non-ruderal vegetation as a habitat in its own right. However, greater woodrush (*Luzula sylvatica*) is locally dominant on the slopes of Snaefell, North Barrule and Beinn y Phott and is a hardy survivor of deforestation. Stands of ferns - lady fern (*Athyrium filix-femina*), male fern (*Dryopteris filix-mas*) and broad buckler fern (*D. affinis*) are also present and lemon-scented fern (*Oreopteris limbosperma*) can be found, especially along upland stream banks.

Threats to tall herb and fern vegetation: Tall ruderal vegetation tends to be regarded as unsightly and is often "tidied-up". However, this habitat is usually created by human actions and losses tend to be made up by new sites developing elsewhere.

D Heathland

Phase 1 definition : Heathland includes vegetation dominated by ericoids (heathers) and/or dwarf gorse species (including western or "Manx" gorse) as well as 'heaths' dominated by lichens and bryophytes, dwarf forms, *Carex bigelowii* or *Juncus trifidus*. Generally occurring on well-drained acid soils, heathland is further distinguished from Mire (E) by being arbitrarily defined as occurring on peat less than 0.5 m thick. Heathland can be *dry* or *wet*.

In northwest Europe, heathland flourishes where there is an oceanic climate, lacking temperature extremes, but with abundant and well-distributed rainfall and generally a high humidity (Gimingham 1972). Upland heathlands occur at various altitudes in the mountains of southern and central Europe, Britain and Scandinavia.

Internationally, the British Isles are unique in still having large expanses of heather-dominated moorland. Heathland plants such as bell heather and western gorse, which are abundant in parts of Britain including the Manx hills, have highly restricted European distributions. Britain also supports substantial proportions of the European populations of certain birds characteristic of heather moorland, including red grouse, hen harrier and merlin (see 3.4.1).

In the past, most of Europe was covered in woodland, and heathland occurred naturally only in a few coastal and upland locations where the combination of poor soils, humid climate and wind exposure was unsuitable for tree growth. Elsewhere heathland is a direct product of human activities. The expansion of heathland began in Neolithic times when the forests were gradually cleared to provide grazing for stock. Since then heaths have been burnt to prevent trees re-establishing and to stimulate new vigorous growth of heather for grazing.

On the European scale, heathland is an oceanic type of vegetation, but within this, it varies in the UK and on the Isle of Man, according to climate and gradients in local conditions. A common gradient is soil wetness, with recognisable dry, damp and wet types of heath.

In any one locality there is often a continuum of habitat types from dry to wet heath, acid grassland, flush and bog communities. This may be coupled with a gradient from nutrient-poor soil to increasing nutrient supply with increased flushing by flowing water. Thus a particular area can include a complex of wet and dry heath types, controlled by the water-table and flow.

Heathlands are of considerable value as wildlife habitats, the plants, animals and soils having developed together over a period of about 6,000 years. They are actively managed by grazing for sheep farming and by burning both for grazing and for grouse-shooting. Active management is vital to the survival of heather moorland and its constituent flora and fauna (see 3.7 and 3.8).

D1 Dry dwarf shrub heath

Phase 1 definition: Vegetation with greater than 25% cover of ericoids or small gorse species in relatively dry situations. *Calluna vulgaris, Vaccinium myrtillus, Erica tetralix, Ulex minor* and *Ulex gallii* are typical of lowland dry dwarf shrub heath, whilst *Empetrum nigrum, Empetrum hermaphroditum, Arctostaphylos uva-ursi* and *Vaccinium vitis-idaea* are found in upland heaths. Acid heaths usually occur on deep podsols developed on base-deficient sands, gravels and clays. Basic heaths are much more restricted in extent.

Throughout the dry heath of upland areas, heather or ling (*Calluna vulgaris*) is an almost universal component and is often dominant. The Manx hills are dominated by ling heather and/or bell heather

(*Erica cinerea*), often with abundant western gorse (*Ulex gallii*) and bilberry (*Vaccinium myrtillus*). Other plants often present include tormentil (*Potentilla erecta*), many-stalked spike-rush (*Eleocharis multicaulis*) and green-ribbed sedge (*Carex binervis*).

Upland (sub-montane) and northern heathlands often have an increasing proportion of grasses, which may reflect the combined effects of sheep grazing and burning. There may also be abundant bilberry, cowberry (*Vaccinium vitis-idaea*) and crowberry (*Empetrum nigrum*). This type of community is described as 'boreal heather moor' is widespread in nothern England (the Pennines, Cumbria, Northumberland, North Yorkshire etc), North Wales and Scotland.

The Phase 1 survey of the government owned hill-land identified 10,131 acres (4,100 ha, Table 1) of dry heath, although the Island supports nearly 13,950 acres (5,645 ha) or 34% of the Island's semi-natural vegetation (DAFF, in press, pers. comm.). Dry heath dominates the southern hills of the Island and on the northern hills occurs in four main blocks (see Figure 2).

Losses of heather moorland in Great Britain

During the last few decades there has been a relatively widespread and rapid decline in heather moorland in Britain. Much traditional use of moorland has been replaced by forestry and reclamation for agriculture, involving not only a reduction in the total area of heathland but also considerable fragmentation of existing habitats. Furthermore, the remaining areas of heath have often been disturbed by industrial developments, mineral extraction, uncontrolled fires, and erosion by vehicles, people and animals.

Ling heather (*Calluna vulgaris*) has been declining in many parts of Britain, particularly in England and Wales. The Nature Conservancy Council & Countryside Commission's National Countryside Monitoring Scheme (NCMS) has estimated a loss of 286 sq.km. of heather-dominated vegetation in Cumbria between the 1940s and 1970s (NCC 1987). Of this 209 sq.km. was drier moorland heath, representing a 70% loss. In the Peak District, Anderson & Yalden (1981) estimated a 36% loss of heather moorland between 1913 and 1981. Even in Scotland the NCMS has revealed surprisingly large losses of heather moorland between the 1940s and 1970s. In the Grampian Region, the loss of drier heather moorland was just over 25%, in Galloway there was a loss of about 63% and in the Borders Region the loss was just over 20% (NCC/CCS 1988, Sydes 1988). In Scotland afforestation has accounted for about half of these losses but conversion to grassland as a result of heavy grazing has been the next most important, accounting for about 25% of total losses.

This scale of heather loss is of great concern to nature conservation in upland Britain. Heather moorland, including that on the Manx hills, exists as a result of the complex interactions between the vegetation and the effects of fire and grazing herbivores (Hobbs and Gimingham 1987). Their future survival is dependent upon the management practices of burning and grazing. The species composition of heathlands is inherently unstable, and successional change will normally follow the cessation of management. Typically, this change is by the colonisation of non-ericoid shrubs and trees.

Where heathland is traditionally managed as rough grazing or grouse moor, this is done by rotational burning and low-intensity grazing. If this traditional careful management is abandoned or relaxed, natural ecological succession will lead to the colonisation by bracken or by trees and scrub such as European gorse and birch, and woodland may eventually develop. Invasion by gorse may be so widespread and dense that heather does not regenerate.

The rate of change depends on the availability of adjacent seed sources, the nature of the soil and the existing structure of the heathland community. Where there are gaps in an uneven-aged stand or after a severe fire, invasion by birch and gorse is common. Rapid colonisation by bracken also occurs, often advancing in from the edges. Increases in grazing pressure may cause heather to change progressively to grassland.

Intense fires on heathland, whether accidental, through management by burning or a deliberate act of vandalism, can prevent the regeneration of heather from either root-buds or seeds but the effect is less marked for bracken which can use the opportunity to spread into previously heather dominated areas. Similarly, birch seems to benefit from frequent fires (Lowday and Wells 1977). Fires not only cause immediate loss of nesting sites to birds and death to some reptiles and insects, but may cause irreversible changes in the vegetation in the long-term. Regular burning can be detrimental to the survival of certain species of flora, lichens and bryophytes and prevent the development of mature stands of heather upon which certain invertebrates and fungi depend.

D2 Wet dwarf shrub heath

Phase 1 definition: As with dry dwarf shrub heath, this vegetation type has more than 25% cover of ericoids and/or small *Ulex* species. However, it differs in that *Molinia caerulea* is often abundant and it generally contains some *Sphagnum compactum* or *Sphagnum tenellum* and less frequently other *Sphagnum* spp. In transitions to mires, the proportion of *Sphagnum* will increase and the species composition will change. *Erica tetralix* is common in wet dwarf shrub heath and is often present in significant quantity. *Trichophorum cespitosum* is occasionally present at lower altitudes. Macrolichens may be locally abundant. The abundance of *Molinia* and *Erica tetralix* decreases in the transition from wet to dry heath.

Almost everywhere that heathland is found, there are gradients of soil wetness, varying from heath on freely-drained soils, through humid heath on moist soils with impeded drainage, to wet heath on soils which are waterlogged for varying periods of the year. Wet heath is widely distributed on peat and gley (waterlogged) soils throughout Britain. In wet heathland on the Isle of Man, purple moor-grass (*Molinia caerulea*) is often abundant and *Sphagnum* moss is generally present. Cross-leaved heath (*Erica tetralix*) is common and often abundant, together with bog asphodel (*Narthecium ossifragum*). The insectivorous plants, round-leaved sundew (*Drosera rotundifolia*) and common butterwort (*Pinguicula vulgaris*) are sometimes present. In northern moorland on peat (the Pennines, North Wales, Cumbria, Northumberland and areas on the Isle of Man), heather is commonly associated with harestail cottongrass (*Eriophorum vaginatum*), together with deer-grass (*Scirpus cespitosus*) and crowberry (*Empetrum nigrum*).

On the government owned hill-land, there are only 425 acres (172 ha) of wet heath (Table 1) with similar areas on both the northern and southern hills (Figures 2 and 3). In addition to supporting different plant species to dry heath, wet heath also supports different communities of invertebrates and are also valuable to birdlife (see 3.4.1). Both wet and dry heath can be found in a habitat mosaic with acid grassland (B1).

Historically, large areas of the northern hills have suffered from "over-grazing" by sheep and cattle and these are characterised by "white" grass moorland dominated by mat-grass (*Nardus stricta*). Bell heather and ling, however, still dominate 7,057 acres (2,856 ha) of the northern hills and most of the southern hills. Botanically, overgrazing has reduced the diversity of flora on the hills (Allen 1984). Mountain pansy (*Viola lutea*) and mountain everlasting (*Antennaria dioica*) were recorded on North Barrule and Snaefell, but have not been seen since 1883 and are thought to have been eliminated by grazing (Allen 1984). Another long-lost species is yellow saxifrage (*Saxifraga aizoides*), see

(3.3.2). Cross-leaved heath *(Erica tetralix)* is noticeably more widespread on the southern hills, indicating a history of less-intensive grazing in that area (Allen 1984).

Losses of heather moorland on the Isle of Man

Table 5 illustrates that 48% of the plantable heather moorland on the government owned hill-land has been afforested so far this century. If the present Afforestation Programme ran its course (ie 1,336 ha planted since 1985), and all was planted on heather, then 64% of plantable government owned heather moorland would have been afforested. This has been reduced from a potential figure of 81% had the original Afforestation Programme been fully implemented (ie 2,024ha planted).

Note: The above are minimum figures and do not take into account heather moorland lost by hill-land improvement schemes, by overgrazing or by encroachment by bracken, for which figures are not available.

It is clear that heather moorland has suffered severe losses throughout the UK as well as on the Isle of Man. This is particularly unfortunate since the British Isles are the stronghold of heather moorland.

Losses of heather moorland on the Isle of Man, based on the Phase 1 habitat survey of government owned hill-land 1991-2 are shown in Table 5

Table 5. Losses of Manx heather moorland as a result of afforestation based on data from the 1991-2 Phase 1 habitat survey. The final line provides an estimate of the area of moorland considered to be unplantable.

	Southern hills (ha)	Northern hills (ha)	All hills (ha)
Planted before 1985	788	454	1242
Planted since 1985	319	371	690
Present area moorland	1332	2857	4189
Total area planted	1107	825	1932
Unplantable moorland	506	1576	2082

Estimated areas of heather moorland planted before 1985:

Southern hills	Area (ha)	Northern hills	Area (ha)
Glen Rushen	46	Slieau Curn	77
Slieau Mooar	18	Tholt e Will	102
Arrasy	70	Sartfell	10
Cringle	101	Brookdale	20
Lhargan	43	Slieau Maggle (2)	8
Fleshwick	4	Eairy Beg	59
Stoney Mountain	98	Greeba	60
South Barrule	128	Colden	60
Earystane	67	Conrhenny	58
Archallagan	154		
Chibbanagh	49		
Slieau Whallian	10		

Estimated area of unplantable heather moorland (above 1,100 ft and coastal):

Southern hills	Area (ha)	Northern hills	Area (ha)
Lhiattee ny Beinnee	63	Greeba/Colden/Slieau Maggle	675
Cronk ny Irree Laa	197	Sartfell/Slieau Freoghane/Dhoo	331
South Barrule	246	Slieau Curn	8
		Glen Crammag	59
		Slieau Ree	92
		Slieau Lhean/Ouyr/Ruy	347
		NW slope Snaefell	11
		Slieau Managh	67

Threats to heathland: As discussed above, the main threats to heather moorland are afforestation, over-intensive management particularly over-burning and ecological over-grazing (leading to the displacement of heather by grasses), and under-grazing (which favours encroachment by bracken and gorse).

E Mire

Phase 1 definition: Mires occur typically on deep peat (over 0.5 m thick) with the water-table at or just below the surface, but flushes and springs on shallow or incipient peats are also included.

The classification of peatlands has recently been revised (see NCC 1989) and the term bog is now restricted to mires fed only by direct precipitation or rain (ombrotrophic), as opposed to those fed by ground water or streams (minerotrophic), including Valley and Basin Mires and Flushes and Springs. The distinction between the different types is not always clear-cut and transitional examples are found.

E1.6.1 Blanket bog

Phase 1 definition: Unmodified bog (blanket bog and raised bog) consists of *Sphagnum*-rich vegetation lying on peat more than 0.5 metres deep, with the water-table at or just below the surface and no input of water from the surrounding land. Modified bog contains little or no *Sphagnum*.

Blanket bog comprises *Sphagnum*-rich vegetation on deep peat, forming a blanket over both concave and convex surfaces, on level to moderately-sloping ground in the uplands. It is widespread in the north and west of Britain, where it may be fragmentary or very extensive. The drainage is usually diffuse and undisturbed blanket bog shows a hummock-and-hollow structure, with *Sphagnum*-rich pools in the hollows. Blanket bog includes watershed mires, saddle mires, terrace bog and valleyside mire and may also include other mire types, where these occur within a blanket bog complex.

This habitat category is used for relatively undamaged blanket bog, with *Sphagnum* usually abundant. A wide range of ericoids, including *Calluna vulgaris*, *Erica tetralix*, *Vaccinium* species and *Empetrum* species, may be present, mainly on the hummocks, together with *Eriophorum vaginatum*, *Eriophorum angustifolium* and *Trichophorum cespitosum*. *Calluna* and/or *Eriophorum vaginatum* are often dominant over large areas, but various mixtures occur.

Significantly damaged blanket bog, in which *Sphagnum* is much reduced or absent is classified as modified bog (see below).

Compared with Ireland, blanket bog on the Isle of Man occupies a small percentage of upland vegetation. The peat of the Manx blanket bog appears to be uniformly very shallow (Allen 1984).

All the bog habitat on the government owned hill-land is found on the northern hills where 245 acres (99 ha) of blanket bog was recorded together with 12 acres (5 ha) of wet modified bog and 165 acres (67 ha) of dry modified bog (Table 2 and Figure 2).

No raised bog was recorded on the government owned hill-land (Table 1').

E1.7 Wet modified bog

Phase 1 definition: This category comprises modified bog vegetation with little or no Sphagnum, often with bare peat and patches of *Trichophorum cespitosum* and/or *Molinia caerulea*. Ericoids may be abundant, sparse or absent.

This vegetation is mainly found on drying and degraded blanket bogs and cut-over raised bogs. It may resemble wet heath (D2), but is distinguished by having a peat depth greater than 0.5m. *Molinia*-dominated vegetation on deep peat is included in this category rather than in marshy grassland (B5).

E1.8 Dry modified bog

Phase 1 definition: The vegetation of dry modified bog is dominated by *Calluna vulgaris* and other ericoids, or by *Eriophorum vaginatum*, on peat more than 0.5m deep. *Sphagnum* is notably absent, but under the dwarf shrubs there may be a carpet of hypnoid mosses, with lichens such as *Cladonia portentosa* and *Cladonia arbuscula*. Where *Eriophorum vaginatum* is dominant, as on many Pennine blanket bogs, other species may be sparse or absent. Essentially dry heath vegetation (or cotton-grass moor) on deep peat, this habitat is typical of areas of blanket bog or raised bog subjected to heavy grazing, burning and draining.

E2 Flush and spring

Phase 1 definition: These types of minerotrophic mire are termed soligenous because they are associated with water movement. They may or may not form peat, but where they do, the peat is often less than 0.5m deep. Flushes occur on gently-sloping ground, are often linear or triangular and may include small water courses. Flushes typically have an open or closed ground layer of *Sphagnum* and/or other bryophytes, together with small sedges and *Juncus* species. The presence of a well developed bryophyte ground layer and the lack of dominant grasses distinguishes flush habitats from marshy grassland and from wet acid, neutral and calcareous grasslands. Complex mosaics of grassland and flush are quite common, particularly in the uplands.

Flushes may be acid, neutral (mesotrophic) or basic.

Acid/neutral flushes typically support species-poor vegetation consisting of a *Sphagnum*-carpet overlain by *Carex* or *Juncus* species. Characteristic moss species include *Sphagnum recurvum*, *S.palustre* and *S.auriculatum*. Overlying vegetation may consist of small *Carex* species (*Carex echinata*, *C.nigra* or *C.curta*), *Carex rostrata*, *Juncus acutiflorus*, *J.effusus*, *J.squarrosus*, or *Eriophorum angustifolium*.

Basic flushes were not recorded during the Phase 1 habitat survey of the Isle of Man.

Flushes on the Manx hills tend to be dominated by rushes (soft rush and sharp-flowered rush) with sedges (carnation sedge, *Carex panicea*; common sedge, *Carex nigra*; star sedge, *Carex echinata*) and/or common cottongrass (*Eriophorum angustifolium*). Other species may include marsh pennywort (*Hydrocotyle vulgaris*), orchids (*Dactylorhiza* spp), round-leaved sundew, common butterwort and marsh violet (*Viola palustris*). Acid watercourses often contain marsh St John's-wort (*Hypericum elodes*) and bog pondweed (*Potamogeton polygonifolius*), particularly on the southern hills.

The Phase 1 habitat survey of government owned hill-land recorded 707 acres (286 ha) of flush in the northern hills (Figure 2) and 47 acres (19 ha) on the southern hills (Figure 3). A total of 1,124 acres (455 ha) was recorded on the Island as a whole, comprising less than 3% of the Island's semi-natural vegetation (DAFF, in press, pers. comm.).

Complex mosaics of flush and other habitats (grassland, heathland, bog and fen) are common.

E3 Fen

Phase 1 definition: Fens are defined as minerotrophic mires, usually over peat more than 0.5m deep. The water-table is at or just below the surface. Three main types of fen can be distinguished, using topographical rather than vegetational criteria. These are valley mire, which, because there is obvious water flow, is classified as soligenous and basin and flood-plain mires, which have impeded drainage and are termed topogenous. However, the distinction between these three mire types is not always clear in the field. Of the above fen types, only valley mire was recorded during the Phase 1 habitat survey of the government owned hill-land.

E3.1 Valley mire

Phase 1 definition: A valley mire develops along the lower slopes and floor of a small valley and receives water from springs and seepages on the valley sides, feeding a central watercourse. Such a fen can be distinguished from a flush because the former is a complex, whereas a flush is a discrete single feature, usually of limited extent.

Valley mires are often dominated by acidophilous vegetation containing *Sphagnum* species, *Carex* species and ericoids. However, vegetation typical of base-rich conditions can also occur, for instance *Schoenus nigricans* and *Juncus subnodulosus*. Floating mats of mosses and sedges may be present. Acid watercourses often contain *Hypericum elodes* and *Potamogeton polygonifolius*.

Only 32 acres (13.6 ha) of valley mire was recorded on the government owned hill-land and was confined to the northern hills (Figure 2). Only 36 acres (14.6 ha) was recorded during the Phase 1 habitat survey of the whole Island (DAFF, in press, pers. comm.), located north east of Snaefell and south west of Sulby Reservoir (Figure 2).

Threats to mire: The major threat to mire vegetation is hill-land improvements by drainage. Mires are also threatened by peat extraction, erosion particularly in the vicinity of footpaths, public rights of way and greenways, over-burning and over-grazing.

F Swamp, marginal and inundation

Phase 1 definition: This habitat category is defined as emergent or frequently inundated vegetation, occurring over peat or mineral soils. Note that this category differs from mire (E) and from marsh/marshy grassland (B5) in having the water table distinctly above the level of the substrate for most of the year.

F1 Swamp

Phase 1 definition: Swamp contains tall emergent vegetation typical of the transition between open water and exposed land. Swamps are generally in standing water for a large part of the year, but may occasionally be found on substrates that are seldom immersed, as in the later stages of the seral succession to marshy grassland.

Species composition varies according to the trophic status of the water, the substrate type, etc. Swamp vegetation includes both mixed and single-species stands of bulrush (*Typha* species), common reed, reed canary-grass and tall sedge species. Single-species stands are usually found in deeper water. Strips of swamp vegetation narrower than 5m bordering watercourses are classified as marginal vegetation (F2.1).

Note that vegetation dominated by purple moor-grass, meadowsweet, mosses, small sedge or rush species, is classified as marsh/marshy grassland (B5) or flush (E2), as appropriate.

Swamp habitat was not recorded during the Phase 1 habitat survey of the government owned hill-land, but the above definition is included here to avoid confusion with other, similar, habitats.

F2 Marginal and inundation

F2.1 Marginal vegetation

Phase 1 definition: This category encompasses all narrow strips of emergent vegetation occurring on the (often steep) margins of lowland watercourses, where the water-table is permanently high. Bands of tall vegetation wider than 5m are classified as swamp (F1, above). Marginal vegetation is typically open and contains plants such as flote grasses, water-cresses, fool's water-cress, lesser water-parsnip, forget-me-not, speedwell, water-plantains, branched burr-reed, pond sedge, soft-rush, also small stands of taller plants such as common reed, bulrush (*Typha* sp) and reed canary-grass.

Although marginal vegetation is present on the hills, it does not occur in areas sufficiently large to map and record under the Phase 1 habitat survey.

F2.2 Inundation vegetation

Phase 1 definition: This category includes open and innately unstable communities that are subject to periodic inundation, as found on sorted or unsorted silts, sands and gravels of river beds and islands and on the draw-down zone around pools, lakes and reservoirs. A wide variety of species occur in such communities, including knotweeds, bulbous rush, bur-marigolds, creeping bent-grass and marsh foxtail, as well as many ruderal species.

Although inundation vegetation is present on the hills, it does not occur in areas sufficiently large to map and record under the Phase 1 habitat survey. However, it is present on the draw-down zone of Cringle reservoir.

Threats to swamp, marginal and inundation vegetation: These habitats are particularly vulnerable to the effects of any drainage works in the vicinity which can alter the water-table. The dredging and clearance of ditches and streams to improve land drainage and water flow can damage or destroy the fringing habitats. Other threats include eutrophication from fertilisers, sewage and slurry from surrounding land and pollution from pesticides. These habitats can also be threatened by natural succession being replaced by scrub and trees.

G Open water

Phase 1 definition: Open water is defined as water lying beyond the limits of swamp or emergent vegetation, although it may contain submerged, free-floating or floating-leaved vegetation.

The Pond Conservation Group (1993) defines a pond as 'a small body of water, between 1 sq.m and 2ha in area, which usually holds water for at least four months of the year'.

G1 Standing water

Phase 1 definition: Standing water includes lakes, reservoirs, pools, flooded gravel pits, ponds (Manx = dubs), water-filled ditches, canals and brackish lagoons.

Open water is aesthetically pleasing and can be very important for birds, fish, invertebrates and aquatic plants. As well being used for recreation it can be an important educational resource: pond-dipping for water-life is popular with schoolchildren and adults alike.

The Phase 1 habitat survey of the government owned hill-land recorded only 3.5 acres (1.4 ha) of standing water (not including the reservoirs), with the majority (3 acres) found on the southern hills. Several ponds (Manx = dub) have been created by the Department of Agriculture, Fisheries and Forestry within the plantations to serve as a source of water in the event of a forest fire, for example, in South Barrule, Archallaghan and Ballaugh plantations. Such ponds, however, also provide habitat for wildlife, supporting wetland flora and fauna and attracting small numbers of wildfowl, dragonflies, damselflies and frogs etc.

A detailed survey of ponds, their number, water chemistry, flora and fauna and pressures upon them is long overdue on the Isle of Man. The MNCT is seeking funding in order to carry out such a survey.

There are six main reservoirs fed from the northern uplands:

(1) The Island's largest reservoir is the Sulby Reservoir (SC3788) 54 acres (22ha) in extent and fed by three main tributaries: Druidale, Glen Crammag and Lhergyrhenny. Other tributary streams flow off the northern hill escarpments into the Sulby River through Tholt-y-Will Glen, Block Eary, Ballaneary, Narradale (east and west), Glen Tramman and Glen Auldyn (including Fern Glen).

(2) The catchment of the West Baldwin Reservoir, Injebreck (SC360835, 42 acres (17ha) in extent, created 1904), includes Slieau Ruy (SC3282), Lhargee Ruy (SC3383), Colden (SC3484), Slieau Maggle (SC3486), Injebreck Hill, Beinn-y-Phott (SC380860) and Slieau Ree (SC3782).

(3) Ballure Reservoir, Ramsey (SC455929), which is largely fed from North Barrule (SC4491).

(4) A small reservoir is located at Bloc Eary (SC388900), a tributary of the Sulby River.

(5) A small reservoir (SC335893) on the Ballalonney stream, east of Kirk Michael.

(6) A disused reservoir is present in upper Glen Roy, west of Laxey, at SC 403833).

Two additional reservoirs, Clypse and Kerroodhoo (SC4080, created 1876-1893), fed by the Groudle River, include a small area of hill-land in their catchment area.

There are only two main reservoirs fed from the southern hills:

(1) The Cringle Reservoir (SC253745, 4 acres (1.6ha) in extent, created 1940), its largely afforested catchment dominated by South Barrule (SC2575).

(2) Kionslieau Reservoir (SC289782) and Eairy Dam whose catchment includes Stoney (Granite) Mountain (SC2876), which is afforested, and Archallaghan Plantation (SC300790) which was an isolated block of heather moorland prior to its planting in 1883.

However, there are an additional three small reservoirs along the Colby River at Earystane (SC228731 - largest) and a flooded quarry at Glen Rushen (SC247783) which supplies Glen Maye.

Of the larger artificial waterbodies created on the Isle of Man, the shallow Kionslieau Reservoir and Eairy Dam are of much greater interest for birdlife than the larger reservoirs created for public water supply (Cullen and Jennings 1986). The above two waterbodies are the best inland waters for wildfowl on the Island with autumn flocks of mallard and teal in excess of 100 and small but wintering populations of pochard, goldeneye and tufted duck. Long-tailed duck and scaup occur most years and for half a century a small party of whooper swans wintered annually (Cullen and Jennings 1986).

Of the reservoirs, Clypse and Kerroodhoo (SC4080) are the oldest (1876-1893) and attract the same common wildfowl as Kionslieau and Eairy. Baldwin, Cringle and Sulby reservoirs are of little interest ornithologically.

Numerous small dubs (ponds) are present on the hills, for example, in the northern hills east of Slieau Managh at SC411915, at the summit of Slieau Freoghane (SC3488) and alongside the Druidale Road (C37 in SC3690) and in the southern hills on Granite Mountain (SC2877) where there are flooded workings.

A detailed survey of the invertebrates present or dependent upon these dubs has not been carried out, although Odonata (dragonflies and damselflies) and frogs are known to occur (personal observation).

The Island is lacking a base-line survey of its watercourses, both upland and lowland. A comprehensive survey of water quality, fish and invertebrate fauna should be carried out and the results published.

The construction of the Sulby Reservoir in the 1980s has apparently had a major effect upon the ecology of the Sulby River downstream. Water analysis undertaken for the Department of Agriculture, Fisheries and Forestry by the Government Analysis on 21st December 1993 shows that the water is more acidic below the Sulby reservoir (pH 5.19-5.68) than above (pH 5.93-6.24). It is dangerous to draw conclusions from only one data set. A comprehensive base-line survey and repeated surveys over time are necessary to make firm conclusions.

G2 Running water

Phase 1 definition: Running water comprises rivers and streams. The direction of flow is indicated by an arrow.

The Sulby River is the Island's longest river at 19km (12 miles) from source to sea at Ramsey. Its catchment area is considerable, extending from the east-facing slopes of Slieau Dhoo (SC3589), Slieau Freoghane (SC3488) and Sartfell (SC3387) in the west, with Slieau Maggle (SC3486), Beinn y Phott (SC380860) and Mullagh Ouyr (SC3986) forming the southern limit and Snaefell (SC3988), Clagh Ouyr (SC4189) and North Barrule (SC4491) forming the eastern catchment boundary.

The other major rivers having upland catchment areas from the northern hills include Glen Dhoo (Ballaugh), Ballure (Ramsey), Cornaa (Corrany), Laxey River (including Glen Roy), River Glass (including its tributary rivers, the Sulby, Baldwin and Awin Darragh), the source of the Greeba River, the River Neb (including its tributary rivers, the Blaber and Rhenass) and the Cooildarry river (including the Ballalonney stream, Glen Wyllin, Kirk Michael).

In the southern hills, the catchment of the Glen Rushen River includes the northern slope of Cronk ny Irree Laa (SC2274), South Barrule (SC2576), Arrasy Hill (SC2578) and Dalby Mountain (SC240780). The Foxdale tributary of the River Neb receives water from Slieau Whallian (SC2680) and Carnagrie (SC2579), the northern slope of South Barrule and from Stoney (Granite) Mountain, the last forming part of the catchment area for the Santan Burn.

The source of the Silver Burn is the catchment for the Cringle Reservoir (see below) and is joined near Ballasalla by a tributary stream (Awin Ruy) from Windy Common (SC2875). The Colby River catchment is dominated by Cronk ny Irree Laa (SC2274) with Slieau Earystane (SC2373) to the east and Lhiattee ny Beinee (SC2172) to the west.

In most of the upland river valleys, the local drift masks a pre-glacial 'V'-shaped profile. The uncharacteristic 'U'-shaped profile of the upper Laxey Glen in the vicinity of Snaefell Mines, can probably be attributed to enhanced glacial erosion (McCarroll, Garrad and Dackombe, 1990).

Erosion of the upland deposits by water must have been initiated shortly after deglaciation, and the gravel fans issuing from the mouth of Glen Dhoo, Ballaugh, and Sulby Glen date from this period. The Sulby River, in particular, must have been considerably more powerful at this time, since the gravel fan now acts as a barrier forcing the river eastwards to Ramsey (McCarroll, Garrad and Dackombe, 1990).

Incision by the upland streams must have been active throughout the Late- and Post-glacial periods. Erosion has worked its way steadily headward, with the lower parts of the major river valleys largely stripped of the glacial deposits, while the valley heads are still deeply mantled (covered with glacial material). Most of the Manx river valleys contain sequences of terraces which record this progressive incision, but they have not been studied in detail (McCarroll, Garrad and Dackombe, 1990)

Threats to open water: Communities of plants and animals in aquatic situations are greatly influenced by the nutrient status and chemistry of the water. On the hill-land, contamination from abandoned mine workings and the acidification of water both from acid rain and as a consequence of conifer afforestation are potential threats. In addition, eutrophication from the application of fertilisers, sewage and slurry can cause rapid growth and death of plant material resulting in anaerobic conditions and a reduction in aquatic fauna. Increased sediment loads caused by afforestation, earth moving activities and the construction of access roads across open moorland, may increase turbidity to unacceptable levels.

A variety of methods to survey the morphology, vegetation, birds, mammals, fish and invertebrates has been developed (RSPB, NRA and RSNC 1994). Such surveys should be carried out for Manx watercourses.

H Coastland

H8.1 Maritime hard cliff

Phase 1 definition: These are cliffs formed of rock with less than 10% vascular plant cover.

The Phase 1 survey of government owned hill-land recorded 3.2 acres (1.28ha) of maritime hard cliff, all of which was recorded from the western slopes of the southern hills near Fleshwick (SC2071, Figure 3) where the hills extend down to sea level.

H8.5 Coastal heathland

Phase 1 definition: All heathlands which include maritime species and which occur on shallow slopes, or even level areas, by the sea are classified as coastal heathland. Indicator species include *Scilla verna, Armeria maritima, Jasione montana, Plantago maritima* and *Plantago coronopus. Calluna vulgaris* is often dominant; *Erica cinerea* and dwarf *Ulex* species are frequently present. Coastal heathland occurs just inland of coastal grassland, and like that category, frequently occurs at the top of cliffs.

The Phase 1 survey of government owned hill-land recorded 9.4 acres (3.8ha) of coastal heathland, all of which was recorded from the western slopes of the southern hills (Figure 3) where the hills extend down towards the sea.

I Rock exposure and waste

Phase 1 definition: This grouping includes both natural and artificial exposed rock surfaces where these are almost entirely lacking in vegetation, as well as various forms of excavations and waste tips.

I1 Natural exposures

Natural rock exposure is present on the river beds of watercourses, providing habitat for fish and invertebrates, including spawning grounds for indigenous populations of brown trout (see 3.5.1).

I2 Artificial exposures and waste tips

I2.1 Quarry

Phase 1 definition: Excavations such as gravel, sand or chalk pits and stone quarries.

I2.2 Spoil

Phase 1 definition: Includes abandoned industrial areas and tips of waste materials such as coal mine spoil and slag.

The Phase 1 habitat survey of the government owned hill-land recorded 50.1 acres (20.3ha) of quarry and associated spoil (Table 1), with 42.7 acres (17.3ha) on the southern hills (Figure 3) and 7.4 acres (3ha) on the northern hills (Figure 2).

J Miscellaneous

J1 Cultivated/disturbed land

J1.1 Arable

Phase 1 definition: This includes arable cropland, horticultural land (for example nurseries, vegetable plots, flower beds), freshly-ploughed land and recently reseeded grassland, such as rye grass and rye-clover leys, often managed for silage.

The Phase 1 survey of the island produced combined figures of improved grassland and arable land (see B4).

J1.2 Amenity grassland

> Phase 1 definition: This comprises intensively managed and regularly mown grasslands, typical of lawns, playing fields, golf course fairways and many urban 'savannah' parks, in which rye-grass, with or without white clover, often predominates. The sward composition will depend on the original seed mixture used and on the age of the community. Herbs such as daisy, greater plantain and dandelion may be present. If the amenity grassland has a sward rich in herbs, it may be possible to classify it as semi-improved acidic, neutral or calcareous grassland as appropriate. In such cases, the area concerned is classified as the specific grassland type and its amenity use noted.

The Phase 1 survey of government owned hill-land recorded just 0.8 acres (0.32ha) of amenity grassland, located on the southern hills.

J2 Boundaries

Fences are usually of little value to wildlife, especially when new or the vegetation is grazed on both sides. However, their value is increased if vegetation is allowed to grow tall at the base and climbing plants such as ivy and honeysuckle or bramble or wild rose use the fence as a climbing frame.

J2.1 Intact hedge

> Phase 1 definition: Entire and more-or-less stockproof.

Hedges can be composed of native species (hawthorn, sloe, willow, holly, hazel, elder, wild rose, bramble) and can be valuable for wildlife and in providing shelter to livestock and as landscape features. However, there are few thorn hedges on the hill-land.

J2.2 Defunct hedge

> Phase 1 definition: Hedges in which there are gaps and which are no longer stockproof.

Defunct hedges are still valuable for wildlife and as landscape features, in providing habitat albeit on a smaller scale than intact hedges but form part of the spectrum from woodland to individual or scattered trees.

J2.3 Hedgerow with trees

Trees provide structural diversity and serve as landscape features, but if there are too many trees, or species which cast a heavy shade (beech, sycamore), then the hedge shrubs can become straggly and do not produce many flowers or fruit. Hedgerow trees are present on the marginal hill-land.

J2.5 Wall

Walls can support significant communities of mosses, lichens or ferns as well as plants frequently found growing on walls such as ivy-leaved toadflax, red valerian, ivy, yellow corydalis and grasses.

The flora of walls is the subject of books, for example, *Ecology of walls* (Darlington 1981) and *Rooted in stone - the natural flora of urban walls* (Gilbert 1992) according to which Britain contains some of the finest examples of wall vegetation in Europe as a result of our mild, wet climate. In addition to their aesthetic role, the vegetation has conservation importance as it contains about 20 species that have their headquarters on walls in the UK, some of these are now very rare in the wild.

In addition to surveying the Island's roadside verges, the MNCT has also produced a special wall flora survey form, although to date only the walls of Peel Castle and Castle Rushen have been surveyed.

J2.6 Ditch

Phase 1 definition: Only ditches which appear to be dry for most of the year are included in this category. Wet ditches are mapped as standing water (G1) or possibly tall swamp (F1).

J4 Bare ground

Phase 1 definition: Any type of bare soil or other substrate not already covered (bare peat E4, maritime cliff H8 and natural rock exposure I).

Recently created or disturbed ground provides germination sites for those species which require clear ground to germinate. Such species tend to be annuals, biennials or short-lived perennials and are often regarded as "weeds". However, rare or unusual plants may also germinate. Bare ground can also be exploited by burrowing bees and wasps which depend on exposed soil.

The Phase 1 habitat survey of the government owned hill-land recorded 41 acres (16.6ha) of bare ground (Table 1), with 30.3 acres (12.3ha) on the northern hills and 10.6 acres (4.3ha) on the southern hills.

3.3.2 Wildlife corridors

If wildlife conservation measures are to work effectively in the long term it is important to consider the environment as a whole and not to devote too many resources to a small number of sites where ecological interest is particularly high. It is quite likely that the fauna and flora of such a site would not survive for long in isolation but are dependant on the physical connection through adjacent habitat of relatively low wildlife value which connects them to other high value sites. Thus in addition to classifying land according to its habitat type and identifying areas of ecological importance, it is also valuable to identify "wildlife" or "green" corridors linking such areas together. This is particularly important in an urban setting where wildlife corridors are often referred to as fingers of the countryside extending into the town.

Wildlife corridors are made up of non-built-up land and include a variety of sites and habitat types which can be of high, medium or low wildlife value. Such corridors provide habitat for plants and animals and link areas of ecological interest together thus reducing their degree of isolation . These links allow plants and animals to move and colonise or re-invade other areas. Plants can move by seeds carried by wind or by animals, while the animals themselves can physically move from area to area or site to site. Wildlife corridors can vary greatly in shape, for example:

large, wide, extensive and suddenly coming to an abrupt end

wedge-shaped becoming narrower towards an end point

a long, thin finger which may be straight, angled or sinuous (for example, along a river)

In addition, very narrow linear features can be important in connecting areas of ecological interest. Such features include rivers, streams and ditches and tree-lined road verges and hedges.

It is important to maintain the integrity of existing corridors. There are three particular examples on the Manx hills where this should be a priority:

- From South Barrule, through the Round Table towards Cronk ny Irree Laa (Figure 3)
- From Dalby Mountain in between Kerroodhoo and Slieau Mooar Plantations to Eary Cushlin (Figure 3)
- From Mount Karrin between Ballaugh Plantation and Tholt-e-Will towards Slieau Dhoo (Figure 2)

Threats to wildlife corridors: The main threat to wildlife corridors on the Manx hills is through habitat fragmentation, in particular the reduction in area or width of areas of blocks of heather moorland as may happen following afforestation, replacement by acid grassland or by the encroachment of bracken. If corridors linking blocks of semi-natural vegetation are so affected, their value as pathways for flora and fauna is reduced and the vegetation blocks may effectively become isolated with little or no transfer and movement of certain species between the blocks. Plants and animals would become isolated from others of the same species and their future survival may be less secure. This may apply equally to birds such as the red grouse as to moorland invertebrates.

3.3.3 Notable species accounts (After Allen 1984)

The following notes aim to present a brief account of notable plants recorded on the Manx hills. It is important that their presence and importance is known, so that they are not damaged or destroyed through ignorance and that in the event of anticipated threats or development, consultations can take place and steps taken towards ensuring their future survival.

Fir Clubmoss *(Huperzia selago)*. Moors, wet rocks. Rare. On and near summit of Snaefell, hill NNE of Injebreck, Slieau Freoghane and Carn Gerjoil, Beinn y Phott, North Barrule and South Barrule quarries.

Stagshorn clubmoss (*Lycopodium clavatum*). Moors, usually amongst heather - but on a wet ledge at the Cluggid falls. Occasional but unknown on the southern hills. Generally between 600 and 900ft. Apparently much diminished in recent years.

Alpine Clubmoss *(Diphasiastrum alpinum)*. High moors. Very rare. Recorded on Snaefell, Caraghan, hill NNE of Injebreck, between North Barrule and Snaefell, top of Ravensdale and Carn Gerjoil.

Wilson's Filmy-fern *(Hymenophyllum wilsonii)*. Boulders in moist upland glens, Very rare. Found on wet rocks along the stream through Colden plantation, Injebreck, in its only Manx site.

Parsley fern (*Cryptogramma crispa*). Slate quarries, acid mountain rocks. Very rare. Present on substitute screes in South Barrule slate quarries and Glen Rushen quarries and on North Barrule and Gob ny Clee (Slieau Whallian).

Beech fern *(Phegopteris connectilis*). Glens and damp shady areas in hill areas. Rare. Recorded at Lhergyrhenny above the Sulby reservoir.

Juniper (*Juniperus communis*). Moors. Very rare, apparently extinct. A solitary bush on a heathy moorland, Dreem Gill, Glen Auldyn., 1947. Transplanted for protection to a nearby enclosure, where it subsequently died.

Mountain Pansy *(Viola lutea)*. Upland grassland, especially on base-rich soils. Very rare, apparently extinct. Recorded on North Barrule and Snaefell, but not since 1883, presumed extinct.

Bird cherry (*Prunus padus*). Upland thickets, lowland plantation. Very rare. A solitary large tree above Baldwin Reservoir, at about 600 ft.

Yellow saxifrage (*Saxifraga aizoides*). Wet stony ground by base-rich mountain flushes. Very rare, perhaps extinct.

Grass-of-Parnassus (*Parnassia palustris*). Credibly reported from the Blaber River above Glen Helen, but confirmation needed.

Least willow (*Salix herbacea*). Bare ground on wet mountains. Very rare, the only true arctic-alpine flowering plant on the Isle of Man. Present on the summit of Snaefell.

Cowberry *(Vaccinium vitis-idaea)*. High moorland usually around summits. Rare. Recorded on the hill NNE of Snaefell, Beinn y Phott, Snaefell, Slieau Freoghane, South Barrule and The Carnanes.

Cranberry *(Vaccinium oxycoccos)*. Upland valley bogs. Very rare. Found near the top of the Cluggid stream, Sulby Glen, at about 900 feet.

Dodder (*Cuscuta epithymum*). Near the sea on heather, thyme and Leguminosae. Rare. Recorded on *Calluna* at Eary Cushlin.

Common Cow-wheat *(Melampyrum pratense* subsp. *pratense)*. Wet acid woodland and heath below 600ft., bilberry moor above 1,250ft. Recorded on North Barrule, Beinn y Phott and South Barrule summit.

Heath cudweed (*Gnaphalium sylvaticum*). Dry heathy ground, at sea level and in the hills. Very rare. Recorded near Tholt-y-Will.

Mountain Everlasting *(Antennaria dioica)*. Dry heathy and rocky ground, especially at high altitudes. Very rare. Recorded with Mountain Pansy as a mountain plant, presumed extinct.

Lesser water-plantain (*Baldellia ranunculoides*). Peaty ditches and pools. Very local; widespread in the north, recently found at Baldwin Reservoir and rediscovered on the Mull Hill.

Lesser twayblade (*Listera cordata*) recorded on the hill NE of Snaefell by Rev. Hugh Davies 1774.

Frog orchid (*Coeloglossum viride*). Short damp turf of hill slopes and old pastures. Very rare and local. Hills near Ramsey and hillside above lower Narradale.

Viviparous Sheep's-fescue *(Festuca vivipara)*. Mountains. Very rare, perhaps extinct. Recorded on a hill NE of Snaefell in the 1700s, presumed extinct.

3.4 Bird communities of the Manx hill-land and the influence of upland afforestation

by Aron Sapsford and Allen S. Moore (*Manx Ornithological Society*)

3.4.1 Introduction

Upland afforestation has many effects, both beneficial and detrimental, on bird communities as a whole. The process of planting open moorland with conifers brings about enormous ecological changes; studies of these changes which occurred amongst upland songbird bird communities in Scotland (Moss 1978, 1979; Moss et al., 1979.) show that both bird species richness and density increased during the first stages of tree growth. Species richness peaked at the stage prior to canopy closure but thereafter rapidly declined.

Passerine communities found on upland grassland and moorlands consist of a small number of species. However, these areas are crucial to the survival of a wider range of more specialised species, corvid and non-passerine, which require particular types of habitat for both feeding and breeding. These communities are typically associated with 'unimproved' land that has not been enclosed within farm boundaries, yet it is often the 'marginal zones', situated between improved agricultural land and the moorland, which are also important for birds.

In animal communities, it is usual to find that species composition and population levels are closely linked to the diversity of the environment and are thus sensitive to habitat changes, including those caused by human intervention. This is certainly true of upland bird populations on the Isle of Man, and the Red Grouse* (*Lagopus lagopus*) is good example of how the success of a species can be influenced by man-made change.

The Manx hills provide habitats for a number of unusual and interesting bird species. Some of these are rare on an international scale, while others are restricted, as far as the Isle of Man is concerned, to upland areas.

In recent years, the concept of 'Important Bird Areas' has been developed by the Royal Society for the Protection of Birds (RSPB) and Birdlife International, a worldwide organisation for the conservation of birds and their habitats. An area is designated an 'Important Bird Area' if it contains 1% or more of all (or of a section) of the population of a species, for example, in the World, Europe, or Britain and the Isle of Man. Applying this concept to the Isle of Man, the uplands stand out as being particularly important for three species for which we have at least 1% of the combined British and Manx population:-

1) Hen Harrier (*Circus cyaneus*); currently about 40 nests per year out of a total of 630 nests in Britain and the Isle of Man, (6.3% of the total).

2) Chough (*Pyrrhocorax pyrrhocorax*); with 77 pairs recorded in 1992 (22.5% of the Britain and Isle of Man total of 342 pairs).

3) Curlew (*Numenius arquata*); with approximately 400 pairs (1.2% of the British and Manx population).

*The Red Grouse is considered separately in this report (section 3.7).

3.4.2 Hen Harrier

The uplands provide the Hen Harrier with nest sites and year round feeding opportunities, although birds tend to move to lower ground during winter months when suitable food becomes more scarce on the hills. Since colonisation in 1977, the Manx population has built up to one of the largest of any area in the British Isles. The large scale establishment of plantations during the past decade, has played a significant role in the expansion of the Hen Harrier's range throughout the Island by providing suitable nesting sites. However, the species remains dependent on open moorland for food (Watson 1977, Watson 1979) and its continued success depends on large areas of prime open moorland interspersed with the afforested areas. Information collected on the remains of pellets found in nests on the Island show that Rabbit (*Oryctolagus cuniculus*) formed 35%, Brown Rat (*Rattus norvegicus*) 8% and small birds (passeriformes) 32%, particularly Skylark (*Alauda arvensis*) and Meadow Pipit (*Anthus pratensis*) which made up 26% of prey items (Lindley et al, 1993). If the prey composition by weight is assessed, then Rabbits undoubtedly account for a much higher proportion of the diet. This clearly indicates the importance of the open moorland as a hunting ground for Harriers, with only 8% of prey items being small bird species associated with plantations.

3.4.3 Chough

The Chough is the rarest member of the crow family, the Corvidae, breeding in the British Isles. Formerly more widespread, its range contracted during the eighteenth and nineteenth centuries and it is now absent from England. The reasons behind this decline are not fully understood, but may include persecution, changes in land use and climatic factors. In recognition of its rarity and needs for active conservation measures, the Chough was placed on Schedule 1 of the U.K.'s Wildlife and Countryside Act 1981 and, in 1985, on Annex 1 of the European Community Directive on the Conservation of Wild Birds. On the Isle of Man the species is afforded special protection under the Wildlife Act 1990.

Certainly from the time of the publication of P.G.Ralfe's 'The Birds of the Isle of Man' in 1905, Choughs have nested in the Manx uplands, generally utilising ruined buildings. The number of nests in such tholtans in the hills is fewer today than it was formerly. A reversal of this trend is one of the aims of the Manx Chough Project. While the number of Choughs breeding inland in the Manx hills is presently quite low (only 3 pairs in 1992-93), the hills are crucially important for a much greater proportion of the Chough population as a feeding area. This is shown clearly by a flock of 73 feeding on heather moorland on the south side of Cronk ny Irree Laa on the 24th of March 1991, the second largest flock on record in the Isle of Man. Choughs are insectivorous birds, specialising in prey items such as ants (Formicidae), beetles (Coleoptera), crane flies (Tipulidae), earwigs (Dermaptera), fly larvae (Diptera) and moth larvae (Lepidoptera) (McCracken *et al* 1992). Prey items are located either on the soil surface, by digging or in livestock dung. Choughs require bare areas of rocks and soil or pasture with a short sward, as areas to locate prey items. These habitats can be found on managed heather moorland and the 'marginal zones' of rough grazed (sheep and/ or cattle) pasture. Even when Choughs are not nesting in the hills, they often forage in upland areas when they are close to coastal breeding sites (notably in the southern Hills between Glen Rushen and Fleshwick), and the family parties often disperse quite widely over the hills in summer. In the winter, the north-eastern hills between the Laxey Valley and North Barrule often have feeding flocks of Choughs; for example, during the winter of 1990-91 a flock of 21 was observed on one occasion on the heather moor at Creg ny Mohlt above Dhoon School (Moore 1991).

3.4.4 Birds of Prey

Both the Peregrine Falcon (*Falco peregrinus*) and Merlin (*F. columbarius*) are typical birds of the Manx uplands, although the latter is more of a passage visitor as far as the hills are concerned (Cullen

and Jennings, 1986). Following the recovery from organochlorine poisoning in the 1960s and 70s, the Manx Peregrine population is now relatively healthy and perhaps still increasing. Although the majority of nest sites are situated on the coast there is an increasing trend towards the expanding population making use of old quarry faces and inland cliffs. The Merlin has been proved to breed in the Isle of Man during the past few years but has a very tentative hold which could be lost with further upland afforestation. Bibby (1986) regarded the effects of present afforestation in Wales as fairly neutral and regarded small amounts of forestry as being possibly beneficial. The species has been known to use newly afforested areas as nest sites (Newton et al, 1978, 1986) but as a rule merlins are generally ground nesters and hunt over open ground. Watson (1979) showed that most of the prey items collected by two pairs of Merlins nesting within conifer plantations came from open moorland and comprised mostly Meadow Pipits. Tree-nesting has been recorded in Northumberland, where the birds use abandoned 'corvid' nests on the edges of coniferous forests.

3.4.5 Waders

The Manx uplands hold relatively few species of wader compared to those of northern England and Scotland. However, for at least one species, the Curlew, the Manx hills are important with 1.2% of the British and Isle of Man breeding populations being present. Small numbers of Lapwing (*Vanellus vanellus*) and Common Snipe (*Gallinago gallinago*) can be found, although both are restricted to wet/boggy areas with the Lapwing also preferring 'marginal' agricultural land. Both species have probably been affected by previous afforestation work, and in particular the status of the Snipe is of concern with a marked decline in breeding records in recent years, probably as the result of habitat drainage.

3.4.6 Owls

Of the three species which breed on the Island, only two, Long-eared Owl (*Asio otus*) and Short-eared Owl (*A. flammeus*), are currently affected by the present afforestation programme. The other, Barn Owl (*Tyto alba*), has been subject to extensive studies and introduction programmes in the British Isles and in recent years has been proved to benefit, at least in the short term, from nest-box schemes run in conjunction with the Forestry Commission.

The Long-eared Owl is the commonest and most widespread of owl species on the Isle of Man and is well documented as making use of coniferous plantations as both nesting and roosting sites. Often using old 'corvid' nests, it is one of the few non-passerine species which are associated with mature plantations. The current trend of controlling pest species such as Magpie (*Pica pica*) and Hooded Crow (*Corvus corone*) using 'Larsson' traps on farmland adjacent to plantations is of concern, due to the long-term effects of removing breeding 'corvid' species and therefore their associated abandoned nest sites. A study of pellets collected on the Island revealed that the Wood Mouse (*Apodemus sylvaticus*) made up 85% of the Long-eared Owl's diet (Callow, 1992).

Short-eared Owls are more nomadic in their nature and their abundance is greatly influenced by the availability of their prey items. As a ground nesting species, younger plantations which support a greater diversity of its prey items are favoured. In the British Isles it has been shown that following the removal of livestock before planting, the growth in vegetation triggers a rapid and enormous rise in the numbers of Field Voles (*Microtus agrestris*) (Chitty, 1952). Very occasionally, vole numbers increase by a factor of 200 in plantations, but usually the increase is about ten-fold (Charles, 1981) and Short-eared Owls can reach densities of six pairs per km sq. The absence of such prey items on the Island perhaps explains the relative paucity of this species as a breeding bird on the Isle of Man. In recent years, nesting by a few pairs has occurred in a range of habitats in the hills, for example, in heather moor, damp rushy areas and new and replanted conifer plantations.

3.4.7 Passerines (excluding corvids)

There are only a small number of passerines which are directly linked with the Manx hills and moorlands, including Skylark, Meadow Pipit, Whinchat (*Saxicola rubetra*), Stonechat (*S. torquata*) and Wheatear (*Oenanthe oenanthe*). However, populations of these species tend to be concentrated on the upland habitats. In particular, areas of rough grazing and the more marginal agricultural land such as the Corrany and Laxey valleys are strongholds for the Manx populations of Whinchat.

3.4. 8 Raven

The Raven (*Corvus corax*) is perhaps the most characteristic species of the Manx uplands. Its present distribution throughout the British Isles is closely linked with hill ranges and moorland (Sharrock, 1976). It has been shown that there is a distinct correlation between the decline of Ravens and increased afforestation (Marquiss et al, 1978) . The establishment of upland forests has a three-fold effect. There is an immediate response with birds deserting newly planted areas. Further reductions in the Raven population occur when the canopy closes and when the birds become dependent on adjacent areas of open moorland for foraging and food. Ravens cannot survive where the hill-land is developed into large expanses of unbroken forest. The removal of lifestock from afforested areas results in a decline in food for Ravens, particularly the insects associated with dung.

3.4.9 Summary

As mentioned above, Chough populations are the most important in international terms of all species occuring on the Isle of Man. Habitats of crucial importance to Chough survival include parts of the hill-land in public ownership managed by DAFF, particularly the southern hills from Cronk ny Irree Laa and Slieau Earystane south to Fleshwick, and parts of the north-eastern hills around the Laxey and Corrany Valleys.

When land is prepared for tree-planting, grazing and heather management for Red Grouse ceases. Choughs are excluded from afforested areas by the physical presence of the trees. Even before the trees are planted, the vigorous growth of pre-existing heather and gorse in newly fenced-off areas alters the habitat so that Choughs are no longer able to reach their insect food in the soil. As noted above, the uplands are important not only for the few pairs of Choughs which nest in the hills; favoured upland areas also provide foraging opportunities for pairs breeding on neighbouring coasts.

The Hen Harrier, another upland species with an internationally important population in the Isle of Man, may benefit initially from afforestation. About a third of Manx nests in 1990 were in new and failed conifer plantations. However, as stated above, harriers nesting in plantations still require a lot of open country within their territory for hunting. Excessive planting within the harriers' range would restrict the area available for hunting to a point where breeding success and population size would be affected. Work by the RSPB (Lindley et al 1993) provided valuable data on the altitudinal range of Hen Harrier's nests in the Isle of Man. Nest sites in open heather moorland and wet acid grassland were noted at altitudes between 146m and 366m above sea level with a mean of about 270m. This range coincides closely with the elevation at which afforestation with conifers is usually carried out. Increased exposure renders higher levels unsuitable for tree planting. The higher areas are also unsuitable for Hen Harriers since less prey is available and adverse weather conditions reduce breeding success. As plantations mature and the tree canopy closes, the harriers can no longer nest amongst the trees.

Other species which are dependent on open country include Raven and Merlin, even if they regularly nest in plantations. Like the Hen Harrier, these species hunt in open country and are adversely affected if the afforested areas become too great. Short-eared Owls are also typical of open country

but can do well in new plantations before the canopy closes. The Peregrine Falcon also typically hunts open country in the hills, but there is very little evidence that it is affected by afforestation (Avery and Leslie 1990). Of the smaller passerines typical of open country, Whinchats and Stonechats have recently been found nesting in new conifer plantations in the Isle of Man (notably in Creg ny Crock Plantation in Glen Rushen), but Wheatears have very rarely been found nesting in plantations anywhere (Avery and Leslie 1990). The effect of afforestation on upland wading bird populations is less obvious but probably significant. Nesting and feeding by Lapwings, Curlews and Snipe are adversely affected, both by tree planting and by drainage of marshy areas. In at least twenty years' experience of one of us (A.S.Moore), Snipe have decreased very markedly in the Isle of Man, although afforestation has had little affect in this case. Lapwings and Curlews seem to have decreased too, although there is less numerical evidence. There are places which had Curlews and Lapwings in the 1970s but which are now afforested and have none.

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3.5 Non-avian vertebrate fauna on the Manx hill-lands
by Ed Pooley

3.5 1 Introduction
The present day non-avian vertebrate fauna of the Isle of Man includes the survivors of a relatively small number of species which probably arrived here before the loss of the land bridge to the east in early Flandrian (post-glacial) times. These early arrivals have been augmented by a larger number of species which have certainly been introduced, both intentionally and unintentionally, by man. The distribution of species shown in the relevant publications prepared by the Institute of Terrestrial Ecology Biological Records Centre (Arnold, 1983 & 1993) is based on incomplete data, which in a few instances amounts to species being unrecorded altogether. For fish, the only authoritative distribution maps date back over 20 years (Maitland, 1972). There are notable absences from the present fauna which are especially significant in the ecology of the upland grasslands. These include Voles (Arvicolinae), especially the field vole (*Microtus agrestis*), deer (Cervidae) notably the red deer (*Cervus elaphus*) and also the adder (*Vipera beris).*

Most species are found to some extent on the hill lands although bats, fish and recently introduced populations of amphibians are poorly represented. Only one animal, the mountain hare (*Lepus timidus*) depends exclusively on open hill-land. The distribution of species in these semi-natural upland habitats is influenced by a wide range of environmental factors, including vegetation, soils, drainage, the degree of exposure to winds and the extent to which management leads to habitat change. Much of the open hills is exposed and both wind speed and rainfall are often two to three times greater than at sea level. The degree of exposure varies with topography and potential windchill, for example, would be less extreme in the shelter of a moorland valley. Rainfall also varies considerably within the uplands. Much of the area is grazed by hill sheep, but even at the maximum permitted stocking density under the hill sheep subsidy scheme of one ewe per two acres, competition between domestic stock and wildlife would probably be minimal. Heather *(Calluna vulgaris)* is an important food for mountain hares and, like sheep, they become more dependent on it in winter when grass is scarce.

Although hares (*Lepus* spp), together with the ubiquitous pygmy shrew (*Sorex minutus)*, are probably the most widespread species on the open hills, other animals find suitable niches well above 300m and in many cases reach almost to the highest summits. Seasonal movements occur, with some species extending their range further up into the hills during the warmer summer months.

The recent planting of exotic conifers over substantial areas of open Manx hill-land has had a profound effect on upland ecology. The impact has involved not only the composition and structure of the vegetation but also microclimate, hydrology and soil and water chemistry. The seral stages of short rotation forestry produce a broadly recognised series of habitat changes (Ratcliffe & Petty, 1986) which may vary according to the circumstances of the original planting and its subsequent management.

Mammals, reptiles and amphibians are probably little affected by the initial establishment phase of afforestation. Once into the 'thicket' stage, where trees are 3 to 10 m in height and canopy closure occurs, there is relatively little useful habitat, bar shelter, within the forest. However, habitats on the forest edge, both on the outer margins and along forest rides, are of benefit to some species. Shelter provided by the trees is particularly relevant in the context of the harsh winter environment on the open hills. Only carnivores are able to profit from all forest growth stages, although the

absence of voles from the Manx fauna means that there is no superabundance of food during the initial (establishment and pre-thicket stages). On balance, these stages are of potential advantage to most species, but it is not until the re-establishment phase of the subsequent rotation that ecological conditions are again as favourable (assuming that extraction methods are environmentally sympathetic). Since second rotation plantings are likely to involve smaller areas, than initial plantings of open moorland, there may be an overall increase in the benefits derived. Successful sites should achieve rotations of around fifty to sixty years and thus nearly 30% of the forest should ultimately be in the re-establishment/pre-thicket stage. Judicious use of broadleaved trees native to the Island on the periphery of a planting and along forest roads and water courses can improve the quality of edge habitat. Forest roads/fire breaks and pre-existing water courses can be kept sufficiently clear of new trees, taking account of their orientation, to achieve good sunlight penetration. On the Island, where the area of hill-land is already relatively small, a major concern is that future afforestation will lead to the excessive fragmentation of upland habitats to the point where isolated pockets can no longer provide the ecological requirements of at least some of the species concerned.

There now follows a review with brief remarks on both the present distribution of species and the implications to their populations of increased afforestation in upland areas. The overall effects of increased afforestation on a particular species would be dependent on the status of the animal over the Island in general. No account is taken of the legal position of the various species but the list includes pest, ground game and protected species.

3.5.2 Insectivorous mammals

The two Manx species find plentiful food supplies, even if of limited diversity, on the open hills particularly in damper areas where many beetle species are abundant. The tiny pygmy shrew can also find shelter easily in low vegetation and is consequently widespread on the hills as it is everywhere else on the Island. The hedgehog (*Erinaceus europaeus)*, with its winter hibernation requirement, is more typically a spring/summer visitor in small numbers to the open hills when it has been noted as high as 400m. Plantation edge habitats favour both species but more particularly at lower rather than at higher altitudes.

3.5.3 Rodents

Two of our three resident species are found on open hills, but in fairly small numbers. The exception is the feral house mouse (*Mus domesticus*). Both common rats *(Rattus norvegicus)* and wood mice (*Apodemus sylvaticus)* have been observed, on occasion, at some of the highest points on the Island. The rats are particularly attracted to inland herring gull *(Larus argentatus*) colonies, for example on the western slopes of Sartfell. Plantation edge habitats are better populated and wood mice derive some positive benefit from most coniferous plantation growth stages, although at low population densities compared to the same species in deciduous woodland.

3.5.4 Lagomorphs

All three resident species, rabbit (*Oryctolagus cuniculus)*, brown hare (*Lepus europaeus*) and mountain hare occur in the uplands. The rabbit is the least common above 300m, although successful breeding burrows have been noted in suitable soils close to the 600m contour in recent years. Mountain hares are well distributed but numbers appear to be declining. Despite occasional reports from the southern hills, it seems that mountain hares continue to be confined to the northern hills where they are observed at all altitudes over 200m. Their presence could be threatened by further afforestation; they probably need the maintenance of at least existing areas of heather and the current maximum intensity of sheep grazing for future success. Brown hares are fairly widespread in the

lowlands of the northern part of the Island. They do not extend much above 350m on the northern hills but at elevations between 180m and 330m they can be observed grazing in company with Mountain hares. On the open land of the southern hills they are found in modest numbers above 300m where rabbits are generally absent. This upland population may be sufficiently sparse and unsupported by any adjoining lowland population to be at risk. The significance of heather as winter food for these hares is, as yet, unproven. Forest edge provides potentially useful shelter for hares but such habitat is believed to play an unimportant role in their ecology. Both species of hare need large open feeding areas because their escape from danger depends on vigilance followed by speed.

3.5.5 Carnivores

The carnivores, which since 1987 have again included a small and currently self-sustaining fox (*Vulpes vulpes*) population, are opportunist predators which range over all the open hill lands. Stoats (*Mustela erminae)* often, as in Ireland, referred to locally as "weasels", closely resemble the Irish sub-species. The stoat population on the Island as a whole appears to be low but stable. The species is rare or absent above the 450m contour but appears to be particularly at home in relatively small plantations with wide internal roads; such a habitat provides a good source of its preferred prey - common rats, rabbits and small birds, their nestlings and eggs. A modest increase in afforestation would probably favour the stoat in particular. The small fox population, despite occasional reports of spring lambs being killed, seems to have taken to rabbit as a primary prey, but ranges freely and has been recorded near the summit of Snaefell (perhaps because rabbits are also found in that area!). The fox stands to gain in much the same way as the stoat from an increase in planting and, if the current population survives, significant new planting could provide a stimulus for increase. Polecat/ferrets (*Mustela putorius/furo*), which are widespread throughout the lowlands, also range freely over the hills particularly in the summer, although open moorland is probably of minor importance for them.

3.5.6 Other terrestrial mammals

Flocks of feral goats (*Capra hircus)* have lived on the hill lands until relatively recently in various locations including the Sulby area, around Cronk ny Irree Laa and in Patrick, but at present the only locality where they survive is on the precipitous coast between Laxey Head and the Dhoon. A free-living colony of Red-necked Wallabies (*Macropus rufogriseus rufogriseus),* essentially sedentary animals, has existed for the past 30 years as a result of an escape from captivity. Members of the colony have been observed to make foraging trips onto the heather above Sulby Glen from their home territory in Ballaugh Curragh. Similar but more extensive heather grazing has been noted in the only other British feral population of this species in the Peak District (Yalden,1991).

3.5.7 Bats

The six species of bats (Chiroptera) recorded on the Island occur chiefly in the lowlands. However, the hill-lands have been shown to provide winter hibernation sites for both Natterer's bats *(Myotis nattereri)* and Daubenton's bats (*Myotis daubentoni*), species which use crevices in old buildings or in abandoned mines and probably also mine and quarry spoil heaps, stone walls and suitable part-stone hedges.

During the summer flight season, the night flying insects on which bats prey remain at rest until temperatures have risen above a threshold and windspeed has fallen below a critical point. Such conditions are often not achieved on the open moorlands except during fine spells in mid-summer. In the smaller bat species navigation by echolocation appears to be hindered by relatively featureless terrain such as open moorland. The fringes of plantations probably assist navigation and are also attractive to insects. However, the food resource associated with exotic conifers, even when modified by the addition of a few broadleaved trees, is very limited. Experiments with bat roosting boxes on

the edges of plantations to compensate for lack of natural tree roosting sites have yet to demonstrate their effectiveness. During summer, the only species to have displayed a tendency towards opportunist foraging over open hill-land is the Natterer's bat which has been observed to venture over such terrain up to the 300m contour. However, the significance of this activity in the overall feeding ecology, of what on the Island is an endangered species, is not clear. On balance, the afforestation issue is probably largely irrelevant to bats.

3.5.8 Reptiles

The only reptile found on the hill lands is the common lizard (*Lacerta vivipara*) which, although absent from within the canopy of plantations, occurs wherever the habitat includes good dry hibernation sites and warm rock surfaces for basking in spring and early summer. Upland quarries and mining spoil heaps as well as stone walls and sheep pens have proved attractive and a south or south easterly aspect often assists in maintaining the good heat-gaining efficiency essential to ectotherms. The open hill supplies sufficient invertebrate food for this unspecialised insectivore. Lizards themselves fall as opportunist prey to foxes, polecats, stoats, hedgehogs and occasionally raptors. Conifer plantations sometimes provide suitable habitat where wide unshaded roads dissect the planted area and hibernation opportunities are available in the vicinity of basking sites.

3.5.9 Amphibians

Our principal amphibian species, the common frog (*Rana temporaria)* is mainly a lowland species. However, it has been observed to spawn in shallow tracts of ephemeral water on the open hills at altitudes up to at least 300m and, as a basically terrestrial amphibian, finds suitable habitat for foraging in the damp hill-land vegetation at these altitudes It seems likely that the scarcity of spawning sites is a major factor limiting populations at higher altitudes. There is a possibility that female frogs, whose preference is for land hibernation, are likely to remain at higher altitudes on hill land for more of the year than males, which normally seek the mud of ponds for winter hibernation. Of the carnivores, polecats probably take more frogs than the other two species. Afforestation would have little effect on frogs and with appropriate management could provide positive advantages.

3.5.10 Predators

Predators probably pose no threat to the long term maintenance of population levels in any of the species under consideration. Mammalian predators present on the Island are known to be catholic and opportunist in their selection of prey but the extent to which raptors are dependent on non-avian prey in the uplands is worthy of consideration. Four bird species routinely take such prey both on the open hills and in and around the plantations. Hen harrier (*Circus cyaneus*) kestrel (*Falco tinnunculus*) long-eared owl (*Asio otus*) and short-eared owl (*Asio flammeus*) all appear to rely for a significant proportion of their diet on small mammals and, more occasionally, reptiles and amphibians. In the absence of voles, which are a key element in the diet of both the kestrel and owl species in Britain, relatively more pygmy shrew, wood mouse, common rat and rabbit are taken by these predators on the Island. The flexibility with which such species can adapt to a variety of prey means that these birds should not be detrimentally affected by changes caused by new afforestation. The hen harrier is larger than the other raptors under consideration and takes larger prey, including common rats and young rabbits weighing up to at least 200g, as well as pygmy shrews and wood mice. It is other birds, however, which generally make up a majority of hen harrier prey, and a recent study of Manx hen harriers (Campbell *et al,* 1994) indicates that rabbits form the bulk of mammalian food intake here. Either way, any effects of habitat change by afforestation on the non-avian vertebrate prey of the hen harrier can be assumed to be a peripheral issue from the perspective of the predator.

3.5.11 Fish

The brown trout *(Salmo trutta)* is the only fish recorded from upland streams. Most rivers on the Island have been stocked extensively with this species during the last few decades and it is unlikely that more than a few local populations of indigenous brown trout remain. Since all water courses at high altitude are relatively small, of high acidity and characterised by highly variable flows, growth rates are low and only small fish occur. Afforestation should be avoided where it is suspected that indigenous brown trout occur. While it is feasible to avoid shading water courses by keeping planting well clear, it is almost impossible to avoid abrupt disturbance to acidity, nutrient levels and mineral balance in catchments while new plantations are being established (Maitland *et al,* 1990) and such changes in water quality could prejudice the survival of trout populations.

3.5.12 Summary

The non-avian vertebrate fauna of the open hill-land includes hares, a variable population of opportunist carnivores, the insectivorous pygmy shrew and common lizard together with a pioneer fringe of other species, particularly in the summer months. New plantations of exotic conifers are of little value to most species, and could lead to the disappearance of mountain hares, any native brown trout populations and also possibly prejudice the survival of brown hares in the south of the Island. Such plantings could also be detrimental to most other Manx species under consideration, unless carefully planned to fit into the overall ecology of the hill-lands. However, the restricted extent of remaining open land in the southern hills in particular leaves little opportunity for the establishment of any new plantations which would not have an adverse effect on the fauna under consideration.

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3.6 Invertebrates

3.6.1 Manx heath and moorland moths
by Gordon Craine

About 30 species of Manx Macolepidopterus moths, listed below, occur in upland habitats. Several are scarce (*) or very rare (**). The others are common, usually emerging in small numbers except for the true lover's knot, July highflyer and lead belle which are at times abundant. Only two appear regularly in daylight, the large and distinctive male emperor moth with its four eye-spots which is active on sunny days and the twin-spot carpet, a small species readily disturbed in heather.

Common name	Scientific name	Flight time	Larval food plant
* Orange swift	*Hepialus sylvina*	late June-early Sep.	Bracken
Map-winged swift	*Hepialus fusconebulosa*	late May-early July	Bracken
Fox moth	*Macrothylacia rubi*	May-June	Heather
Emperor moth	*Pavonia pavonia*	April-May	Heather
Lead belle	*Scotopteryx mucronata*	mid-May-mid-June	Heather
Grey mountain carpet	*Entephria caesiata*	late June-early Aug	Bilberry, heather
Striped twin-spot carpet	*Nebula salicata*	mid May-mid July	Bedstraws
Northern spinach	*Eulithis populata*	July-Aug.	Bilberry
July highflyer	*Hydriomena furcata*	July-Aug.	Heather, bilberry
** Argent & Sable	*Rheumaptera hastata*	May-June	Bog myrtle
Small autumnal moth	*Epirrita autumnata*	Aug-early Sept.	Heather, bilberry
Twin-spot carpet	*Perizoma didymata*	late June-Aug.	Bilberry, grasses
**Ling pug	*Eupithecia gooseniata*	June-July	Heather flowers
*Treble-bar	*Aplocera plagiata*	May-June	St. John's wort
**Bordered grey	*Selidosema brunnearia*	July-Aug.	Heather
Annulet	*Gnophos obscurata*	July-Aug.	Heather, trefoil
**Grey scalloped bar	*Dyscia fagaria*	late May-July	Heather
*Wood tiger	*Parasemia plantaginis*	late May-July	Herbaceous
White-line dart	*Euxoa tritici*	July-early Aug.	Heather, ragwort
True lover's knot	*Lycophotia porphyrea*	June-Aug.	Heather
*Neglected rustic	*Xestia castanea*	Aug.-Sept.	Heather
*Heath rustic	*Xestia agathina*	Sept.	Heather
Red chestnut	*Cerastis rubricosa*	Mar.-Apr.	Herbaceous
Sword-grass	*Xylena exoleta*	Mar-Apr:Sep-Oct.	Low plants
**Light knot grass	*Acronicta menyanthidis*	late May-early July	Heather, bilberry
Brown rustic	*Rusina ferruginea*	June-July	Dock, groundsel
*Crescent	*Caelena leucostigma*	late July-early Sep.	Yellow iris
Anomalous	*Stilbia anomala*	Aug.-Sept.	Wavy hair-grass
Common heath	*Ematurga atomaria*	May-June then late July-mid Aug.	Heather, clover

Details of rare moths:

Argent & Sable	1894 (IoM); 1954 Curraghs
Ling pug	1891 (Injebreck)
Bordered grey	1946 (Archallaghan)
Grey scalloped bar	1893 (IoM); 1968 Castletown
Light knot grass	1988 (Calf of Man)

Other comments: The annulet and white-line dart are also found in rocky coastal areas. The red chestnut and crescent are found in boggy moorland areas. The sword-grass is one of the few moths to overwinter as an adult. The common heath is double-brooded.

3.6.2 A survey of spiders in Druidale Valley, Isle of Man
by John Lamb and James Wright

3.6.2.1 Introduction
The invertebrate fauna of the Manx hills is under-recorded with only casual observations previously made. As the spider recorder for the Isle of Man, James Wright is carrying out an on-going survey of spiders and their populations on the Island.

In June 1994 the Island's Department of Agriculture, Fisheries and Forestry announced that the east-facing hill slope of Slieau Freoghane, between Montpelier beech plantation (SC354881) and Sartfell conifer plantation (SC343868), in the upper reaches of the Druidale Valley, was to be planted with 160 acres of conifers up to the 1000 foot contour.

Nothing was known of the hill-land invertebrate fauna which would be affected by the planting proposal and the object of the present survey using pitfall traps was to investigate the composition and status of invertebrate communities on the site. This paper presents the results for spiders collected during the survey.

As far as the authors are aware this is the first pitfall survey carried out on any area of hill-land on the Isle of Man.

3.6.2.2 Methods
On the 27th July 1994 the authors set-up two pitfall transects on the hill slope. Each transect comprised a series of nine traps in a straight line approximately 3m apart. The pitfall traps were round thick plastic beakers, approximately 10cm diameter and 15cm deep, 'charged' with a neat commercial anti-freeze to a depth of approximately 3cm. The traps were left uncovered throughout the survey.

One transect, aligned in a northeast-southwest direction, was positioned south of Montpelier along a slightly sloping and raised ridge at an altitude of ca 259m in damp heathland, the habitat being a transitional type between wet and dry dwarf shrub heath (Phase 1 habitat survey, NCC 1990). The second transect was placed further up the valley closer to Sartfell (SC353878) at ca 335m in dry dwarf shrub heath.

The vegetation along the wet heath transect was generally open, being grazed by rabbits, and dominated by purple moor-grass (*Molinia caerulea*) and ling (*Calluna vulgaris*) with common bent

(*Agrostis capillaris*), heath-rush (*Juncus squarrosus*), sweet vernal grass (*Anthoxanthum odoratum*), mat-grass (*Nardus stricta*), sheep's fescue (*Festuca ovina*), heath woodrush (*Luzula congesta*), bilberry (*Vaccinium myrtillus*), tormentil (*Potentilla erecta*) and cross-leaved heath (*Erica tetralix*).

The dry heath was dominated by ling but other plants recorded along the transect were common bent, sweet vernal grass, bilberry, tormentil, soft rush (*Juncus effusus*), green-ribbed sedge (*Carex binervis*) and heath bedstraw (*Galium saxatile*).

The traps along the dry heath transect were under cover of ling which formed a closed canopy which required parting when the traps were set or 'recharged'. The heather was even-aged, in the building phase (5-15 years old, Gimingham 1972) of the natural cycle of heather regeneration/degeneration, after a management burn some years previously. The hill-slope has not been grazed by sheep for several years, although rabbits and hares were present and were grazing the lower and more open patches of grass-dominated vegetation.

A photograph was taken of each transect in a southwest-northeast direction.

The traps were emptied and re-charged at approximately fortnightly intervals. The first set of traps was collected on the 10th August with subsequent collections taken on the 26th August, 7th September, 29th September, 12th October and 27th October, the transects being stopped and the trap holes infilled on the 27th October following the onset of adverse winter weather conditions.

Other than pygmy shrews which were discarded, the contents of the nine traps per transect were transferred to a single container and covered with 70% ethyl alcohol, in order to preserve and fix the spiders. The contents were sent to Dr Martin Luff at Newcastle University for sorting . Dr Luff identified the carabid beetles and the results will be presented at the Manx Hill-land Seminar 11-13 April 1995 and published in the proceedings of the seminar. The spiders, which are the subject of this paper, were identified by James Wright, with a couple of verifications by Dr Peter Merrett.

3.6.2.3 Results

A total of 259 spiders were collected in the pitfalls, of which it was possible to identify 239 specimens, consisting of 22 species. The species recorded, their dates and transect, are presented in Table 7. The number of species and specimens per family is presented in Table 6.

Table 6 Analysis of spider catches from pitfall traps, Montpelier 1994

	Families represented	Number of specimens	Number of species	Total species in Manx fauna	% of species in Manx fauna caught
Gnaphosidae	1	1	1	9	11
Liocranidae	1	5	1	3	33.
Thomisidae	2	2	2	6	33.3
Lycosidae	5	170	5	13	38
Hahniidae	1	1	1	3	33.3
Theridiidae	1	2	1	11	9
Tetragnathidae	1	4	1	4	25
Linyphiidae	10	54	10	100	10
Totals	**22**	**239**			

Table 7 Numbers of male (M), female (F), and intersex (G) spiders caught in pitfall traps on dry heath and wet heath at Montpelier, Isle of Man between 27 July and 27 October 1994. The presence of immature (imm) spiders is also noted.

Collection date	10 Aug		26 Aug		7 Sept		29 Sept		12 Oct		27 Oct	
Species:	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet	Dry	Wet
Drassodes sp.	-	-	-	-	-	-	imm	-	-	-	-	-
Agroeca proxima	-	-	-	-	-	-	3M	1M	-	-	1M	-
Xysticus cristatus	-	-	-	-	-	1F	-	-	-	-	-	-
Xysticus erraticus	-	-	-	-	-	-	-	-	1M	-	-	-
Pardosa pullata	17F 4M	5F 4M	30F 3M	4F 5M	14F 1M	8F	9F 1G	1F 1M	1F	2F	5F	1F
Pardosa nigriceps	4F 1M	1F 1M	6F 1M	1F 4M	4F	-	1F	1F	1F	-	-	1F
Alopecosa pulverulenta	2F	3F	3F	-	imm	-	-	-	-	-	-	-
Trochosa terricola	1F	-	4F	-	1F	-	-	1F	-	-	-	-
Trochosa spp.	-	-	-	-	imm	-	-	-	-	-	-	-
Pirata piraticus	-	-	4F	-	2F	imm	4F	-	-	-	-	-
Antistea elegans	-	-	-	-	-	-	-	-	-	-	1M	-
Robertus lividus	-	-	-	-	-	-	-	-	-	1F	1F	-
Paghygnatha degeeri	-	-	1F 1M	-	-	-	-	-	1F	-	1F	-
Walckenaeria acuminata	-	1F	2F	-	-	-	-	-	-	-	1F	1F
Walckenaeria antica	-	-	-	-	-	-	-	-	-	-	1F	-
Walckenaeria vigilax	-	-	-	-	1M	-	-	-	-	-	-	-
Gonatium rubens	-	-	-	1F	-	-	-	-	-	-	-	-
Oedothorax retusus	-	1F	1F	-	-	-	-	-	-	-	-	-
Saaristoa abnormis	-	-	1M	-	-	-	-	-	-	1F	3M	-
Bathyphantes gracilis	-	-	-	1F	-	-	-	-	-	-	-	-
Lepthyphantes tenuis	-	-	-	-	1F	-	1F	-	-	-	-	-
Lepthyphantes zimmermanni	-	-	-	-	-	1F	-	-	-	-	-	-
Allomengea scopigera	-	-	-	1F	-	-	2F 1M	-	1F 8M	1M	8F 8M	5M

Catches from wet heath included 82% of the species recorded from the two sites (74% of the total catch), compared with 68% of species recorded and 26% of the total catch in the dry heath samples. Fifty per cent of the species were recorded in both transects.

The Lycosids, made-up only 23% of the species, but 71% of the total catch. The Linyphiids, which made up 45% of the species, contributed only 23% of the total catch. The seven other taxa made up the remaining 32% of species but formed just 6% of the total number.

The Lycosids were present in quite large numbers at the beginning of the survey, but dropped off sharply towards the end, at a time when numbers of Linyphiids were beginning to increase.

The following species recorded are worthy of comment:

Xysticus erraticus. This species is generally widespread and fairly common in the UK. However, there are few records on the Isle of Man. This could be as a consequence of it being an inhabitant of the ground layer and not being found on lower vegetation.

Antistea elegans. This species is fairly widespread and common around the UK, but on the Isle of Man has only been previously recorded on the Calf of Man. This is the first record from the main Island.

Walckenaeria vigilax. Despite having a widespread distribution, this species is generally uncommon, and has been previously recorded on the Isle of Man.

The presence of the *Pardosa pullata* intersex (Table 1, 29th September, dry heath) is interesting. This species is one of the most common spiders in the UK, and was the most abundant species recorded in this survey. However, intersexes of any species are quite a rare phenomena. The specimen recorded was probably an irregular gynandromorph. The anterior was seen to have a sub-adult male palp, on the right side, while the posterior had a fully formed epigyne on the right, which was totally absent on the left. No colour changes were noted.

3.6.2.4 Discussion

Certain spider families, either by their general behaviour or requirements, are able to avoid pitfall traps. This is probably the reason why no Salticids, only one Theridiid, and no Araneid species were noted during the present survey. The absence of any Clubionid species, however, was more unexpected. The results of another survey carried out on the Isle of Man in 1994 (Wright, 1995), indicate that invertebrate numbers and species counts were markedly lower than in previous years probably as a result of climatic factors.

The results of the present survey are generally comparable with, and representative of, data from similar studies in northern England (Rushton and Eyre 1992, Rushton, Topping and Eyre 1985 and Usher and Smart 1988). As more work of this kind is carried out on the Island, a fuller 'picture' of the hill-land spider fauna will be revealed and comparisons can be made with the results of this survey both on the Island and with the UK.

However, had the hill slope been planted with coniferous trees, most of the species recorded would have been severly disturbed. Since most of the species recorded require a damp habitat with a high humidity, it could be predicted that certain species would be displaced as the trees grew, and could

be lost altogether from the site unless suitable areas were left unplanted. As the trees closed canopy the majority of the species would probably be lost although other species would take advantage of the available niche. However, such species tend to be common and it is those species which depend on the open moorland habitats which are most likely to be lost (see 3.6.3 below).

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3.6.3 Forest arthropods

In the UK, coniferous afforestation in the uplands since the 1920s. has resulted in major changes in the flora and fauna of forested areas (Hill 1986; Ratcliffe and Thompson 1988). Ground preparation, including drainage and ploughing, followed by the growth of trees, disrupt environmental gradients causing plant and animal communities to change. Different species are dominant in different habitat types. Most, if not all, species are affected and for a variety of reasons. Communities in sensitive habitats such as flushes and mires can lose species when the hydrology of the area is changed (Butterfield 1992; Chapman and Rose 1991; Smith and Charman 1988).

However, it is acknowledged that afforestation can have positive effects. The trees do provide an additional habitat and increase structural diversity to an otherwise open landscape. During the forestry cycle, the various stages of felling, replanting and regrowth can create a mosaic of habitat structures different to the more uniform moorland habitats. There is an increasing amount of evidence that afforestation may result in increases in the density and diversity of common woodland birds during the early stages of afforestation (see 3.4.1), the habitat mosaic allowing differing communities to exist together. There have also been examples of increases in rare species such as crossbill and siskin following conifer afforestation (Bibby 1987).

Whilst many studies have been made on the effects of afforestation on birds, there is little information about the effects on invertebrate communities, although much research has been carried out on major pest species (Speight and Wainhouse 1989). The most frequently planted conifers, such as spruce (*Picea* species) support very few species (Southwood and Kennedy 1984, Table 4) and most of these are considered pests (Bevan 1987). Those studies that have been undertaken concentrate on soil invertebrates such as beetles (Buse and Good 1993, Butterfield 1992). Day and McCarthy (1988) found a decrease in diversity when blanket bog was afforested in Ireland.

Ground beetles (Caribidae) as a group are sensitive indicators of temperature and moisture gradients and different habitat types support distinct, identifiable communities (Thiele 1977). In the north of England, the characteristic carabid communities of moorland, upland grassland and woodland have

been described (Butterfield and Coulson 1983, Eyre and Luff 1994, Gardner 1991, Luff *et al* 1989, 1992).

The further discussion of this subject examines two recent papers

(1) *Carabid beetle communities as indicators of conservation potential in upland forests* by Butterfield, Luff, Baines and Eyre (in press).

The paper compares carabid beetles from forests and moorland on the border between Scotland and England. They concluded that although the forest as a whole had as many species as moorland, most of these only occurred in the clear-fell stage. The closed-canopy forest was extremely species-poor but did contain species that were scarce or absent on the open sites. Closed-canopy forest had significantly fewer species than any of the other habitats (clear fell, deciduous and mixed woodland, grassland, heather moorland and mire), but clear-felled areas had significantly more species. The deciduous woodland sites formed a heterogeneous group, ranging from birch woods with low numbers of carabids to a species-rich mixed conifer/deciduous plantation, and did not differ significantly from the open habitats. The open hills, however, differed from each other with sites in the forests being less species-rich than those outside. Catches under closed-canopies, those of conifer sites in particular, were dominated by a small number of species with over 50% of the catch composed of two species.

Carabid fauna of open areas within forests are influenced by the surrounding trees and woodland species tend to increase at the expense of open-habitat species. However, clear-fell areas mitigate this trend. These artificially created areas provide habitat for a wide spectrum of species including examples characteristic of open moorland. Clear-fell areas can offer an extensive habitat to species which can move into the area rapidly, for example, by flight. However, species which are less capable of rapid colonisation cannot take advantage of this short-lived stage in the forest cycle, and it is often the species that have poor dispersal abilities that are rare.

Despite their high species-richness, clear-fell areas do not appear to make a major contribution to the conservation of the less common and rare species of open habitats.

Changes in afforested areas can cause increases in woodland species and decreases in wet and open habitat species. Species typical of moorland and grassland habitats are adversely affected by afforestation. The clear-fell areas which were species-rich are not favourable habitats for the rare species and do not compensate for the loss of rarer species .

Butterfield (1992) studied soil surface invertebrates and found that numbers of other invertebrates varied in the same way as carabid beetles. The catches in mature plantations decreased by 57% compared to the surrounding moorland but in clear-fell areas increased by 72%. The trends in carabid communities can be expected to extend across the invertebrate community as a whole.

Conifer plantations introduce higher invertebrate diversity into upland areas but do not favour the rarer species typical of moorland and grassland habitats. The continued existence of these species depends on the retention of the original habitats within the forest boundaries and their adequate maintenance. Areas of high conservation importance within plantations need careful monitoring and special conservation measures to maintain them.

(2) *Conifer forests are not the 'deserts' they seem.* Article published in the *New Scientist* by Oliver Tickell (1994), based on work by Foggo and Ozane.

The popular conception is that conifers are a dark, dank, acid, alien environment but the invertebrates of plantation canopies can be abundant and diverse and may contain 18 times as much insect life as the same area of native broadleaved woodland. Foggo and Ozane used the insecticide Pybuthrin to "knock-down" invertebrates from a 30-35 year old Norway spruce plantation near Oxford, and recorded 10,640 organisms per square metre (sq.m.) compared to 591 in a mature oak woodland in Berkshire.

They found a particular abundance of booklice, detritus eaters of the order Psocoptera. They recorded a greater diversity of spiders in the oak canopy than in the conifer canopy (1.67 per sq.m. compared to 1.32 per sq.m respectively).

It is generally thought that the woodland edge habitats are biologically the richest. Foggo and Ozane, however, found that the number of booklice, as well as total biomass, increased at distances further than 15m from the woodland edge and the number of spider species increased for 24m from an edge, although the predator-prey ratio was highest at the edge.

Preliminary data indicate that populations of forest floor invertebrates fluctuate for 40m into the woodland, initially dropping-off from the edge to reach a minimum at 20m, and then sharply increasing towards the interior. Hence it can be concluded that for a woodland to have conservation value for those invertebrates which require stable, dark, still and humid conditions then it should contain substantial areas more than 50m from the nearest edge, and for "wildlife corridors" that connect woodlands to convey slow-dispersing woodland core species, 50m would be a minimum width.

The above article deserves further comment:

Invertebrates will occupy vacant ecological niches and alien species of conifer can offer substantial niches for both native and introduced invertebrate species. Conifers have dense foliage and it is expected that high density of foliage is likely to support larger numbers of individual organisms. Conifers provide abundant over-wintering sites amongst their needles and cones and hence their all-year round fauna is likely to be enhanced.

There are significant peaks of invertebrate abundance on deciduous trees due to the seasonal leaf-fall. However, the densities of invertebrates for both conifer and broadleaved trees will change over a year. The article only presents a snapshot in time. Whatever the time of the year that samples are taken, it can still be expected that conifers will yield the most abundant samples. An extraordinary abundance of aphids and booklice can be present in the canopy of conifers. Such populations attract predators and most conifers support large number of spiders, which may result in turn in high densities of passerine birds to exploit the abundant food supply.

Booklice prosper in dark, dank environments, the majority feeding on algae and fungi growing in humid places and tend to be less well represented in the woodland edge. The need to conserve the woodland fauna of stable, dark, still and humid conditions is acknowledged and it is agreed that woodland corridors should aim to be at least 50m wide. The results demonstrate that although a host of common detritivores and alien conifer associates benefit from dense conifer plantations, very few other native woodland invertebrates make use of these habitats.

The conservation of biodiversity depends upon allocating resources to conserve indigenous species in their natural or semi-natural habitats. We cannot afford to allocate prime areas of our natural heritage to the production of alien habitats supporting common or exotic species.

3.6.4. Other upland invertebrates (after Garrad 1972)

The micro-moth *Coleophora caespititiella* is found infesting the flowering heads of the bog-rush. Other micro-moths are common on the hills but such specialised knowledge is required to identify them that many species may well remain unrecorded.

Beetles are one of the best studied groups of Manx insects and form a considerable part of the macroscopic litter fauna on the hill heath above about 1,000 feet. The ground beetle *Carabus granulatus* is frequent, whilst the closely-related Violet ground beetle *(C. violaceus)* is very rare, or possibly absent.

The yellow-spotted bright green Tiger beetle flies on the lower slopes of the hills. Another beetle, *Salpingus ater*, which normally inhabits burnt twigs, is frequent on the hill slopes. Its survival from when the hills were wooded has probably been fostered by hill burning. Other woodland or tree-loving species have survived on the hills and it is possible that some will increase with afforestation, but this depends on the tree species composition. The results of the carabid beetle fauna collected during the pitfall trap survey on the hill-slope at Montpelier (see 3.6.2) will be presented at the Manx Hill-land Seminar, 11-13 April 1995, and published in the proceedings.

Of the butterflies, the Common Blue, Small Heath, Small Copper and Wall are abundant but the Meadow Brown seldom occurs above 1,000 feet. The Large Skipper, Scotch Argus, Ringlet and Pearl-bordered Fritillary were all apparently recorded in the 19th Century (Garrad 1972), but no recent observations have been made.

Several species of ant occur in the hills, with *Lasius flavus* apparently the most frequent.. The first Manx record of *Formica lemani* came from South Barrule quarry at nearly 1,000 feet but it reaches the summit of South Barrule at 1,585 ft, despite usually preferring lower ground. *Myrmica ruginodis* reaches 1,750 feet on North Barrule and 2,000 feet on Snaefell. *Lagus niger* also reaches 1,000 feet in the upper Cornaa valley but is not generally distributed on the hills (Garrad 1972).

The flowers of heather and gorse provide food for many insects. Bumble bees of the *Bombus lucorum* group are common. The red-tailed *Bombus lapponicus* is characteristic of bilberry moor and is abundant on the northern hills and on South Barrule. Bees of this species build individual nests in light well-drained soil, and on the Manx hills the bare soil of paths and sod hedges seem particularly favoured.

As most of the upland soils are lime-deficient, snails occur only where human activity has enriched the land. Usually they have reached their more isolated locations with human aid, although the ubiquitous *Discus rotundatus* may appear up to 750 feet together with the equally widespread woodlouse *Oniscus asellus*. Once established, snails may persist long afterwards, for example, *Lauria cylindricea* on a fragmentary wall on the south side of South Barrule. Slugs, particularly the large black *Arion ater* agg., are fairly common. The altitudinal range of molluscs is being studied by Dr Garrad.

3.7 The red grouse (*Lagopus lagopus*)
by Bruce Walker

3.7.1 Introduction to the Manx Grouse Research Project
In 1985 Bruce Walker and Denis Hughes began to examine the status of the Red Grouse on the Isle of Man in an attempt to discover the reasons for the decline in population.

Topics which have been studied since then include:
- Size and range of breeding population
- Nest site selection
- Clutch size
- Hatching success
- Territorial behaviour

The project is currently conducting a three year investigation into chick survival, autumn dispersal and winter predation using radio-tracking techniques to monitor individual grouse.

This radio telemetry work is being funded by a grant from Manx Airlines as part of their Project 2000 Conservation Awards.

3.7.2 History and present status of the red grouse
More than any other bird the red grouse symbolises the upland landscape of the British Isles. The heather moorland on which it lives is an internationally important land-type and the bird itself is found nowhere else in the world.

Red grouse are known to have been associated with the Manx Hills for hundreds of years, during which time the population has enjoyed fluctuating fortunes. Contemporary sources suggest that grouse were common in the second half of the eighteenth century and abundant in the early years of the nineteenth century. However, by 1847 they had become extinct in the Isle of Man for reasons which are unclear, but almost certainly connected with changes in land-use.

Grouse were reintroduced into Druidale in 1880 and by the beginning of the present century they were again well-distributed, though in limited numbers, throughout the Manx uplands.

The population continued to flourish over the next two decades and the period from the end of the First World War to 1970 was one of stability with red grouse present in fair numbers all over the heather hills.

Although the years 1972 to 1977 were generally good breeding seasons the total grouse population had begun to decrease due to loss of habitat as a result of the Government's afforestation programme which had planted large areas of the best heather moorland between 1955 and 1978.

This decline was followed by a more sudden drop in numbers at the end of the seventies from which grouse stocks are showing few general signs of recovery although the implementation by shooting tenants of an increasingly comprehensive habitat management regime is meeting with some local success.

There has been a noticeable contraction of range over the past twenty five years and this trend will continue as further areas of moorland are lost to afforestation.

The Isle of Man red grouse population in April 1993 was in the region of 40 to 55 pairs divided fairly evenly between the southern hills and the larger expanse of heather on the central/northern hills where they are more sparsely distributed.

This compares with an estimated population of 300 to 400 pairs during the period 1910 to 1970.

3.7.3 Afforestation and its effect on the hill-lands

Red grouse live and breed only on heather moorland, without which they cannot survive. Large areas of heather ground have been afforested during the last forty years and the establishment of new plantations is due to continue for at least ten more years.

As a result grouse numbers have fallen considerably and there has been a pronounced reduction of range. The problem is most acute in the southern hills where information gathered by the Manx Grouse Research Project suggests that red grouse will become extinct if proposed planting plans are implemented on Lanagore (Cronk Fedjag) and Glen Rushen.

Lanagore is particularly important for its central position, its sheltered aspect, its large insect-rich bog and its known potential for holding good stocks of grouse (from historical bag records and observations made before management levels decreased in the mid-eighties when it became known that the ground was to be planted).

In this context it should be noted that when the Forestry Division commissioned an independent Game Conservancy survey on the effects of the proposed afforestation on game stocks they were advised that the above areas were vital to the future of the grouse population, and should therefore not be planted. This view was strongly re-emphasised in a report to shooting tenants in 1985.

The direct and indirect effects of afforestation on red grouse can be considered separately as follows:

(a) **Direct effects of afforestation**

Although grouse will often continue to live on newly planted moorland for some years, such ground is lost permanently to grouse when the trees shade out the heather. Afforestation tends to take out much of the most productive grouse habitat (below 1100 ft) and this has a disproportionate effect on grouse stocks, causing a reduction in breeding density as well as a fall in population.

There are many locations where grouse were formerly plentiful but no longer occur as a direct result of afforestation. Examples of these include Stoney Mountain, Arrasey, The Lhargan, Slieau Eairystane, Eary Beg, Corlea, Conrhenny, and what are now Glen Rushen, Cringle, Colden and Slieau Managh plantations.

(b) **Indirect effects of afforestation**

The direct loss of habitat caused by the afforestation of heather moorland is compounded in the longer term by the reluctance of many moorland birds, including grouse, to nest close to mature plantations. The reasons for this presumably include the increased risk of nest and chick predation by hooded crows and magpies which use the trees as vantage points to overlook potential nest sites.

The amount of apparently suitable heather moorland rendered unproductive or less productive by this phenomenon is illustrated by a study conducted by the Manx Grouse Research Project between 1985 and 1993 which found that only 6 out of 104 grouse nests were overlooked by mature trees.

Any calculation of the effects of the current planting programme on grouse stocks must take into account the additional long-term loss of habitat caused by these sterile areas which can extend for a considerable distance onto the moorland from the forest edge.

A further danger is that remaining areas of heather moorland may be too small or too isolated to support viable breeding populations, as large blocks of trees form an effective barrier to the movement of groups.

Stoney Mountain provides a good example of this encircling and fragmentation effect. What is now the new Stoney Mountain South plantation was still open moorland in 1985 - 400 acres of heather wedged in between the long-established South Barrule plantation to the west and the maturing Stoney Mountain plantation to the north.

This isolated 400 acre block supported one pair of grouse at a time when the average population density in the southern hills was a pair to approximately 90 acres.

In a similar way, if Lanagore and Glen Rushen were planted not only would much good grouse ground be lost but South Barrule would be completely encircled and Cronk ny Arrey Laa would be cut off from the rest of the southern hills. It is unlikely that the grouse population would survive in such circumstances.

3.7.4 Loss of heather moorland for other reasons

Heather is often regarded as an almost inexhaustible resource which will always renew itself no matter how it is burned or grazed. This is a fallacy. To maintain moorland in good condition requires careful control of grazing pressures and a systematic long-term approach to heather burning.

Incorrect management can lead to the replacement of heather by other plants such as bracken, gorse and most commonly 'white' grasses. The grasses which supplant heather are usually of poorer feed value to sheep and are of no use to grouse.

The principle cause of heather loss is overgrazing combined with over-burning, but burning too infrequently is just as harmful as the heather becomes too old to withstand competition from other plants when it is eventually burnt.

Very little historical data exists about upland vegetation changes in the Isle of Man but it is likely that large areas of what is now white grass in the northern hills were once heather moorland. Analysis of soil samples from the Clagh Ouyr/Snaefell/Mullagh Ouyr area would confirm whether this was the case.

On the other hand with the decline of crofting and mining, marginal land probably reverted to heather moorland in places like Glen Rushen and Dreembeary.

More recent examples of loss of heather are shown below. The list is by no means comprehensive and is based largely on personal observation and anecdotal evidence.

Some examples of heather loss in the Manx hills

	Cause of loss	Location
(i)	Bracken encroachment	Corrany and other northern valleys
(ii)	Gorse encroachment	Dalby Mountain, Slieau Whallian, Lhiattee ny Beinnee *(Beary - parts of Cringle)
(iii)	Erosion - (caused by overhot summer fires)	Sartfell Summit Lhargee Ruy
(iv)	Agricultural improvement	Garey Mooar, Glen Rushen
(v)	Overgrazing and/or	Parts of North Barrule, Colden, Snaefell, The Rheast
(vi)	Poor burning practices	Ballaugh Mountain

Problems with bracken and gorse encroachment are often made worse by poor grazing and burning practices.

Heather loss is likely to continue unless the improved standards of upland management which have been adopted by an increasing number of shooting tenants become general practice with the full support of grazing tenants, private landowners and the Forestry Division.

3.7.5 Solutions and conclusions

There are two main requirements if a future is to be secured for red grouse on the Isle of Man:

(a) The heather moorland must be properly managed;
(b) The extent of heather moorland must be maintained.

(a) Upland management

In 1982, in response to concern about falling grouse numbers the Forestry Division declared its intention to initiate and direct a long-term management plan for the uplands which would include the establishment of a proper rotational burning programme for all its heather moorland.

Unfortunately the theory and the practice proved to be quite different. The Forestry Division failed to take the lead and the improvements which have taken place since then have been almost exclusively the result of a committed approach to upland conservation by shooting tenants.

Three of the seventeen heather hills have been managed continuously since 1982, several more are four or five years into their management programmes, and most of the rest have recently been taken in hand.

The delay will probably have a detrimental effect on grouse stocks for years to come and need not have occurred. The Forestry Division have provided some material assistance to shooting tenants, but until they are prepared to assign sufficient resources to moorland conservation the onus will remain with the shooting tenants who already devote hundreds of hours of unpaid labour to the task of improving their heather ground and grouse stocks.

Practical upland management courses are readily available and could be arranged locally. It would make good sense for all shooting and grazing tenants and the relevant members of staff of the Forestry Division to have access to these.

The value of long-term management can be gauged by the fact that the managed hills have consistently held the biggest stocks of grouse in recent years.

(b) Maintaining the extent of heather moorland

Some 5,000 acres of heather moorland have been lost to afforestation, the vast majority since 1955. It should therefore be recognised that even if grouse densities were to reach previous levels overall numbers would be much lower because there is now considerably less heather and much of the most productive grouse ground has been planted. So it is even more essential that we protect our remaining heather moors.

The probable effect of further planting in the southern hills has already been discussed. But there are other vulnerable areas such as Montpelier, and the Corrany 'plateau' on the north-east slopes of Slieau Ouyr. The implications of planting in the northern hills have not been closely studied and even now, nine years into the current afforestation programme, the Forestry Division has not revealed which areas it intends to plant. It should do so as a matter of priority so that the significance of these plans can be properly debated.

It is of great concern that large areas of the Manx uplands can be subjected to major changes of land use without adequate consultation procedures and without an independent assessment of the impact of such changes.

The Government and the Forestry Division should recognise that they have the same duty to protect and maintain the open hill-land in their care as they do to look after their Forestry estate.

The over-riding priority in the case of red grouse is for an independent review of the present afforestation programme and an integrated approach to the long-term management of our heather moorlands.

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3.8 Upland management

Upland grassland and heathland have been managed by traditional methods for centuries and there is little doubt that much of their present wildlife interest stems from the practices of grazing and burning. The farmers of the past were at least as skilful as their modern counterparts and it would be arrogant for ecologists to suggest that they could do better. However, it is the role of the ecologist to describe and analyse the ecological situations with the purpose of finding out how the systems work and the effects of different management techniques.

Most, if not all, of the vegetation communities on the Manx hills have resulted from human intervention through burning, grazing and cutting and are maintained as a plagioclimax in which natural succession is arrested or deflected. They are relatively unstable and unless they continue to be managed, their composition will tend to change in a similar manner to that undergoing natural succession. An understanding of succession and plagioclimaxes is fundamental to the consideration of management options for the continued maintenance of grassland and heathland.

The Government-owned hill-lands are split into 11 protected tenancies. Through the Hill Sheep Subsidy Scheme 1991, the Department of Agriculture, Fisheries and Forestry, provides payment of £6-40 per eligible ewe kept on approved hill-land throughout the calendar year. Approved hill-land means mountain and hill-land which is only suitable for the use of the maintenance of sheep of a hardy kind and which have been approved by the Department as such. Similarly, the Hill Cow Subsidy Scheme 1992 provides payment.

The subject of upland management, including stocking rates and frequency of burning regimes, is not dealt with at length here as there is extensive literature on the subject, for example, Mowforth and Sydes (1989), Usher and Thompson (1988), Phillips and Watson (in press), Lawton (1990). However, the requirement upon the grazing tenant under the hill-land tenancy from the Department of Agriculture, Fisheries and Forestry, to burn on a seven year cycle is not sustainable either in its own right but especially in conjunction with grazing. Although the seven year cycle is probably never actually achieved, it should be removed from the tenancy agreement and replaced with one that is sustainable in terms of heather regeneration and livestock production.

Throughout the British Isles, sheep numbers have increased dramatically relative to cattle in recent years due to additional support available from Sheep Annual Premiums and the lower fixed rate and variable costs associated with their upkeep. The evidence suggests that a reduction in stocking, particularly sheep, is needed throughout the British Isles, over large areas of the hills, accompanied by an increase in livestock in those areas which are currently undergrazed.

A long tradition has led to high standards of flock management and the production of lambs of good quality. The Island's physical regions have been well integrated into sheep production. The system involves hardy ewe production on the hill-lands, from which the upland flocks are able to produce high quality ewes which provide the lowlands with lambs for fattening (Davies 1990).

The Report of the Commission of Inquiry into Agriculture and Horticulture (1975) commented on the lack of integration between mountain and hill grazings and lowland farms. The hill enterprises often suffered from a lack of nearby enclosed lower land. This trend is being reversed and land improvements and more integration have taken place since 1975, leading to higher stocking rates and

increased sheep numbers. Numbers of sheep have increased steadily increased from 122,924 in 1967 to 154,065 in 1993, an increase of 25% (IoM Government 1994). Upland improvement is also reflected in a reduction of 3.5% between 1986 and 1987 in the area of rough grazing (Davies 1990). However, the MNCT has been informed that little or no further agricultural improvement of upland sites is likely to be carried out in conjunction with the Afforestation Programme.

The ecological effects of pasture improvement can be dramatic. The species composition of ground beetles and spiders after "improvements" are poor and similar to that on intensively managed pastures at lower altitudes (Rushton, Luff and Eyre 1989). Both spider and ground beetle populations are also known to be reduced by regular applications of insecticides. Pasture improvements right up to the hill wall can be regarded as detrimental to the appearance and landscape of the uplands (see 3.8).

The combination of a short-burning season, which is shorter than elsewhere in the British Isles, together with a tenancy requirement to burn one seventh of the heather each year, has promoted the burning of large fires which are harmful to heather moorland and grouse populations. A seven year rotation is very short, largely unachievable and unrealistic. It is more usual for one twentieth of heather moorland to be burnt each year, either in strips or small blocks.

3.9 Forestry

The Forestry, Amenities and Lands Division of the Department of Agriculture, Fisheries & Forestry declined an invitation to provide an account of their activities on the Manx hill-land. Hence the following account has been compiled from the available information, in particular:

Notes prepared for visit of the Royal Forestry Society - 1st July 1988 (DAFF 1988)

Afforestation Policy Review (DAFF 1994)

3.9.1 History

The origins of the Forestry Division can be traced to 1866 when the Trustees of Common lands were established to administer unenclosed land transferred from the Crown. Afforestation began in the 1880s when the Crown Commissioners formed three plantations: Archallaghan, South Barrule and Greeba (Totalling 324 ha, 800 acres).

No further planting was carried out until 1906 when the Manx Arboricultural Society formed two plantations. Afforestation progressed very slowly thereafter under the Board of Agriculture, the Manx Tree Planting Board and, in 1931, the Forestry Board. Afforestation grew rapidly in the mid-1950s when the Crown plantations and unenclosed land were vested in the Forestry, Mines & Lands Board. Details of the plantations established up to 1978 are provided in Table 8, and a summary of the area, species composition, and age structure of these earlier plantings appears in Table 9.

The poor showing of larch in the yield class results (Table 9) was influenced by its use on inferior sites and its retention beyond rotation. Lodgepole pine has been planted in the traditional manner on the most exacting sites, including unplantable. It suffers from *Rhamachloridium* to the extent that a clearance programme has been implemented in the worst hit stands. Scots pine appears in an over favourable light in the results due to its selective planting on sites capable of producing higher yields. A gradual decline in yield class with increasing elevation is quite prominent in many plantations.

Birch (1964) estimated that woodland covered 3,500 acres of which 759 (21%) were in coniferous plantations. In 1987, woodland was estimated to cover 5,500 acres, of which 80% were conifer plantations (Davies 1990).

The majority of the Department's plantations are on metamorphic rocks, predominantly slates of the Ordovician period.

3.9.2 Exposure

The Island falls within wind zone B-C (based on tatter flag studies 1982-85).

45% of plantations fall within windthrow hazard class 3
47% of plantations fall within windthrow hazard class 4
7% of plantations fall within windthrow hazard class 5

Wind is the limiting factor to tree growth. Salt-laden winds can be particularly damaging and salt scorch appears in many exposed plantations. The maritime nature of the Island's climate produces severe conditions for tree growth, ie, aspect, exposure to salt spray and physiological drought (Davies 1990). The relatively high wind factor produces a high rate of transpiration and although there is an annual net surplus between precipitation and transpiration of between four and eight inches in certain seasons and locations, drought stress can set in.

Table 8 Details of conifer plantations established in the Isle of Man between 1906 and 1978

Plantation	Area (ha)	Area (acres)	Planting year(s)
Slieau Whallian	42	104	1906/1967
Gob-e-Volley	31	77	1907/1949
Beary	9	22	1934
The Vaaish	17	42	1935/1965
Arrasey	99	245	1935/1967
South Barrule	128	316	1935/1979
Tholt-y-Will	102	252	1939/1961
Greeba	63	156	1940-51
Skyhill	54	133	1948/1965
Ballakillinghan	26	64	1948/1969
Axnfell	36	89	1951-67
Ballakerka	38	84	1952-62
Ohio	28	69	1954
Glen Rushen	46	114	1957
Colden	71	175	1957-61
Cringle	101	250	1958-67
Slieau Mooar	18	44	1959
Eairy Beg	85	210	1959-63
Archallaghan	154	381	1959-65
Ballaugh	140	346	1959-67
Injebreck	29	72	1959-67
The Rhenny	22	54	1960
Ballig	4	10	1960
Kerroodhoo	53	131	1960-68
Dreemskerry	3	7	1961
Ballacuberagh	35	86	1961-72
Chibbanagh	49	121	1962-68
Glen Helen	8	20	1963
Sartfell	10	25	1964
Earystane	72	178	1964-68
Kion Slieau	3	7	1965
Ballure	30	74	1965/67
Stoney Mountain	127	314	1965-68
Barroose	5	12	1966
Slieau Maggle	4	10	1966
Conrhenny	58	143	1968
Fleshwick	8	20	1971
Brookdale	60	148	1972-73
Lhargan	42	104	1977-78
Slieau Curn	77	190	1977-78

Table 9 Summary of woodland composition prior to the beginning of the Afforestation Programme in 1985, by area and species composition (DAFF 1988)

Area	
Woodland gross area	2017 ha
Average plantation size	45 ha
Largest individual plantation	154 ha (Archallaghan)
Smallest individual plantation	4 ha (Dreemskerry)
Unplantable within woodland stock	200 ha approx.
Unstocked and understocked areas	264 ha approx.

Species composition (fully stocked areas)

Species	**Area (ha)**	**% total area**
Conifers:		
Sitka spruce	664	43
Japanese larch	379	24
Lodgepole pine	264	17
Scots pine	55	4
Corsican pine	44	3
others	106	6
Broadleaves:	40	3

Yield class (m3/ha/yr) analysis

Species	**Yield class**	**Weighted average**
Sitka spruce	4-24	13/14
Japanese larch	4-14	8
lodgepole pine	2-16	8
Scots pine	2-16	10
Corsican pine	6-16	11
European larch	2-14	7
Norway spruce	6-20	14
Noble and grand firs	10-14	12
Douglas fir	8-20	14

3.9.3 Topography

Plantations are located from sea level to an altitude of 380m above sea level, although most are situated between 150m and 300m. Local shelter from south-westerlies is important. Crops with a northerly aspect do best.

3.9.4 Afforestation Programme 1985

The estate administered by the Department of Agriculture, Fisheries and Forestry amounts to 26,000 acres (10,522ha) or 18% of the Island's land area, and is made up as follows:

Land use	acres	ha
Open hills and farmland	17,836	7,223
Established plantations	5,500	2,227
New afforestation	1,664	674
National glens, parkland etc.	1,000	405

A sawmill was constructed in 1982/3 and a timber treatment plant commissioned in January 1992. The labour force in 1988 was 67.

Proposals for forestry expansion and hill land improvement were debated in Tynwald and a resolution passed in 1985 to double the area of productive plantations by planting a further 5,000 acres (2,024ha). Originally it was intended that this would be achieved over a 10 year period but in order not to repeat the mistakes of the past (see age class distribution), this was rescheduled for implementation over a 15-20 year period. The programme aimed to create a forest reserve of sufficient in size to provide the Island's needs for basic grades of home-grown timber for the forseeable future. Consultations took place with a variety of organisations and the following reports were commissioned:

- on the red grouse population and upland management by the Game Conservancy in 1980,
- a landscape architect's report was prepared by Mr G. Patterson in 1985 and,
- an agricultural consultant's report by the Director of Redesdale Experimental farm in Northumbria based on assessments of each grazing tenancy to evaluate the possible impact of any afforestation on the future viability of each holding. The report contains confidential information hence is not available for public consultation.

At that time, however, the conservation lobby was very much in its infancy with no staff employed and it was not in a position to respond to the likely effects upon the ecology of the hills. It was a major oversight that a report on the ecological implications was not also commissioned at the time. Such a report has still not been produced to date.

All afforestation is undertaken on land within the Department's ownership and subject to grazing by tenant farmers. The policy of the Department was to carry out hill land improvements in conjunction with afforestation to ensure that a viable hill grazing unit was maintained.

A major review and re-assessment of available planting land was carried out in 1987, which resulted in the "target" acreage for afforestation being reduced to approximately 3,800 acres (1,538ha).

The Afforestation Programme was reviewed for a second time in September 1994 and the target acreage was revised to approximately 3,300 acres (1,336ha), of which 1,886 acres (763ha) has already been planted. Hence the original 1985 programme has now been reduced by one third. The newly revised target is considered by the DAFF to be the minimum level at which their long-term policy objectives can still be met. DAFF has re-considered all the areas that were identified for planting in 1985 and has identified three proposed plantations as being in areas of a particularly sensitive nature, for one reason or another, and these are not included in the revised Afforestation Programme 1994.

Hence, in the Department's programme, 1,414 acres (567ha) remains to be planted and should be fully implemented by the year 2005. The above areas are gross acreage figures, and do not take into account the 15-20% of land left unplanted within each plantation. The remaining afforestation sites are to be located within Glen Rushen, the Black Mountain at Ballaugh, Block Eary and Cornaa, Maughold. DAFF has introduced a consultatory process to provide the opportunity for interested parties to comment on proposals for future planting. A full consultation exercise will be carried out for each of the above sites. DAFF intends that any new plantings will be undertaken with benefit of appropriate advice to ensure a sympathetic approach to the landscape, having due regard to physiographic features, wildlife conservation, safeguarding items of archaeological interest, and to secure effective integration with agriculture. The Department will continue to review its Afforestation Policy in line with best available advice.

The following areas have been planted since 1985 under the Afforestation Programme:

Location	acres	ha
Slieau Managh, Lezayre	155	63
Black Mountain, Ballaugh	180	73
Creg-ny-Crock, Glen Rushen	108	44.5
Cross Vein shelterbelt	6	2.5
Stoney Mountain	358	145
Corlea	222	90
Round Table	52	21
Cronkdhoo, Greeba	62	25
Glion Gill, Greeba	623	252.5
Tholt-y-Will	120	28.6
Total	**1,886**	**746.6**

The largest area planted to date, at Glion Gill, Greeba is 623 acres (252ha), but this is divided into four separate blocks. The largest single area of planting carried out under the Afforestation Programme is at Stoney Mountain (358 acres, 145ha). However, Stoney Mountain Plantation is continuous with South Barrule Plantation and the planting of Corlea Plantation has connected South Barrule Plantation with Cringle Plantation (Figure 3). Hence the largest continuous block of conifer plantation is some 1,460 acres (591ha).

When the Afforestation Programme was formulated, it was recognised that the Island has very few areas of broadleaved woodland accessible to the public. In concentrating the future commercial management of the forest estate on newly-established plantations, the opportunity was created to convert some of the older plantations to broadleaves. This policy has been followed since 1985, with the result that 57 acres of previously conifer crops have been converted to broadleaves. In addition, a further 110 acres of broadleaves have been planted under the Afforestation Programme itself. In the long-term, it is proposed that up to 10% of the whole forest estate should be broadleaved.

3.9.5 Economics

This section presents two alternative views of the economics of afforestation on the Manx hill-lands. The first is based on the recent review of the Afforestation Programme in September 1994 (DAFF 1994) and the second is based on a report to the MNCT by the Chief Executive of the Heather Trust following his visit to the Island in December 1993 (Phillips 1994).

(i) DAFF (1994)

Sawn timber imports on the Island have averaged 4,733 tonnes per year between 1989 and 1994, giving an estimated round-timber consumption of between 15-20,000 cubic metres per year, once a conversion factor has been applied for roundwood to square sawn. The value of Manx timber imports is estimated at well in excess of £1M per year. Sales of timber from the sawmill reached £233,000 in 1993/4.

Current Island-based production averages approximately 5,000 cubic metres, with a potential increase to over 7,000 cubic metres over the next 30 years. Assuming the 1985 forest estate was capable of producing 7,000 cubic metres, then a fully commercial forest estate of 10,700 acres would be required to become self-sufficient. The Afforestation Programme is designed to meet the predicted decline in local timber supply after the year 2025, to achieve a sustainable production of around 7,000 cubic metres.

There will be an increasing volume of timber being harvested on the Island over the next 20-30 years, but then a decrease in production (Figure 4b). It is believed that sawmill sales could be doubled over this period, assuming a much greater market share. Against this background, an Afforestation Programme capable of meeting likely future demand has been designed. The Department's policy is to become increasingly self-sufficient in timber supplies. With a relatively low value, bulky, raw material, DAFF believes this to be the most economic and environmentally sound land use policy, although it requires long-term stability to enable the peaks and troughs of past afforestation to be evened-out, giving a forest age structure capable of long-term sustainable production.

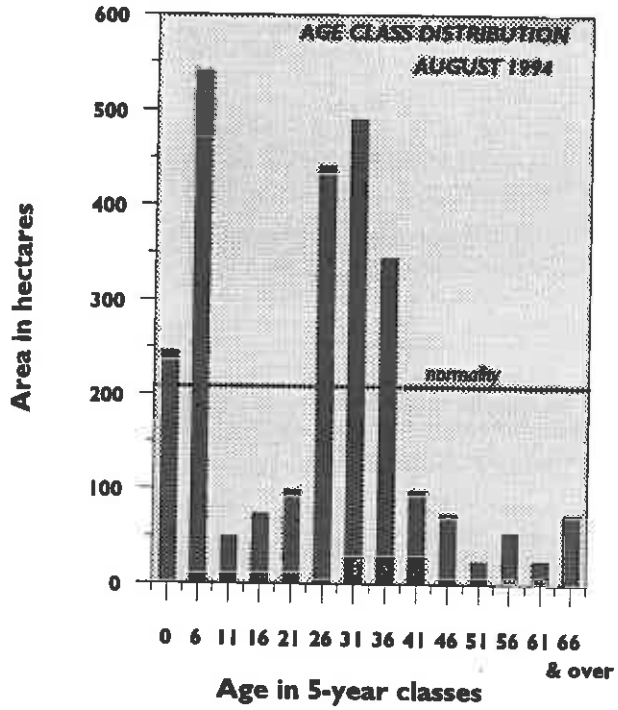
The 1994 profile on Figure 4a illustrates the peaks and troughs in future production resulting from the dominance of middle-aged, pole stage crops. The age profile for 2030 shows how this acreage will be converted to young crops following restocking.

The Department envisages that the majority of its timber will continue to be marketed for agricultural and lower grade constructional outlets. Examination of the detailed government accounts (The Treasury 1994) shows that income from forestry 1993-4 was £248,836, with fencing posts (retail and wholesale) providing £121,674, ie 49% of the total income from forestry. Forestry has an expenditure of £902,824 which includes £438,043 on salaries and wages and £122,479 on contract harvesting.

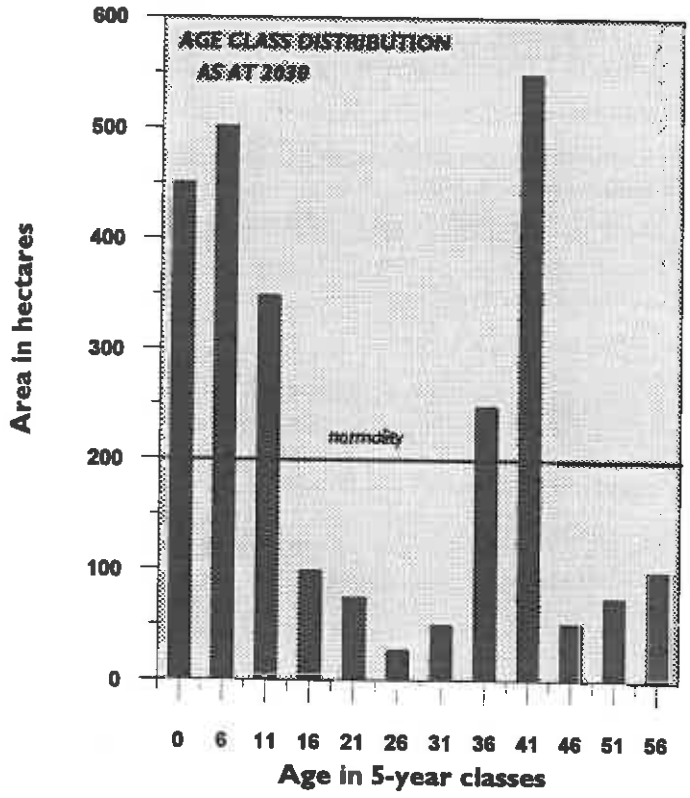
(ii) Phillips (1994)

The estate administered by the DAFF totals 26,000 acres (10,522ha) of which 5,500 acres are established plantations and 1,664 acres are new afforestation. This forest industry is minute when compared with the British and Irish industry, which in turn is minute in terms of western Europe. Sites capable of economic yield-classes are restricted because of the well-recognised constraints of exposure and soils. Notwithstanding this, however, afforestation is taking place widely on moorland throughout the Island. The total cost of the forestry expansion scheme is £1,700,000, with committed schemes approved by Tynwald of £1,500,000. The probable cost of the scheme to 31/03/95 is £871,868, with £85,000 per annum allocated for 1995-2000 after which a further £403,132 expenditure is forecast (IoM Government 1994).

Figure 4 Age class distribution for conifers in Manx forests for (a) 1994 and (b) projected for the year 2030.



(a) August 1994



(b) projection for 2030

It is quite acceptable to state that the general policy is to restore a greater degree of tree cover to the Isle of Man. Many, even most, people would concur with this and there are undoubtedly many sites where amenity woods of high conservation value could be established for the benefit of the Island and its natural heritage.

However, Manx-grown timber and timber products are poor in quality, as well as being low in volume and value. Wood products can be imported more cheaply than they can be produced and it is irresponsible of the government to consider that commercial forestry activity is worthwhile on the Island, either as practised in its present form or in any form which could be envisaged in the course of the next half-century.

"Deficiencies of climate and soil" are identified as being serious constraints on hardwood planting, and are put forward as the excuse for having to grow conifers. The fact that Sitka spruce (the most widely grown species > 40% in 1988) is declared as having a weighted average yield class of 13/14 cubic metres/ha/yr, highlights the deficiencies inherent in the argument (DAFF 1988). A Yield Class of 13/14 is widely regarded as the break-even point for growing trees commercially when the cost of money is medium/low. Japanese larch and lodgepole pine, which together made up over 40% of the plantations in 1988, show weighted yield classes of 8. Yield classes at this level fail to make money even when no interest charges are made. Fulford (1993) wrote a highly critical review of British forest policy which is entirely relevant to conditions on the Isle of Man.

It is also government policy that "New planting will be undertaken in an environmentally sensitive manner with due regard to physiographical features, wildlife conservation, safeguarding items of archaeological interest and securing effective integration with agriculture." The most recent plantations (for example, Glion Gill, Tholt y Will and Corlea) do not fit this definition. Fence lines are harsh, tree species unsympathetic and alien and sites are likely to be in the lower/lowest yield classes.

It is stated that self-sufficiency "in basic timber products" is an aim of the Afforestation Programme. Much of the standing timber inspected in December 1993 was rubbish; much of it was in check, neglected and unlikely to be harvested. Lodgepole pine has been widely used (17% - Table 9) and it is possible that outbreaks of pine beauty moth could kill extensive areas of this species.

The Department's vow "to have regard to the protection of these assets together with the open hill-land in its ownership" is contradictory as long as it continues to plant the moorland.

However, the Department's aim "to promote the recreational and amenity value of the national glens and plantations" has been meeting with more success. There were some charming places for visitors to walk and picnic (eg Tholt-e-Will, Ballaugh Glen and Glen Helen) and where there was topographical shelter in such sites tree growth was excellent, with the certainty of producing quality saw-logs - but in tiny amounts.

Afforestation as a land use policy is often buttressed by arguments attempting to show that "tree-planting = jobs". The level of employment in forestry and related industries is very small.

With an unemployment rate of < 7% in a population of 70,000 of which about 15,000 are adult males, no significant impact on the unemployment figures will be achieved by increasing the area of afforestation.

The wood processing plant is one of the most modern of its kind. However, the quality of the raw material is very poor and when allied to the poor quality of so much of the growing stock it is difficult to envisage the plant ever working at a profit.

The out-turn of value from the plant in 1993-4 was £248,836 equivalent to 16.5 employees at £15,000 per annum each.

Inspection of the Department's price list of produce shows prices significantly higher than for equivalent material in mainland Britain.

The produce is of such poor quality that it has a very limited value, and in some cases is of no value whatsoever. Few of the plantations of age-class <30 years are likely even to yield money enough to cover the harvesting costs.

While there is an intention to improve the supply of basic timber products, those products that can be produced are indeed basic; rough fencing stobs of assorted lengths must make up the biggest percentage by volume of the throughput, leaving only a small part of the output of high-margin quality sawn material. With mainland Britain so close, imports of timber will always pose a serious economic threat to the mill which during its life will never be able to draw on a sufficiency of quality produce to enable it to trade profitably. It is likely, therefore, to be a continual drain on the Manx taxpayer.

There are very good arguments in favour of changing the thrust and direction of the whole forestry policy on the Island to include much greater emphasis on amenity plantings with an active policy of running down the existing uneconomic areas and returning them to heather, particularly on the upper slopes and moor edge. If this policy were followed sympathetically, there would be significant amenity and conservation dividends.

3.10 The effects of afforestation on watercourses
by John Griffiths and John Lamb

3.10.1 Introduction
The acidification of rivers and lakes has been the subject of increased concern in Europe and North America in recent years.

Declining fish stocks have been widely reported and surface waters with previously productive fisheries have in many cases become fishless. In addition to the direct effects of increased acidity, elevated concentrations of dissolved aluminium are also implicated. In regions where the buffering capacity of water is poor, dissolved aluminium is acutely toxic to many forms of aquatic life.

The acidification of surface waters has considerable cost implications for the public drinking water industry.

Acidic deposition from the burning of fossil fuels are proven to cause increased surface water acidity. The UK's Department of the Environment has identified areas under threat from acid rain (DOE 1991) but this has not been extended to the Isle of Man. However, data collected from the rainfall monitoring station on Beinn-y-Phott (SC367861, altitude 411m) have shown that rainfall on the Island is on average at least five times more acidic than unpolluted rain with an average pH of 4.6 and individual events as low as pH 3.9 being recorded.

Along with wet deposition (rain, hail, sleet and snow), occult (cloud and mist) and dry deposition (particles and soot) settle on the hills, although there is no provision at the moment for monitoring the acid input from occult and dry deposition.

In addition, secondary effects arising from changes in land use are compounding the problem. In particular conifer planting and the reduced liming of uplands has led to increased levels of dissolved aluminium being leached into water courses.

Upland pastures regularly received applications of lime in order to raise the pH of the soil and improve the quality of grazing. Not only does liming improve grass production, it also raises the pH of run-off by neutralising acid deposition.

The subsidy for the application of lime available form the Department of Agriculture, Fisheries and Forestry (DAFF) has recently been reduced making it more expensive with the result that the practice has been abandoned or cheaper alternatives such as NPK fertiliser used. The loss of the buffering effect of liming has resulted in an increase of the acidity of streams draining the Island's hills.

The Institute of Hydrology (IH) has been investigating the interaction between upland land use and stream processes since 1968. The IH initiated catchment studies at Plynlimon in Wales to compare established forestry and rough pasture. Other associated studies include the comparison of nutrient losses from the two land uses (Roberts *et al* 1983) and the effect of pre-afforestation ditching on sediment losses (Newson 1980b, Arkell *et al* 1983)

The Institute has also initiated three studies in mid-Wales into the effects of upland land use change; afforestation at Llanbrynmiar; clearfelling in the Hafren Forest and upland pasture improvement at Nany-y-Moch. Each study adopted a twin-catchment approach, one being undisturbed and acting as a control, the other subject to the land use change following a suitable calibration period.

3.10.2 Ground preparation

The practice of ground preparation involving ploughing or "ripping and screefing" before planting creates drains across the hillsides. This leads to a more rapid run-off causing river levels to rise and fall more quickly than run off from open moorland leading to turbidity and sedimentation downstream. Considerable quantities of soil and silt are washed off ploughed areas. The construction of roads for access can also lead to erosion.

In terms of water quality, the biggest effect of afforestation is an increase in sediment (mostly clay, silt and fine sands) resulting from drainage operations. Robinson and Blyth (1982) found that pre-afforestation drainage increased sediment concentrations by over two orders of magnitude. It was calculated that the sediment yields over five years were equivalent to nearly 50 years load at pre-drainage rates. Subsequent sediment yield did not decline to pre-drainage levels, but remained about four times higher as a result of erosion of the drains. Most of the sediment, accounting for more than 99% of the total, was in suspended form. There was no change in sediment concentrations when trees were planted.

Robinson (1980) found that pre-afforestation drainage produced a storm response, with higher peaks, higher flood flows and a reduction of 50% in the time to peak, drainage reducing the storage capacity of the soil. On the other hand, Burke (1968) showed that drainage increased the storage capacity above the water table, resulting in a less rapid response to rainfall in drained than undrained areas. At Llanbrynmair drainage for forestry significantly increased peak flows: the increase for an individual rainfall event depended on its duration, ranging from 5% for a 10 hour fall to 20% for a five hour fall. When the tree canopy closes, the response difference is small. McDonald (1973) suggested that soil type is the major factor in determining the effect of drainage on peak flows but type of drainage, topography and the amount and intensity of rainfall are also relevant. The majority of studies (for example, Burke 1968, Robinson 1980) suggest an increase in low flows following drainage.

Substantial nutrient losses, particularly of nitrogen, have been reported as a result of drainage (Duxbury and Peverly 1978, Benoit 1973). Roberts *et al* (1986) found increased nitrate concentrations, whilst the concentrations of other forms of nitrogen and of potassium and phosphorus seemed unaffected. Robinson (1980) found that drainage prior to afforestation produced increases in concentrations of calcium and, to a lesser extent, magnesium, whilst the concentration of sodium and potassium showed little evidence of change.

Stretton (1984) reported massive increases in total iron, manganese and aluminium following drainage for afforestation. The Llanbrynmair experiment suggested that afforestation affected concentrations within the upper catchment basin but not in the lower basin or catchment outfall. However, the increases did not constitute a problem for water supply purposes, although the ortho-phosphate concentrations were well above the values generally regarded as limiting for eutrophication. No results are known from long-term studies of the effects of planting and subsequent growth of young saplings on water chemistry.

On the Isle of Man, as in the UK (Thompson 1984), heather-dominated upland sites are ploughed prior to planting. Ploughing suppresses competing vegetation, improves surface drainage and aeration, produces an improved planting position and increases rooting depth. Drains are designed to remove surface water and therefore reduce waterlogging and improve rooting conditions (Thompson 1979). The disturbance and drying can produce an increased rate of decomposition with a release of elements into drainage waters with a consequent impact on water quality (see below). The ploughing also exposes subsoil which may lead to increased rates of weathering and element release.

3.10.3 Water temperature

Forestry affects stream temperature due to the shading effect of the tree canopy. Roberts and James (1972) recorded monthly mean streamwater temperatures in forested catchments generally two degrees Centigrade cooler in the summer and up to one degree warmer in the winter. Gray and Edington (1969) found that the effect of felling woodland bordering a tributary stream increased the maximum summer stream temperature by up to 6.5 degrees Centigrade.

3.10.4 Water chemistry

Studies in Wales (Stoner *et al* 1984 Stoner and Gee 1985), northwest England (Bull and Hall 1986) and Scotland (Harriman and Morrison 1982), have reported differences in water chemistry between streams draining established upland plantations and from adjacent unplanted moorland on otherwise similar sites. Concern has focused on the increased acidity and high aluminium concentrations in forest streams. These changes have been linked to reductions in the diversity of invertebrate populations and fish numbers (Ormerod *et al* 1987).

The link between aluminium and acidity appears to be restricted to those areas where acid soils underlie massive base-poor bedrock, as on the Isle of Man. Given these conditions, aluminium concentrations and acidity may be greater in forest steams at all flow levels. The differences between aluminium concentrations in forest and moorland streams are, however, greatest during periods of heavy flow. The causes of high acidity and aluminium concentrations are still being investigated and it seems that a number of processes may be involved (Miller 1985).

Studies have clearly demonstrated changes in soil chemistry, biology and processes following afforestation (Hornung 1985). Stemflow is more concentrated and is usually more acid than the throughfall or canopy drip. The chemistry of throughfall varies markedly with tree species and age (Miller 1984) with larch producing a more acid throughfall than spruce or pine. Most conifers produce a humus which is significantly more acid than organic horizons produced by the preceding vegetation.

Clearfelling of established forests has received the greatest attention in terms of water quality, following the study at Hubbard Brook, New Hampshire (Likens *et al* 1970) which showed a massive deterioration in water quality after clearfelling. Other studies have also examined alternative harvesting and post-harvesting practices.

Many study reviews, including Sopper (1975), Stone *et al* (1978) and Martin *et al* (1984), report a wide range of results reflecting the techniques adopted and showing the beneficial effects of using various protection practices during felling operations. O'Loughlin *et al* (1980) found much smaller nitrate losses from a felled catchment where a riparian protection zone nominally of 20m wide was left on each side of the stream.

3.10.5 Sediments

In the Institutes of Hydrology's Llanbrynmair catchment study, afforestation led to the mobilisation of sediment from previously stable areas. Contour ploughing reduced the initial output of fine sediments from the lower parts of the catchment to the stream channel. However, road cutting made a considerable amount of gravel available to the stream. Loose gravels exposed on steep road embankments are readily transported by gravity and gully erosion into the stream channel.

Mature forest subcatchments still yield 3-5 times the volume of sediment (Newson 1980, Arkell *et al* 1983). Similar ratios have been found between drained and undrained areas elsewhere. Forested

streams may also increase stream bank erosion (Murgatroyd and Ternan 1983). Bank erosion rates were observed to be higher along forested reaches relative to non-forested. This increase was attributed to suppression by the forest cover of the development of vegetation and its associated dense root networks, and secondly, to the river tending to bypass log and debris jams in the stream.

During felling operations there can be significant increases in suspended sediment yields. For example, at the Hore catchment since felling began, bed-load increased five fold at the downstream end of the catchment. The lack of ground cover vegetation leads to excessive quantities of soil and silt being washed away during periods of heavy rain. High levels of silt can have harmful effects on the ecology and drainage over the full length of a river, reducing the fauna and increasing mortality of both spawn and juveniles of salmonid fish.

It has been suggested that road construction is also likely to have a considerable effect on water quality (Binns 1979). The erosion of forestry roads has been implicated in causing increased streamflow sediment loads (Mills 1980, Graesser 1979) though quantitative evidence is lacking, particularly in upland Britain. However, research in the USA has quantified losses from forestry roads and has identified factors such as means of construction, gradient, maintenance and traffic intensity as being important in determining the magnitude of increased sediment. Increases in sediment from the uplands may also affect river stability in downstream reaches (Newson and Leeks 1987).

3.10.6 Public water supplies

Research has shown that afforestation of upland catchments can be detrimental to water resources. Loss of rainfall is greater from a forest than from grassland (Law 1956, 57, IH study at Plynlimon) and transpiration is higher from established forestry than from grassland (Newson 1979). This is due to the interception and subsequent evaporation of rainfall within the forest canopy (Calder 1976). Calder and Newson (1979) predicted an average reduction in yield of about 10% for increasing afforestation up to 50% canopy cover. Most of the reduction occurs during the spring and summer when public demand for water is greatest.

Up to 15% of rainfall is taken up by upland vegetation (grasses and heather), the rest runs-off into watercourses. Conifer plantations, however, increase the evaporation and take up water from the ground. Run off from afforested areas being 30% less, afforestation in the catchment of reservoirs causes a reduction in yield of raw water to the reservoirs.

Conifers are efficient in the uptake of acidic pollutants from the air, mist clouds and rain, particularly when the tree canopy becomes complete 10 to 15 years after planting, with levels of acidity being 30% greater under a tree canopy than that of open moorland. The lack of ground cover vegetation in plantations reduces the buffering capacity further. As the rainwater soaks into the ground there is increased leaching of minerals, in particular aluminium, iron, manganese, copper and zinc. Once the pH drops below 5.5, aluminium, copper and zinc are extremely toxic to fish.

Burt *et al* (1984) reported large suspended sediment yield following the open ditching of two small upland catchments for afforestation above Holmestyles Reservoir in the South Pennines. This caused a major pollution problem at the reservoir and a new treatment works had to be constructed to provide potable water (Austin and Brown 1982). Similar problems were caused to the water industry by ploughing of land for forestry in South Wales in 1981, resulting in discoloration and high turbidity of water treated for public supply (Stretton 1984). Silting reduces the capacity of reservoirs.

Many studies on the impact of clearfelling on water quality have been carried out in North America, and have reported increased concentrations of nitrate and base cations following felling. The increased nitrate concentrations, in particular, have given rise to considerable concern about the possible effects on drinking water. Bonneau (1978) suggests that there may be significant short-term effects on availability of some base cations. A series of studies to examine the impact of felling on soils, soil waters and water quality is being carried out by the Institute of Terrestrial Ecology, Institute of Hydrology and the Forestry Commission.

The Isle of Man Water Authority is required to ensure that the public water supply is of sufficient purity and quality as to be fit for ordinary domestic purposes. A role of the Department of Local Government and the Environment (DLGE) is to monitor the supply and set standards for water quality. The Water Authority is already committed to the EC Directive 80/778 on Drinking Water Quality and the World Health Organisation's Guidelines on Drinking Water Quality 1984 and it is working towards ensuring that all areas of supply comply with these requirements.

There is a need for a baseline survey of watercourses and catchment areas on the Isle of Man and to determine the existing water quality. This need has been recognised by the DAFF but has not yet been initiated.

With regard to river waters, the DLGE, in conjunction with DAFF, aims to prevent pollution of river waters and seek to improve the quality of those rivers having regard to intended use, e.g. fishing, amenity, public water supply etc. A River Pollution Bill has been proposed, which will include the following (DLGE 1991):

(i) General care of duty placed on Government Departments to inspect controlled waters and monitor the extent of pollution; take all such steps as are reasonably practicable to maintain or improve the quality of controlled waters; and carry out investigations into problems of pollution of controlled waters not caused by direct discharges.

(ii) Water quality objectives. For the purpose of maintaining and improving the quality of controlled waters but consistent with the provisions of the Water Act, the Departments should have powers to issue water quality objectives in regard to any water or groups of waters.

(iii) Environmental Impact Assessments (EIA). In the case of planning applications for major developments which might lead to pollution of controlled waters, the Departments should have powers to require the applicants to undertake an EIA including an ecological study into the relevant stretch of water.

In the above proposals, the DLGE does not acknowledge the possible effects of conifer afforestation on water quality and drinking water supplies. This matter is of concern and should be fully investigated.

The IOM Water Authority is faced with increased costs both in the treatment of raw water as the quality drops and also for the loss of supply from catchments that have been afforested.

At Sulby reservoir an annual cost of £25,000 is required to pay for the treatment of drainage water below the reservoir, the low pH and high levels of aluminium in the drainage water being influenced by acid deposition on conifers in the catchment. Prior to the Water Authority undertaking action to treat the problem, the Sulby river from the reservoir down to Tholt-y-Will was devoid of fish, with

stocks being only a fraction of their previous level down to the Sulby Bridge. The river has only recently showed signs of recovery.

At Struan Barrule the supply has had to be abandoned due to the high levels of aluminium present. This small stream that supplied part of the Foxdale area drains a conifer plantation. The Water Authority is having to construct a new storage tank supplied from West Baldwin Reservoir.

Increased costs are also incurred due to the greater quantities of chemicals that are used to pretreat the raw water from the reservoirs, in particular West Baldwin. The high levels of iron and manganese are causing considerable difficulties especially when there has been a burst main or sudden demand. Although harmless, the general public are concerned when their tap water is heavily discoloured.

Water treatment processes are employed by the Water Authority in order to reduce levels of natural aluminium to acceptable levels. The effective removal of iron and manganese requires a different process from that for aluminium, hence the Authority is intending to employ a multi-stage treatment.

At the Glencrutchery Road filter plant the Water Authority is experiencing problems disposing of the waste water from the filter plant. The high levels of iron, manganese and aluminium left in the filters after the raw water from West Baldwin is treated has to be washed out daily. The resulting effluent is too polluted for it to be disposed of to the sewers. Instead it is discharged into the River Glass and has been described as one of the worst cases of long term pollution of the Island's rivers (Corrin 1993).

By necessity the above discussion is based on research carried out in the UK. No equivalent research has been carried out on the Isle of Man and historical data for water quality lacking, hence robust scientific evidence and proof is simply not available. There are inherent difficulties in applying the results from studies carried out elsewhere which do not take into account local soil types and geology, catchment areas, land management, rainfall and atmospheric pollution. However, from the limited data available, it appears that water quality is heavily influenced by the base-deficient nature of the upland soils. Water draining from the upper catchment areas is very soft, slightly coloured, acid and with a certain amount of aluminium, iron and manganese naturally present. This applies to catchments which have been afforested and those which have not.

It has been suggested that, in the near future, there may be restrictions on conifer planting in the UK in sensitive catchment areas used for public drinking water supplies (Royal Commission on Environmental Pollution 1992). Careful consideration should be given before further conifer afforestation is allowed to go ahead in catchment areas for public water supply on the Isle of Man.

In addition to the above problems, a number of areas of the Island's uplands are contaminated with heavy metals from old mine workings. At Laxey and Foxdale lead, zinc, copper, cadmium, mercury and arsenic are known to be present (Clarke 1990, Wolverhampton Polytechnic 1990) Not only are the spoil heaps contaminated but the working practices when the mines were operating and subsequent erosion has resulted in increased levels of heavy metals in river bed silt, with lead, copper and zinc being recorded as high as 10,000 ppm. During acid flushes heavy metals dissolve, become mobilised and enter the water table with implications for the ecology of watercourse, agricultural use and public water supply.

The Forestry Commission who control conifer planting in the UK have acknowledged the harmful effects that afforestation can have on surface waters in regions with low buffering capacity, i.e.

southwest Scotland, the Pennines, south west Cumbria, central and north Wales. It has published detailed guidance on techniques of forest establishment and management intended to ensure, as far as practicable, that water draining from forests is of a satisfactory standard (Forestry Commission 1991). Applications for afforestation are subject to scrutiny by the Forestry Commission and to consultation with local authorities and environmental agencies. The Forestry Commission may require an application to be subject to an Environmental Assessment when it judges that a proposed new planting may have a significant effect on the environment because of its size, nature or location. The Commission requires applications to conform to its guidelines on forest and water and may refuse grant aid where the expected effects are severe and it is not possible to reduce them to acceptable levels. One of the conditions restricts planting to no more than 10% of the land area of catchment in acid sensitive areas.

On the Isle of Man, there have been no Environmental Impact Assessments made prior to afforestation or the creation of access roads across open moorland.

3.10.6 Freshwater fisheries

Samples of water draining from catchments from the older plantations indicate that a number of streams are now so acidic that they are incapable of supporting fish (DAFF 1991, 1993). Over the last few years the Freshwater Fisheries Division has found that trout stocked from the hatchery at Ballaglass have died from pH shock. Both Baldwin and Cringle reservoirs have a pH of 5.5 which is below the minimum required by EEC regulations (pH > 6). There are no requirements for the DAFF to take remedial action over the effects the older plantations are having on the ecology of the rivers.

Concern has been expressed by trout farmers on the Island concerning the long-term viability of their enterprises.

3.11 Landscape and aesthetic values

The Island's landscape is very much a product of agricultural activity and this aspect of the island is increasingly being appreciated by both the resident population and by visitors.

It is acknowledged that landscape assessment is subjective, particularly with respect to afforestation in the uplands. On the one hand it is claimed that conifer plantations add shape, texture and form to the landscape, while on the other that the upland landscape is composed of an infinite variety of form, texture and colours in its natural state and that conifer plantations are alien in shape, size and colour as well as species, and are an unacceptable intrusion into the landscape.

3.12 Access and recreation

3.12.1 Public access.

On the Isle of Man, the Government-owned land, including the hill-land in Government ownership, is open to public ramblage (ie, can be wandered over freely) in contrast to many parts of the UK where access is restricted. A series of public footpaths and public rights of way (see below) are present on the hills. Rambling is a popular pastime on the Island both to residents and visitors. A number of publications detail specific routes, for example; *Manx Hill Walks* (Manx Conservation Council, undated), *Short Walks - Northern Section)*, Manx Conservation Council, undated), *Short Walks - Southern Section* (Manx Footpaths Conservation Group, undated), *Holiday Walks in the Isle of Man* (Manx Conservation Council, undated), *Rambling in the Isle of Man* (Hulme 1988), *More Rambling in the Isle of Man* (Hulme 1993), *The Isle of Man by Tram, Train and Foot* (Basnett and Freke, 1990) and *Hidden places of Mann* (Basnett, 1993). Three long distance footpaths, the Millenium Way, Bayr ny Skeddan and Raad ny Foillan, all including extensive sections through hill-land, have been waymarked in recent years (Evans 1987). The Raad ny Foillan (Way of the Gull) running close to the coast round the whole Island is considered to be one of the classic coastal walks of Britain (Collins 1990).

The Manx Footpaths Conservation Group (formerly part of the Manx Conservation Council) continues to foster walking in the Isle of Man. A regular programme of walks led by members of the group is arranged and these often include walks on the hill-lands. For a week in May 1993, the group played host to a visiting party from the Milton Mountaineers Blind Hill Walkers, an intrepid group of blind and partially-sighted walkers who spent the week walking hill-land routes.

3.12.2 Vehicles

On the Isle of Man, motor vehicles including motorbikes and 4-wheel drive vehicles, share the public rights of way (but not the public footpaths) with pedestrians, cyclists and horseriders. The public rights of way are marked on the Public Rights of Way and Outdoor Leisure Map, Scale 1:25 000 (Sixth Edition, July 1993) published by the Department of Local Government and the Environment. On the southern hills there are seven public rights of way:

1. From the end of the Ballaberna Road (D24) above Surby to the Sloc Road (A36),

2. From the A36 near Cronk ny Irree Laa to Kerroodhoo Plantation, continuing to join the Raad ny Foillan at SC 220 767,

3. From the junction of 2 with Kerroodhoo Plantation to the A27,

4. From Dalby Mountain to Glen Maye,

5. From the Round Table crossroads to join the Bayr ny Skeddan at Lhargan Plantation,

6. The Slieau Whallian Back Road (U70) from the Garey Road (D47) to the Slieau Whallian Road (C17),

7. The Stoney Mountain Road (U53) from Westview to the A3.

and on the northern hills there are a further 13 public rights of way:

8. From Windy Corner on the TT course (A18) to Glen Roy,

9. The Ballacurn Road (U187) from Sartfell Plantation on the Beinn ny Phott Road (B10) to Slieu Curn Plantation,

10. From the Druidale Road (C37) at SC 364 905 to its junction with (9) at SC 345 884,

11. From the junction with (10) at SC 351 888 to Lhergyvreck, Kirk Michael,

12. From Sartfell Plantation on the B10 south to SC 342 854,

13. The Cronagh or Ballaugh Plantation Road (U83) from Ravensdale to the Druidale Road (C37),

14. From Ravensdale to Glendhoo,

15. The Ballcuberagh Road (U100) from the Druidale Road (C37), alongside Mount Karrin, to the A14 in Sulby Glen,

16. From Agneash to Snaefell Mines,

17. From the A2 near the Hibernian past Park Lewellyn towards Clagh Ouyr,

18. The Sky Hill Road from the Lezayre Road (TT course, A18) to the Mountain Box on the TT course including a section of the Millenium Way,

19. From the end of the Rollick Road (U77), Narradale, to the Millenium Way at SC 408 915.

20. From the Glen Auldyn Road through upper Glen Auldyn,

There is sometimes a conflict between pedestrians, horse riders and motor vehicles with complaints of noise and rutting/erosion caused by vehicular traffic and erosion by horses. Between 11 May and 10 November 1992, through the Temporary Prohibition of Through Traffic Order 1992, the Department of Highways, Ports and Properties prohibited the use of the unsurfaced moorland highways (9) and (11) above to all horse and motor vehicles to prevent serious damage to the highways.

The Department of Agriculture, Fisheries and Forestry has issued press releases stating its continued concern over unauthorised use of its hill-lands by off-road motorcyclists and 4-wheel-drive vehicles. Other than the 20 routes outlined above, no public rights of way exist on the open hill-lands.

3.12.3 Recreational value of plantations (After DAFF 1994)

The recreational value of plantations is of ever-increasing importance, as leisure time grows. The Forestry Division plays host to many events held in the plantations throughout the year. These average one per week and include:

- walking and rambling (informal and organised),
- motorcycle events,
- car rallying,
- mountain bike events,
- orienteering/archery/youth club events,
- horse riding,
- military training.

Several "one-off" events are also held, such as choral evenings.

3.13 The Management and Conservation of the Archaeological Resource

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3.13.1 Introduction

The Manx hill-lands represent the richest reservoir of well preserved archaeological evidence in the Island, comparable in importance to areas in Britain such as Dartmoor and the North Yorkshire Moors which are much better understood.

The purpose of this paper is to describe the range and nature of this evidence and to suggest ways in which it can be properly assessed, conserved and presented to the wider public.

3.13.2 The resource

The hill-lands contain four major types of archaeological resource:

(i) Upstanding prehistoric sites and monuments

These consist principally of Bronze Age funerary monuments and Iron Age defended and open settlements and attendant field systems. In earlier prehistory, at a time of warmer and drier climatic regimes, deciduous woodland and human settlement were present at much higher altitudes than is the case today.

(ii) Upstanding post-prehistoric sites and monuments

Subsequent attempts to utilise the hill-lands are represented, in particular, by the sites of medieval shielings (upland seasonal farms), intacks of varying date and a whole range of mining and quarrying activity. The international significance of the Manx shielings has recently been demonstrated by Gillian Quine (1990). Many of the mining and quarrying complexes are very well preserved (Bawden et al, 1972).

(iii) Buried prehistoric sites and monuments

The enormous potential of the hill-lands to reveal well-preserved prehistoric settlement is evidenced from a number of finds which have taken place as a result of ploughing-up for afforestation in recent years. For example, on Black Mountain, Dr L S Garrad recovered important Neolithic burial and settlement evidence and on the slopes of South Barrule Mr R Farrar identified a rich late Neolithic settlement.

Although a majority of the most recently discovered prehistoric sites in the Isle of Man have been located in the northern plain, these new finds are the product of deep ploughing which has been extremely destructive of structural evidence. The hill-lands provide the best opportunities for the location of well-preserved buried sites, as they have been undisturbed for many centuries.

(iv) Palaeo-environmental evidence

Much of the hill-land is covered with a mantle of blanket peat. A single study of this from cores taken on Beinn-y-Phott has shown the potential of this resource for the understanding of environmental change not only in the uplands but for the Island as a whole. The peat at Beinn-y-Phott appeared to have its origins in the Late Bronze Age (Russell 1978). Comprehensive mapping and sampling of longer sequences, including valley deposits, would provide invaluable insights into not only the history of Manx vegetation itself but also the impact of human activity upon it.

3.13.3 The problem

The Isle of Man suffers from a serious lack of primary archaeological survey work. The work for the Manx Archaeological Survey dates from the early part of the century and only dealt with Early Christian sites (Kermode 1909 - 1918; Bruce 1968). There is no Royal Commission volume in which sites and monuments are listed, surveyed and interpreted, such as would be the case for the majority of the United Kingdom. The Ordnance Survey archaeological field records are limited in detail and have not been recently verified. There has been no published account of the vernacular architecture of the Island, such as would now be available for many areas in the British Isles.

The Sites and Monuments Record (SMR) in the Manx Museum is a computerised compilation of the Ordnance Survey records and those held by the Museum. There has been no systematic ground survey to test either the accuracy or the completeness of this data-base and few attempts at synthesis. The last attempt to produce a distribution map of Manx Bronze Age sites, for example, was by Clarke in 1935 and his study only dealt with diagnostic finds, not with sites as such.

Accidental and controlled fires in the heather and gorse cover of the hill-lands have demonstrated that many archaeological sites are disguised by the vegetation and extremely difficult to locate. The available air photographs are of insufficient quality to be used as a secure means of identifying threatened sites in the hill-lands. The locations of buried sites cannot be predicted. There is no research strategy for the mapping and evaluation of the blanket peats.

Developments such as afforestation, which involve ground preparation (by ripping and screefing) of very large acreages, are most likely to occur at lower altitudes in the hill-lands which are the very areas in which most archaeological evidence is concentrated.

The result is that, should an archaeological assessment be required of an area in the hill-lands, only new primary survey work is likely to provide a satisfactory basis for decision. The lack of synthesis of existing information means that it is virtually impossible to assess the value of any new site in a Manx context.

These problems are exacerbated by the lack of sufficient planning controls over development in the hill-lands which would ensure the identification, preservation and recording of heritage sites.

3.13.4 The solution

In the longer term, a detailed programme of mapping and field survey would ensure that all possible upstanding sites were identified and the information available as part of the development/planning process.

More immediately, the archaeological resource would be best assessed and preserved if all large scale developments in the hill-lands were subject to the production of an environmental statement. This would ensure that:

a full archaeological assessment was carried out before planning consent

appropriate mitigative measures would be proposed and would form part of any planning permission

there would be archaeological monitoring of the development process itself.

The emphasis should be on the conservation of the archaeological resource for future generations, wherever possible.

A suggested structure for the archaeological component of an environmental statement is contained in the Appendix.

3.13.5 Presentation

The hill-lands represent a major leisure resource for Manx residents and are attractive to tourists. At a relatively low cost, a great deal more could be made of the archaeological and architectural resource. The provision of a range of suitable literature, including a number of 'heritage walks' together with appropriate on-site information would help to make a wider public aware of the value of the hills as historic and prehistoric landscapes.

3.13.6 Appendix

Archaeological assessment and the Environmental Statement

The purpose of an archaeological assessment is to identify and evaluate any archaeological site or evidence which would be damaged, destroyed or otherwise affected by any proposed development. The new Design Manual for Roads and Bridges (Volume 11 - Environmental Assessment) which was issued in the UK last year is a useful model for any archaeological assessment of a large scale development project (of Volume 11, Section 3, Part 2).

An archaeological assessment of a development in the Manx hill-lands would probably take the following form:

(i) The desk-top study

Existing information would be collated for the development area and its environs. This would include reference to the Sites and Monuments Record held in the Manx Museum, published and unpublished documents, air photographs and also involve consultation with land-owners and relevant specialists. It would probably also include an initial walkover of the site.

Information from this study can be used to inform decisions about choices of site, where there are alternative possibilities.

(ii) Field survey

The study area would be subject to standard methods of archaeological survey. Any upstanding features and surface finds would be mapped and the condition of scheduled sites and those recorded in the SMR would be described.

(iii) Field assessment

Any upstanding sites which have been identified within the study area should be assessed in order to estimate their value in national and international terms. In particular, the dating of upstanding features and artifact scatters, together with the quality of evidence which they preserve would need to be assessed. This might be done by means of geophysical survey, trial excavation or both.

(iv) The report

The archaeological report should contain full details of the desk-top study and field surveys and assessments. It should make recommendations which are likely to take one of the following forms:

The archaeological site(s) and evidence which will be damaged or destroyed are so important that the boundaries of the proposed development should be modified or an alternative site should be sought.

The sites to be affected by the development are not of sufficient importance to warrant alteration of the development area, but should be "preserved by record" in advance of their destruction. This would normally involve a rescue excavation carried out after the planning process has been completed, but before the development is begun. This would normally be carried out at the expense of the developer.

Any sites affected by the development are of insufficient importance to warrant any further work.

The report would almost certainly recommend that a professional field archaeologist be retained on a watching brief during earth-stripping, extensive ploughing, road building or any similar invasive activity.

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3.14 Miscellaneous hill-land activities

The Manx hills are also put to a variety of additional uses as briefly outlined below.

3.14.1 Bilberry picking

The collection of ripe bilberries (*Vaccinium myrtillus)* for the making of home-made pies and wines is a popular activity on the hills. This appears to be most frequently carried out along roadside verges, for example, around the Round Table crossroads, and along public rights of way, for example, the track from the A36 to Kerroodhoo Plantation. Bilberry picking is carried out by young and old and is often a family outing.

3.14.2 Drawing and painting

The Manx hills have been a popular subject for local artists from long before the time of Archibald Knox and Willian Hoggatt, who themselves painted many upland landscapes, right up to the present day. A leaflet entitled *Views for photographers* has been produced by the Department of Tourism and includes Fleshwick Bay, Port Erin to Bradda Head, Cronk ny Irree Laa, Niarbyl and Snaefell from Slieau Dhoo, all of which include hill-land views.

3.14.3 Peat digging (Based on Manx Heritage Foundation 1991).

In the days before electricity, Manx people depended on turf (ie, "peat") from the hills and wet areas in the lowlands for their heating. Heather was also brought home from the hills. The gathering of turf was like a harvest and the places from which turf could be dug were called "turbaries". Upland turbaries were present on Snaefell, Beinn y Phott, Stoney Mountain, Glen Rushen and Earystane. The hill-land turf was preferred because it contained less Sulphur and did not smell as strongly as the lowland turf when burned. The turf was cut with a special spade called a 'faayl'.

On arrival diggers would first remove the top soil to a depth of about 30cm and these growing sods were put to one side, to be replaced when the turf had been removed. The turf beneath could be 1.5-2m thick, the deeper turf being the best. Diggers often worked as a team, with others carrying the turf to those who spread it out to dry and yet others replacing the growing sods.

There were various old Manx laws about turf digging. For example, turf could only be cut between the 1st May and the 1st July and the growing surface sods had to be replaced within 14 days. The turf was not to be used for any other purpose than for fuel and was not to be removed between 5pm and daybreak or on a misty day!

Reliance on turf for fuel lessened when coal from Whitehaven became available and by 1900 very little turf cutting was carried out. However, turf is still dug each year and its control is vested in the Department of Agriculture, Fisheries and Forestry in accordance with the Forestry Act 1984. Under the terms of the Act an Order has been made which enables and defines the area of the Public Turbary on Beinn y Phott and also regulates and controls the cutting of turf. The season commences on the 1st May and carries a registration fee of £3.

Until quite recently instruction was given to the turf cutters and it was a requirement that the turf should be left in a suitable condition from which it can regenerate. It has been suggested that a minimum depth of 50cm of peat should remain. However, on the modern turbary on Beinn y Phott, much of the area licensed has little over 50cm of peat prior to cutting and the turf is being removed

down to ground level, from which it is unlikely to regenerate because the climatic conditions are not the same as when the peat was laid down.

The turbaries on Beinn y Phott and that previously licensed on Mullagh Ouyr, can be regarded as unsightly scars on the hill-sides, very visible from the TT course (A18), the Sulby Glen Road (A14), the Beinn y Phott Road (B10) and the surrounding hill-lands.

Due to the scarcity of suitable habitat for peat digging on the government-owned hill-lands serious consideration should be given to ending this practice unless it can be performed on a sustainable basis.

3.14.4 Heather cutting

For a number of years heather has been cut from the hills as a filter in the treatment of sewage by the Department of Highways, Ports and Properties and the animal by-products plant, Baldwin, Braddan. Plans submitted by the plant in 1993 proposed increasing the heather bed from 140 to 200 cubic metres (Isle of Man Courier, 28 October 1993). Heather is a medium for odour abatement. It is actually bacteria, which growing and metabolising on the heather, 'feed' on the odours and so reduce emitted smells. Forest Enterprise, the organisation responsible for managing Forestry Commission woodland, exports heather from the North Yorkshire Moors to Holland, where it is used as a filter to cleanse air and water supplies. About 30 acres (12 ha) was expected to be cut in 1994 (Farmers Weekly, 9-15 September 1994).

Strips or areas of heather, not to be confused with fire-breaks, have been noted by the editors above Ballaugh Plantation.

3.14.5 Bees and honey.

Nectar from the flowers of heather produces highly regarded honey. Bee hives are often moved into the hills during the summer months when the heather is in flower.

3.14.6 Hang gliding.

Manx hills are used for the launch of hang gliders where steep slopes cause updraughts and produce uplift sufficient for take-off. Once in the air, hang gliders use the uplift and thermals for transportation, the hills themselves providing a spectacular landscape of a kind only visible from the air.

3.15 Potential uses

3.15.1 Wind energy.

It remains to be seen how soon wind farming becomes a political possibility on the Isle of Man. If the eventual outcome of the recent 'debate' is that wind turbines should not be visible from domestic dwellings, then the only feasible areas are in the hills. It is important that the need for clean energy is sympathetic with the ecology of the hill-land. Potential sites suitable for the siting of wind farms have been identified by the Manx Wind Energy Services, after taking into account the relevant constraints of flight paths, transmitting stations, access, visibility, proximity to plantations etc.

3.15.2 Tourism.

In the earlier decades of this century, the Isle of Man was much prized as a tourist venue before cheap package holidays to hotter climes came within the reach of many people. This competitive edge has

now gone but there are other resources that the Island possesses which set it apart in a British Isles context, and one of the major resource centre on "green" tourism for wildlife and landscape.

Almost uniquely in the British Isles, the Isle of Man is largely "unspoiled" in the sense of the landscape being well cared for and attractive for visitors with many different interests. The majority of the Isle of Man has been agriculturally improved but the hill-lands represent one of the last major wildife refuges on the Island. The hills are of great scenic significance and therefore of importance to the tourist industry. Many coaches transport visitors around the Island and over the hills to admire the outstanding upland scenery, particularly in late summer when the heather and western (Manx) gorse are both in flower, producing a breathtaking landscape. There is great potential for the organisation of specialist holidays, including natural history, birdwatching, rambling, painting, geology and archaeology. The Department of Tourism and Leisure has very recently set-up regional committees to examine potential options for tourism on the Island. It is hoped that they will appreciate the value of the Island's natural heritage and its inherent potential.

It can be argued that present land use policies are detrimental to the future of the hills, their ecology, landscape and hence tourist potential.

4 FUTURE OPTIONS

The evaluation section of this report stresses the importance of the Manx hill-lands as part of our natural heritage where in recent years development, particularly afforestation, has destroyed considerable tracts of valuable natural habitat and altered familiar landscapes. Such development has taken place with no consideration for ecological merit since the areas selected have been chiefly heather moorland, now regarded internationally as an increasingly rare and threatened habitat. Safeguards are urgently needed on the Island to guarantee the proper management and future survival of habitats, wildlife and landscapes in the uplands. Much of the hill-land (over 15% of the total area of the Island) is in public ownership, and the establishment of effective safeguards could be relatively easy if in future Government adopted a more enlightened attitude to conservation and the environment than it has shown in the past. In this section detailed options for conservation and management of the hill-land are presented and discussed at length.

4.1 Site protection

The conservation of the natural heritage can be carried out in a number of ways:

by statutory protection

by non-statutory protection

by default, with no serious attempt made towards safeguarding the future

The latter approach is inadvisable since ignorance can easily lead to the damage or destruction of a valuable site, even where the owner might have been anxious to conserve wildlife. The MNCT cannot recommend "by default" as a means of protecting the natural heritage and its wildlife.

Wildlife, but not sites or habitats of wildlife importance, is already protected on the Isle of Man by the Wildlife Act 1990. It is an offence, for example, to carry out any of the following:

to kill, injure or take any wild bird

take damage or destroy the nest of any wild bird whilst that nest is in use or being built

take or destroy an egg of any wild bird

intentionally kill, injure or take any wild animal included in Schedule 5

damage or destroy, or obstructs access to, any structure or place which any wild animal included in Schedule 5 uses for shelter or protection

intentionally pick, uproot or destroy any wild plant included in Schedule 7

not being an authorised person, to intentionally uproot any wild plant not included in Schedule 7

The *Wildlife Act 1990* provides more detailed information.

4.1.1 Statutory site protection

There are a number of mechanisms for the statutory protection of land of ecological importance on the Isle of Man:

(i) By designation as a Wild Bird Sanctuary under the Protection of Birds (Amendment) Act 1975

There are presently only three such areas designated on the Isle of Man (part of Langness, Barnell reservoir, Patrick, owned and managed by the MNCT and a private reserve at Ballachrink, West Baldwin). The main interest of all these sites concerns wildfowl on areas of open water.

(ii) By designation under the Wildlife Act 1990:

as an Area of Special Protection for birds, or an Area of Special Protection for animals and plants.

as an Area of Special Scientific Interest (ASSI),

as a National Nature Reserve,

Substantial areas of both the southern and northern hills are worthy of designation as ASSI's or Areas of Special Protection because of their special interest and importance to the natural heritage of the Isle of Man. Site designation should consider the following:

sites of ecological importance identified in the 1975 NCC/ITE report

important bird areas identified by Pritchard et al (1992) (see below)

areas supporting rare and/or endangered species of flora and fauna

habitats of international importance which are declining or under threat elsewhere in the world

ecological units of a sufficient size to be sustainable and to be of value in maintaining the biodiversity of upland habitats

Criteria used originally to assess the conservation value of sites in the UK are described by Ratcliffe (1977), but more recently, comprehensive guidelines for the selection of biological SSSI's have been produced (NCC 1989). The Wildlife Act 1990 is based on the UK's Wildlife and Countryside Act 1981 and in the absence of and Manx Government guidelines for site assessment it would be practical use the NCC criteria for sites here.

Lessons have been learned in the UK from the experiences of the Wildlife and Countryside Act 1981 which angered landowners by listing "operations" which could not be carried out without permission from the NCC. More recently a new style of management has been promoted, using a series of grants to promote management techniques appropriate and sensitive to the ecology of the area, whilst maintaining the rural economy and landscape. In Scotland, for example, the grants aim to curtail over-grazing by sheep on the peatlands. The scheme encourages landowners to feel more positive about nature conservation so that they will work more closely with the statutory bodies. In this way, positive agreements can make a significant financial contribution to farmers and crofters.

The Isle of Man has the opportunity for a more enlightened approach from the outset by learning from the UK experience.

So far, action Government action under the Wildlife Act 1990 has been woefully inadequate. It was hoped originally that the Manx Museum and National Trust would be responsible for implementing and administering the new Act and that adequate funding for the appointment of necessary staff

would be forthcoming. Eventually the Department of Agriculture, Fisheries and Forestry were given the responsibility, but not the resources for implementing the Act.

A Wildlife Committee has been formed with the Director of the Wildlife Park as Convenor. Members include the Chief Forester, the Chief Veterinary Officer, the Chief Agricultural Advisor and the Biological Records Officer (Manx Museum). Recommendations for the designation of ASSIs fall within the concerns of this Committee. No action has yet been taken on designating any Manx site although many are worthy of ASSI status and some are threatened with damage or destruction. The opportunity to provide statutory protection for certain hill-land sites has so far not been taken even though the entire Government owned area was surveyed in 1991 as part of a Phase 1 habitat survey of the whole Island. These sites could have been earmarked for designation on the basis the Phase 1 survey data.

There is clearly an important need for an independent Government agency devoted to the implementation of the Wildlife Act. With specialist staff such an agency could work in a truly effective way to conserve wildlife and the environment. A Wildlife Division set up within DAFF on equal footing with the present Forestry, Amenities and Land Division would be adequate but ideally a separate Department of Wildlife should be established

(iii) Through acquisition by Manx National Heritage

The Manx National Trust was created by Act of Tynwald to preserve wildlife and areas of outstanding natural beauty. The organisation, now part of Manx National Heritage, already owns over 2000 acres of land, including some of the finest coastal sites for scenery and wildlife in the Island. Manx National Heritage prohibits interference with wildlife, such as picking and uprooting plants or collecting insects on its land.

(iv) By further legislation

The need for international treaties to protect habitats and species is accepted by many countries (IUCN 1986). The Isle of Man is a signatory to the following:

the RAMSAR convention for wetland sites

the Convention on the Conservation of European Wildlife and Natural Habitats ("the Berne Convention")

the Convention on the Conservation of Migratory species of wild animals ("the Bonn Convention").

There is little point, however, in labelling sites as nationally or internationally important if they are not then protected and managed wisely. Designation should be seen as the starting point for management which will conserve and provide adequate protection for such sites.

4.1.2 Non-statutory site protection

There are a number of mechanisms available for the non-statutory protection of land of ecological importance on the Isle of Man:

(i) Ownership by a Wildlife Trust

Protection can be achieved through ownership or management by the Manx Nature Conservation Trust or similar organisations devoted to wildlife conservation. The MNCT currently owns and manages 12 nature reserves on the Isle of Man, amounting to over 120 acres. The Trust is constantly assessing the value of additional sites for acquisition.

Sites of wildlife merit equal to the potential ASSI sites identified above would certainly fulfil the criteria of the MNCT reserve acquisition policy. A number of additional hill-land sites would also merit MNCT reserve status.

(ii) Private ownership

Protection is achieved by dedicated landowners or managers committed to the conservation of sites for the sake of wildlife. Such a commitment would normally involve the implementation of sympathetic management regimes combined with survey and/or monitoring work to confirm that the wildlife value is being conserved.

The fact that a wildlife resource is properly and permanently managed is more important than the issue of who owns the land or actually carries out the management work. A dedicated conservationist could carry out sympathetic management just as effectively as the MNCT or Manx National Heritage. However, problems could arise in the long term when ownership or responsibility for management changed. Under such circumstances the wildlife value might not be appreciated and the habitat damaged or even destroyed.

David Bellamy, in his capacity as President of PLANTLIFE, Britain's only conservation organisation specifically dedicated to conserving wildplants, recently stated that " it is a sad fact of 1990s life that any land not owned by a dedicated conservationist or conservation body is in grave danger". We cannot afford to be complacent on the Isle of Man and there are many recent examples of the wildlife value of land here being damaged or destroyed, and even examples of government itself carrying out the destruction!

(iii) Non-statutory systems

Protection is provided by the importance of the wildlife resource being recognised in a non-statutory system. Several notable systems have been developed:

(a) Wildlife Sites

Wildlife Site systems have been set up, often independently, in most counties in the UK. The publication *Natural Assets: a non-statutory sites of importance for nature conservation* (Collis and Tydesley 1993) provides a detailed background study of various systems and the *Wildlife Sites manual* produced by the Scottish Wildlife Trust (Halcrow, Sommerville and Smart 1993) is a practical manual for implementing such a system. The Wildlife Trusts have recently produced *The Wildlife Sites handbook* (RSNC 1994) which provides advice on how a system should be developed.

The Wildlife Trusts have been involved in running Wildlife Sites Systems for over 20 years. Currently, 45 of the 47 Trusts are working towards the development of a widely recognised standard for Wildlife Sites Systems that will lead to better resources and greater protection for such sites.

There is a clear need to develop an effective system to ensure the protection and future of Wildlife Sites. This applies more so in the Isle of Man than in the UK in the absence of grant aid and support schemes from the Manx Government and the present lack of commitment towards implementing fully the Island's Wildlife Act (1990).

Through the Wildlife Sites System, sites are conserved by two key mechanisms:

By liaising with landowners and managers, providing advice, and in some cases financial support, to ensure appropriate management. Landowners can request help and advice

over aspects of managing their land with which they may be unfamiliar. They can be made aware of new opportunities for their land through grant schemes and incentive payments for more environmentally friendly and sustainable practices.

By including policies within structure and local plans to recognise the importance of the wildlife resource and identify the most important Wildlife Sites. Through the system, landowners are made aware of potential conflicts which could arise over proposed developments on their land at the earliest possible stage, enabling then to liaise with appropriate specialists before entering the often complicated, time-consuming and costly planning process. Discussions can ensure that planning applications have taken into account the nature conservation interest of a site and are more likely to receive consent.

While a Wildlife Site is not itself subject to a statutory designation, it may be given some protection by statutory policies in Structure Plans or Local Plans. In the UK many Councils include Wildlife Sites in development plans but only a few have adopted a strong policy. This needs to be discussed in some detail on the Isle of Man.

(b) Important Bird Areas

The Royal Society for the Protection of Birds and Birdlife International recently identified a network of Important Bird Areas, specially favoured sites which support valuable species or particularly large numbers of birds, or both (Pritchard *et al* 1992). The proper protection of these areas is an essential link in the conservation of bird populations in the Isle of Man, the British Isles and Europe, as required under international directives and conventions.

There are 256 such areas listed, all of which are of international importance and qualify for protection under the EC Directive on the Conservation of Wild Birds. They are maintained, where possible, through sympathetic land management, with core areas notified as SSSI's (or ASSI's in the Isle of Man and Northern Ireland). All areas have been carefully validated to confirm that they do support internationally important bird populations and this assessment must continue to be kept under review.

The sites listed support internationally important assemblages of birds. The protection of these areas is of paramount importance for bird conservation. Each area qualifies for designation as a Special Protection Area (SPA) in the context of the EC Directive 79/409 in the Conservation of Wild Birds ("the Birds Directive") which does NOT, however, apply to the Isle of Man.

Five Important Bird Areas are listed for the Isle of Man:

001 Isle of Man Sea Cliffs
002 Calf of man
003 The Ayres
004 Ballaugh Curragh
005 The Isle of Man Hills

The hills include both the northern and southern hills, a total area of 8,650ha in the Sheadings of Ayre, Garff, Glenfaba, Michael, Middle and Rushen.

(c) The special designation of species

Conservation efforts are often directed towards rare species and habitats of greatest diversity. This attitude fails to appreciate that climatic and edaphic factors prevent many semi-natural habitats from having great rarities or high level of species diversity, including acid grassland and heather moorland. To disregard such habitat would ignore large tracts of countryside and these species which are common in these habitats because they have the ability to flourish in such specialised habitat, upon which they often depend, whereas many more species cannot survive in these habitats due to the climatic or edaphic extremes. With increasing pressures upon the countryside, their value is likely to increase in the future. Not very long ago lowland heathland and unimproved hay meadows were common in the UK.

In assessing the ecological importance of a site or habitat, it is not only important to consider rare species but also communities which are themselves rare or threatened and plant communities upon which rare or threatened fauna depends. The following categories can be used in an assessment of a species significance:

RDB - Red Data Book, species recorded from 1-15 ten kilometre squares in the British Isles

NSS - Nationally Scarce Species, recorded from 16-100 ten kilometre squares in the British Isles

CSS - County Scarce Species, recorded from three or less sites within a County (excluding RDB and NSS)

CRDB - County Red Data Book, an account of all RDB, NSS and CSS species

CNS - County Notable Species, not in the CRDB, but of importance for reasons other than extreme rarity.

The first four categories are precisely defined and self-explanatory. The CNS, however, consists of all species which would be expected to occur in good habitats but which are not rare enough to be included in the CRDB. Such species are used to help identify good habitat and are called 'indicator' species. They can include the foodplants of rare animals.

It is very important to conserve the existing wildlife resource as outlined above, but it is also important to identify and progress opportunities to enhance wildlife and its appreciation through habitat creation, education and interpretation.

4.2 Town and country planning

The report commissioned by the Manx Government *Nature Conservation on the Isle of Man* (NCC/ ITE 1975) recommended that two steps should be taken in order to support and promote nature conservation in the Isle of Man :

(i) The establishment of a principal agency with overall responsibility for nature conservation. The report suggested that the Manx Museum and National Trust (now known as Manx National Heritage) should be this principal agency and be given adequate resources in this respect.

As noted in the proceeding section, this advice was not followed.

(ii) The establishment of procedures for the designating nature conservation areas by Government in the preparation of Development Plans.

Action has been taken and Nature Conservation Zones, Nature Reserves and Sites of Ecological Importance for Conservation are all incorporated into the Island's Strategic Plan (Planning Circular 10/91).
The Department of Local Government and the Environment (DLGE) has recognised that planning must incorporate adequate provisions for preserving the character of the countryside including its wildlife habitats (DLGE 1992). It is also recognised that there should be powers to refuse a development where this would have an undue ecological impact and there should be a requirement for Environmental Impact Assessments (EIAs) for proposals of appropriate size and/or nature. The publication *Planning for the future - possible provisions for a Town and Country Planning Bill* (DLGE, 1992) includes the proposal that planning control should be required for afforestation schemes exceeding one hectare.
In Northern Ireland, all afforestation proposals must have regard to both the environmental value of the site itself and the environmental impact on contiguous or downstream areas. The conservation value of a site may be classified, on the basis of local, regional, national or international importance. Valuable sites should receive official protection, for example by being scheduled as Historic Monuments or Areas of Special Scientific Interest (ASSI). In addition, extensive areas of the hills should be classified as important landscapes (comparable to Areas of Outstanding Natural Beauty - AONB - or Environmentally Sensitive Areas - ESA's - in the UK). Watercourses should be considered for designation as "salmonid" or "cyprinid" according to their need for protection or improvement in order to safeguard fish life, particularly the indigenous brown trout.

In its Environmental Strategy for the Isle of Man, DLGE proposes that there should be powers to declare Landscape Conservation Areas in which it would be an offence to destroy or damage landscape features (DLGE 1992). It is envisaged that large areas of the hill-land would be so designated and that major restrictions would be imposed on afforestation in order to conserve the landscape of the open moorland and marginal lands.

The Environmental Protection Bill, proposed for introduction during 1995/6 under the responsibilities of DLGE, will amend existing legislation dealing with the environment (IoM Government, 1994).

4.3 Establishment of a Hill-land Working Group

It is evident from the evaluation section of this report that there are misunderstandings and conflicts between government, graziers, shooters, conservationists and ramblers. The hills have to fulfil the needs and meet the requirements of all users. The MNCT proposes that the best way forward for the future of the Manx hill-lands is for the government to set-up a hill-land working group comprising representatives of all user groups, and that regular meetings and site visits are held in order to discuss pertinent matters with the intention of reaching solutions that are acceptable to all.

Hence the MNCT suggests that the Manx government initiates the establishment of such a working group with the various user groups invited to attend. The following organisations should be represented: Department of Agriculture, Fisheries and Forestry, Department of Local Government and the Environment, Department of Transport, Department of Tourism and Leisure, Manx National Heritage, Manx National Farmers Union, IoM Farming and Wildlife Advisory Group, Centre for Manx Studies, MNCT, Manx Ornithological Society, Manx Footpaths Group and the Society for the Preservation of the Manx Countryside and Environment.

In response to the Hill-land questionnaire (see page 6) 95.1% of respondents agreed that the establishment of a hill-land working party was a good idea.

4.4 Provision of management grants

A variety of grants are available for landowners in the UK towards the sympathetic management of lands of ecological value, and in some cases the creation of new wildlife habitats. They include grants relating to the following schemes: Countryside Stewardship, Environmentally Sensitive Areas, Less Favoured Areas.

The Isle of Man Farming and Wildlife Advisory Group (FWAG), with the support of the Manx National Farmers Union, has put together a proposal for the support of conservation on farms which involves the provision of management grants for targeted habitats. Whilst this has not progressed further, it is believed that such a scheme would be popular with farmers and provide an incentive for positive management and the prevention of habitat deterioration. Such a scheme could be extended to upland habitats.

4.5 Provision of training courses in upland management

There is much to be learned about the ecology and management of habitats on the Isle of Man. The correct management of heather moorland is of particular importance since this habitat type is not only vital for the future survival of the red grouse but is also important for grazing, landscape and its dependent flora and fauna.

There appears to be much mis-understanding of upland management and its implementation among hill-land tenants, conservationists, the public and even the Government's own advisors. This is demonstrated by the inclusion of a seven year cycle for the burning of heather as a condition of grazing tenancies and the continued over-grazing of heather moorland in the misguided belief that the "white" grasses which replace the heather are better forage for livestock.

The organisation of training courses in upland management, involving trainers from the UK and/or Ireland initially, would provide the opportunity for hill-land tenants, conservationists and government advisers to learn and work together towards the implementation of sound management practices to the satisfaction of all parties.

Unlike the UK, the Isle of Man is of such a size that a positive management programme could be successfully initiated, funded and implemented through co-operation between landowners, tenants, government departments, ecologists and archaeologists.

4.6 A possible future for afforestation on the Isle of Man

The MNCT have found that most people are in favour of tree planting and increasing the amount of woodland on the Isle of Man, especially of native broadleaves. There are many benefits including the provision of shelter and screening, structure and colour, acting as noise and pollution filters, providing landscape diversity and habitat for wildlife.

The MNCT supports an increase in woodland, especially of native species, and in suitable situations of mixed coniferous and broadleaved species.

However, despite the benefits, there are still sites where tree planting would be inappropriate: too close to buildings, where archaeological sites or remains would be damaged, where detrimental to the landscape and on land of existing ecological value. Habitats with an ecological merit so high that

planting should be avoided, include wildflower meadows, certain types of marshy/boggy ground and heather moorland. Only after very careful consideration, to avoid damaging the ecology of such areas should any trees be planted.

In Northern Ireland, Government policy is to encourage afforestation on land where forestry is considered to be the most appropriate long-term land use. Afforestation requires a change in land use, usually from agriculture. In the past, this was often on poor quality upland farms and displaced relatively little agricultural production. Today, there is an opportunity to extend afforestation "down the hill" onto more productive sites. The Department of Agriculture for Northern Ireland (DANI) has introduced an enclosed land supplement to their Woodland Grant Scheme and Farm Woodland Premium Scheme to assist in this development (DANI 1993).

There is also an increasing awareness of the need to conserve important habitats. Some of these have been identified on a European scale in Council Directive 92/43/EEC on the Conservation of natural habitats and of wild fauna and flora. An objective of both DANI's Forest Service planting and the Woodland Grant Scheme is that afforestation should enhance and conserve the rural environment (DANI 1987).
DANI acknowledges the risk that the introduction of woodland onto unsuitable sites, or in an inappropriate way, may reduce the overall conservation and landscape value of the countryside. Where it appears that afforestation is likely to have a significant effect on the environment, an Environmental Assessment is required for both private and public sector proposals. This includes a general presumption against afforestation on heather moorland (DANI 1993).

On the Isle of Man, planting under the Afforestation Programme has been more-or-less confined to heather moorland. There are many opportunities for trees to be planted without damage to ecology, landscape or archaeology, but most are not on Government-owned land. However, by terminating the current Afforestation Programme and redirecting the remaining money into a new grant aid system for private landowners, or possibly revising the Small Woods Scheme, much could be achieved on private land.

The Department of Agriculture, Fisheries and Forestry has funded a Phase 1 habitat survey of the Island (DAFF, in press) and the Department's own ecological surveyors could interpret the maps and identify areas suitable for tree planting without damaging areas of existing ecological value. These areas could then be targeted with grant aid towards tree planting or the promotion of natural regeneration.

The best place to plant trees to benefit wildlife is next to an existing woodland, provided the land is not of existing ecological value in its own right, thus enlarging the area of the woodland. Strips or blocks of trees can be planted to connect woodlands together thus providing a corridor for animals and plants to colonise and spread. Within a field, trees can be planted along the edges or in field corners. If trees are planted in the corners where three or four fields meet, then a small copse can be created.

Increase in tree cover also occurs by natural regeneration. Examples include, Sulby Glen, Lower Foxdale, between Glen Maye and Dalby Mountain, the Baldwin valleys, Laxey Glen/Glen Roy and Ballaugh Glen. Here native trees and shrubs are self-seeding and will eventually form broadleaved woodlands. This should be encouraged and more opportunities identified. Often only a fence is needed to stop livestock eating the young seedlings.

There is urgent need for a review of the Afforestation Programme. A start could involve the production of a Forestry Policy providing discussion and direction for the future of woodland on the Isle of Man. Although the MNCT believes that the current afforestation programme be brought to an end, the Trust would support the multi-functional use of the Island's forest estate and would be pleased to see the creation of new glens on lowland sites such as those listed above. However, the MNCT cannot support the continuing planting on sites of ecological importance.

4.7 Enhancing existing plantations

There are many opportunities to benefit not only wildlife but also landscape, access, recreation, education and research. Unproductive areas of conifers, for example, could be removed and the land turned back to open moorland, other areas could be thinned to create scattered tree groups amongst natural vegetation. Blocks of broadleaves could replace conifers, hidden landscapes and rock exposures could be opened-up, existing wildlife habitats enlarged and managed, pedestrian access improved, nature trails created, interpretation provided, and opportunities for education, research and monitoring developed.

The Forestry, Amenities and Lands Division have already carried our some of the suggestions, but there is great scope for much more to be achieved. Perhaps the best way forward is through a partnership between foresters, ecologists and those employed in education as is happening in the UK.

The survival of many plants and animals in British woodlands depends on the existence of open areas. In many woodlands, open areas are confined to rides and glades which make up a relatively small part of most woods, but their value for wildlife can be out of all proportion to their size provided that they are properly managed.

A ride is regarded as any linear track or cutting within a woodland and is taken to include all the area between the trees on either side (Warren and Fuller 1993). Hence this includes the grassy surface of the ride itself, together with any ditches and scrub which often develops between the ride and the trees. Each of these components can be important to wildlife and together they can support a wide range of flora and fauna.

Woodland glades provide similar conditions for wildlife and are defined as all permanent non-linear areas within woods which have few or no trees (Warren and Fuller 1993). Glades are permanent features, not including young plantations or clearings containing developing or replanted woodland.

Most woods have a network of rides which are maintained primarily to aid timber extraction. In conifer plantations, rides can also act as fire breaks. In commercial woodlands, the rides are usually classified as main rides (typically 6-9m wide) or secondary rides (typically 3-5m wide). With increasing leisure time and demand for countryside recreation, rides have become important leisure amenities, providing easy access for pedestrians and horses.

Rides and glades tend to develop a completely different flora and fauna from the rest of the woodland. Light-demanding plants and animals can thrive within rides and glades simply because they provide open sunny conditions. Other plants, which occur in suitable habitats outside woodland, rely on the interface between grassland and woodland and are more-or-less confined to woods or woodland edges. Rides and glades can be particularly important in coniferous plantations as they may be the only place in the entire wood where deciduous trees and shrubs, and their associated wildlife, are found.

Within woodlands, many plants will not tolerate dense shade, but depend upon more open areas either beneath a sparse canopy or in rides and glades. Few plants are completely restricted to rides and glades, but many are commoner there than in almost any other habitat, for example, hedge woundwort, creeping jenny and common figwort (Warren and Fuller 1993).

Rides which are wide and sunny tend to have the greatest variety of plant species which flower more profusely in sunny conditions. Management by periodic cutting and/or grazing is necessary to maintain the open conditions by controlling the more competitive species that may otherwise dominate the vegetation. Ground disturbance caused by grazing helps to promote seed germination.

Open sunny rides which are rich in flowers offer the greatest opportunities for insects. Large numbers of invertebrates occur in woodland rides and glades, but, apart from butterflies and moths, little is known about their precise requirements. Flower-rich areas provide valuable sources of nectar and pollen to a great variety of insects, notably hoverflies and bees. Many insects are virtually confined to open areas within woods, but others fly there to visit flowers and breed elsewhere. Bees and wasps often need patches of bare ground, partly because these provide nesting sites and partly because they provide a warm microclimate. Crumbling south-facing banks or rides with rutted and disturbed ground can be particularly valuable.

In contrast to butterflies, a much larger proportion of moths are dependent on trees and shrubs for breeding. The shrubby margins of rides are, therefore, vital to moths, especially in conifer plantations where broadleaved trees are otherwise scarce. The importance of age or height of trees and shrubs to moths is poorly known, largely because of difficulties in sampling mature tree crowns. However, regrowth of birch, hawthorn and other woody shrubs in rides support large numbers of moth larvae even when only one or two metres tall. Greater numbers of moth species tend to occur where the margins of rides are composed of varied ages and species of shrubs.

Rides and glades can also be valuable for lizards, particularly if sunny banks and bare ground are present and permanent ditches can be valuable for frogs.

The value of rides for nesting birds is depends on width and the nature of the vegetation. Narrow rides and those with no marginal belt of shrubby vegetation are the least interesting for birds. The shrubby strip between the open ride surface and the adjacent tree stand should be not less than five metres wide and ideally much broader. A management option to favour migrant birds is the cutting of coppice belts 10-20m either side of rides. Such strips are typically of greater value for breeding birds when they have 3-8 years of regrowth. Wrens are often associated with rides, particularly where occasional heaps of brushwood have been left. The richest glades for breeding birds are those with a mosaic of open vegetation and scrub. Very small glades, of less than half an acre and those dominated by bracken are generally of little interest for birds.

Grassland and coppice in rides can support large populations of small mammals which, in turn, attract predators such as the kestrel and owls. Bats may also use rides for hunting insects.

Management is needed to conserve and enhance rides and glades for wildlife. Three features have a major influence on the wildlife value: shade, width and cutting or grazing regime. The level of shade is affected by the width of the ride, the height of the surrounding trees and the orientation with respect to the sun. As a rule of thumb, the most open rides need to be at least as wide and preferably 1.5 times as wide as the height of the trees. The type of cutting regime is crucial to wildlife, as it influences

both the composition and structure of the vegetation. Management should aim to create a variety of conditions. The least beneficial regime is the regular mowing of a ride from edge to edge as this eliminates all structural variation. Vegetation structure can be varied most easily by dividing the ride into strips and giving each strip a different treatment.

Warren and Fuller (1993) identify four management systems:

(i) A simple two-zone system. This system is most appropriate to woods where costs have to be kept to an absolute minimum. The central portion of the ride is mown once or twice annually to maintain easy access, and the marginal strip either side is allowed to develop into a mixture of tall grass, herbs and light scrub which is cut on a two to seven year rotation with a side-mounted flail. The main disadvantage of this system is that it does not allow the development of dense scrub.

(ii) A three-zone system with coppice. This caters for a far greater range of species than system (i). The central strip is again mown once or twice annually, but is bordered either side by a zone of tall grasses and herbs cut piecemeal on a two to four year rotation with opposite sides of the ride cut in different years. On either side of the tall grass is a zone of scrub and tree regrowth which is managed as coppice on a 8-20 year rotation.

(iii) Along forest roads the short grass/herb zone is moved to a narrow strip on either side of the road surface and is maintained by annual cutting. On either side of this strip is a zone of tall grass and herbs and a zone of scrub or coppice, both managed as described in (ii).

(iv) The introduction of scalloped edges which increase the length of boundary between different habitat types and reduces the problem of wind channelling along long straight rides. Scallops can be cut along both sides of a ride and managed on a rotation. The scallops can be arranged to coincide with each other to maximise the sunlight, or staggered to create a series of sheltered bays. The most suitable size for each scallop is probably in the region of 30-50m long and 10-20 m deep.

It is always preferable to remove as much of the grass cuttings as possible. Ideally this should be either raked and stacked into heaps or removed altogether. The heaps can provide an additional habitat for birds, invertebrates, lizards and small mammals.

The wildlife of many woods can be enhanced considerably by the creation of new rides or the widening of existing ones. The presence of glades increases the variety of habitats for wildlife in a woodland. Although small openings or bays along ride edges will benefit some species, to encourage a variety of wildlife, some glades should be at least 0.5 acres (0.25ha) and preferably 1-5 acres (0.5-2ha) in size. A substantial glade can be created most easily by enlarging the intersection where two rides cross (or a T-junction).

The principles of glade management are essentially the same as for ride management above. Management of rides and glades can apply equally to broadleaved and conifer plantations and to semi-natural woodland.

4.8 Habitat restoration and prevention of degradation

4.8.1 Restoration

Habitats can be restored or recreated in areas from which they have been lost through a variety of reasons, both natural and artificial. Natural losses include erosion and the processes of natural succession whereby scrub, trees and/or bracken invade and replace other habitats. Artificial processes include afforestation and land reclamation for agriculture or development. It is particularly important to restore habitats of high ecological value, including those which have, or are being, lost at a high rate. On the Manx hill-lands such habitats include mire habitats (in particular blanket bog) and heather moorland.

In the case of mire habitats the most important conservation measure is to prevent further losses and habitat degradation by the prevention of threats such as drainage and reclamation schemes.
Former areas of heather moorland can be restored by the active removal of vegetation which has replaced the heather. On the Isle of Man, heather moorland has been replaced by afforestation, encroachment by bracken and scrub, and through reclamation for agriculture. If areas that have been so reclaimed are not maintained by continued application of fertiliser and lime, by maintenance of the drainage system or by ploughing and re-seeding, then it is possible that will revert back to heather-dominated vegetation. Examples of heather reverting can be seen in fields at Earystane (SC2273) and Cronkdhoo (SC3386).

However, restoration of heather is most likely to be achieved by the active removal of blocks of conifers from the upper fringes of plantations. Unlike most broadleaved trees and shrubs, conifers do not regenerate from the stump when cut down . Heather often regenerates when small blocks of conifers are felled as has occurred in South Barrule Plantation. The removal of sections of plantation would be particularly justified in the following situations:

(i) Where tree growth is poor and the tree crop is not economic to harvest. Examples include the following plantations: Earystane, Greeba, Slieau Curn.

(ii) Where corridors of semi-natural vegetation can be widened or enlarged so as to create or restore the means for wildlife to travel between otherwise isolated or fragmented habitats. Such areas include the links between Ballaugh plantation and Tholt-e-Will; Glen Rushen plantation and Cringle; Dalby Mountain and Eary Cushlin.

(iii) Where ecologically important habitats can be enlarged. Examples include South Barrule plantation (SC269762), Earystane Plantation (SC2373), Greeba Plantation (SC320814) and Colden Plantation (SC354836).

(iv) Where views or features can be exposed to the benefit of the upland landscape. Examples include Greeba and Colden Plantations, and Ballakerka Plantation (SC388924).

Examples of locations in the UK where the Forestry Enterprise (the body responsible for the management of the Forestry Commission estate) has removed conifers from heathland and bog habitats are: Delamere Mosses, Delamere Forest, Cheshire; Abbots Moss, Cheshire; Border Mires, Northumberland; Wareham Forest, Dorset; Ringwood Forest, Dorset; Olsters plantation, Woodhall Spa, Lincolnshire; Allethorpe Common, Yorkshire; Kielder Forest, Northumberland; Pit House Pond, Gloucestershire; Wigpool, Gloucestershire; Edgehills, Gloucestershire; Great Kensley Enclosure, Gloucestershire; St. Leonard's Forest, Sussex; Stedham Forest, West Sussex; New Forest, Hampshire.

Forest Enterprise are planning to increase the amount of heathland in Cannock Chase, Staffordshire by 50% and are involved with clearing heathland patches for sand lizards in Dorset. There are also plans for substantial felling in Brightstone Forest on the Isle of Wight.

4.8.2 Control of bracken

Bracken has spread on the hillsides in recent decades and continuous bracken cover accounted for 3.5% of the Government owned hill-land in 1991 (Table1). It is possible to control bracken by regular cutting in mid-June to late July when rhizome reserves are low. Daniels (1983) has argued that cutting twice a year is unnecessary, and reports that at Cannock Chase bracken was severely weakened by cutting once a year for four years.

There is considerable experience of the control of bracken in heathland using the herbicide asulam, marketed as "Asulox" (for example, Lowday 1983). There is a general consensus that asulam applied once in July when fronds are fully expanded will give up to 95% reduction in frond density in the following year (Lowday 1983). Daniels (1983) also found that respraying asulam in five successive years gave the best bracken control but did not eradicate it. Daniels recommends that optimum control is achieved by spraying asulam in year one, cutting in years two, three and four and spraying asulam again in year five.

Small areas of bracken can be treated with herbicide using a knapsack sprayer. Larger areas can be treated with a mistblower or tractor mounted sprayers. The method used will relate to the size of the operation and the nature of the terrain.

4.8.3 Control of scrub

Rapid succession to gorse scrub or scrub woodland is possible if the seed of gorse, birch or other shrubs/trees is present in the soil's seed bank or an abundant and adjacent seed source is present.

In relatively small areas, and in the early stages of scrub encroachment, labour intensive hand-pulling will control young birch. Cutting will not control gorse or birch, which regenerate from cut stumps. On a larger-scale, and where scrub is older, spraying of individual plants or cutting followed by herbicide treatment of the stumps may be necessary. There is an effective range of herbicides available for the control of woody species, and their use for heathland management has been thoroughly tested and reviewed.

Scattered bushes of European gorse and other unwanted scrubs may be removed by pulling-out with a chain and tractor. Larger areas of gorse may require a bulldozer to move them. The cleared area is reseeded with heather cuttings from an adjacent area.

There is widespread evidence that grazing by large herbivores (including sheep) reduces the establishment and growth of newly restored areas of heather (Ling and bell heather). Following restoration, young heather seedlings are damaged by trampling, and small plants may be pulled out of the ground. Protection of restored areas may, therefore, be necessary for up to five years (British Gas 1988). Provision for maintenance of fences should be included in to any restoration scheme where grazing or trampling is seen as a potential problem.

5 RECOMMENDATIONS

5.1 That the current Afforestation Programme is subject to an independent and fully comprehensive review which would examine its economic basis and include a full Environmental Impact Study and Assessment to determine the effects on upland ecology, archaeology, rural economy and landscape.

5.2 That the importance of the Manx hill-lands is recognised by the designation of Areas of Special Scientific Interest (ASSI's) under the Wildlife Act 1990. All those areas which meet the criteria should be considered for designation as soon as possible.

5.3 That those areas of hill-land which do not qualify for statutory designation under the Wildlife Act but are nevertheless of significant ecological value should also be recognised. The development and implementation of a Wildlife Sites System is recommended in this respect.

5.4 That the proposal to make afforestation schemes subject to planning permission through the Town and Country Planning Act is implemented and that similar permission should be required for the construction of forest access roads.

5.5 That the Government initiates a Hill-land Working Group, formed of representatives of all user groups: hill-land tenants, Government departments, ecologists, archaeologists and special interest groups

5.6 That training courses in upland management practices are organised to provide the mechanism for hill-land tenants, private landowners, government advisers, ecologists, conservationists and concerned members of the public to learn from one another and work together towards the development of improved standards of upland management practices and an integrated approach to the long-term future of the hill-lands.

5.7 That management grants are provided to assist the implementation of the most appropriate management regimes to the benefit of grazing, grouse and wildlife. In order to be effective it is recommended that a cooperative effort is progressed with the full support of both grazing and shooting tenants. Such grants should encourage the restoration of degraded areas of heather moorland.

5.8 That steps are taken to enhance the value of established plantations to the benefit of landscape, wildlife, access and recreation, education and research. In addition, the possibility of converting back to heather moorland sections of established plantations which have failed or are uneconomic should be investigated

5.9 That a programme of survey and monitoring work is initiated to include invertebrate fauna, the identification of indigenous populations of brown trout, the further survey of vegetation and a study of upland hydrology.

5.10 That alternative systems of afforestation are investigated and monies redirected from the current Afforestation Programme in order to promote and finance an increase in woodland cover, of broadleaved trees in particular, on the Isle of Man.

5.11 That an independent government agency is established to administer wildlife legislation and promote nature conservation.

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