PROCEEDINGS
of the
MANX HILL-LAND SEMINAR

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DTP by Betty Hopson

Foreword

In April 1995 the first seminar in the Isle of Man on the management of hill-land was held at King William's College, Castletown. It was organised by the Manx Nature Conservation Trust (MNCT), but it followed several years of public discussion about the Island's afforestation programme, and an initiative taken by the late Lord Northesk in inviting the MNCT to address the issue. The success of the seminar in attracting some of the most knowledgeable speakers on the subject in Britain is self evident from the contributions to this report. It is not the wish of the MNCT to attempt to dictate to others how the Manx hill-lands should be managed, but to use its influence to ensure that decisions are made in the light of the latest and best advice available. I hope that this report will contribute to a better understanding of the issues involved.

The seminar would not have taken place without the hard work and enthusiasm of Aron Sapsford, Jacky Hall and the other volunteers and this report would not have appeared without the dedicated work of Betty Hopson. The Principal and staff of King William's College are also to be thanked for making available the venue for the seminar and the catering arrangements.

This report should be read in conjunction with the 'Manx Hill-land Report published by the MNCT in April 1995 and edited by Tony Hopson and John Lamb. The 'Manx Hill-land Report' is an impressive and detailed survey of the uplands of the Isle of Man, and should be studied by all those interested in the Manx hills. It can be obtained from the Nature Conservation Centre at the Courtyard, Tynwald Mills, St Johns (Tel. 01624 801985)

William Cain
MNCT Chairman

Contents

Progress towards statutory conservation of the Manx hills

NICK PINDER
Convenor, Wildlife Committee, Department of Agriculture, Fisheries and Forestry.

The talk described the role of the Wildlife Committee and of the ecological surveyors employed by the Department of Agriculture before presenting the results of that ecological survey, in particular those relating to the hill land. The way in which these results might be used in order to conserve habitats in the Island was described.

The Department of Agriculture, Fisheries and Forestry is the Government department which has been given responsibility for nature conservation in the Isle of Man. The Wildlife Act 1990 gives the Department similar powers and responsibilities as was given to the old Nature Conservancy Council in the UK under their 1981 Wildlife and Countryside Act.

In particular, the Wildlife Act permits the DAFF to designate areas of special protection for birds and other animals, and for plants, areas of special scientific interest, national nature reserves and marine nature reserves. Before the Department could designate any such sites an inventory was needed to provide an informed picture of the wildlife habitats present on the Island at the time. Starting in 1991 an ecological habitat survey of the whole island was commenced.

The first 3 years were devoted to a survey at Phase 1 level, using methods devised by the UK's then NCC. This involves examination, but not necessarily a visit, of each parcel of land and each boundary and assigning the habitats present to one of some 90 habitat types. These are then recorded on 1:10560 maps using standardised colour codes. It is then possible to add up all the areas covered by any one habitat type and this has been done. The results are available in the Isle of Man Ecological Habitat Survey, Phase 1 Report 1991-1994 (July 1995, DAFF, price £2.90).

The results can be broadly summarised as showing that, at the time of the survey, agricultural use covered nearly 60% of the Island, built-up land and amenity grassland just over 5%, and plantations, both broad-leaved and coniferous, just over 6%. The total of all semi-natural vegetation is therefore 16438.9 ha., representing 29% of the area of the Island, a proportion very similar to that worked out for the United Kingdom.

The various categories of habitat included in the above total are as shown in Table 1.

The main habitat types of interest in the present context are heathland, acid grassland and mire. Heathland includes vegetation dominated by ericoid or dwarf gorse species, as well as heaths dominated by lichens and bryophytes and is regarded as occurring on peat less than 0.5m in depth. The following categories were recognised:

Dry dwarf shrub heath: 5,645.72 ha. This is categorised as having vegetation with more than 25% cover of ericoids/ dwarf gorse in relatively dry situations. It is the largest single category of semi-natural habitat types and occurs in the largest continuous blocks. The largest, 2143.34 ha., includes Greeba and Beary Mountains, Colden, Slieu Maggle, Slieu Freoghane, Slieu Dhoo, Slieu Ouyr and Mount Karrin.

Wet dwarf shrub heath: 309.94 ha. The same definition as above but occurring in wetter situations and therefore having differences in the species composition. Bell heather (*Erica cinerea*) is not usually present in any significant quantity. This habitat occurs predominantly in the uplands, tending to occur on the lower slopes of the hills usually associated with water courses. It is possible that some of the sites classified as wet heath would more correctly be described as bogs if the depth of peat could be established.

Acid grassland: 3,152.88 ha. This habitat type develops where precipitation exceeds evaporation, resulting in the leaching of basic nutrient ions from the surface layers of the soil down the soil profile. It occurs where sheep grazing prevents heathland species dominating, and where mire cannot form. It is likely that much of this habitat has been derived from dry dwarf shrub heath as a result of burning and grazing. The greater proportion occurs in the northern hills, with that in the southern hills usually occurring as a mosaic with dry dwarf shrub heath, for

Table 1: Categories of semi-natural habitat recorded in the Isle of Man Ecological Habitat Survey, Phase 1, 1991-94

Semi-natural habitat type	Total area hectares	% of Island	%semi-natural habitat type
Woodland & scrub	1,189.88	2.11	7.24
Grassland & marsh	5,896.80	10.44	35.87
Tall Herb & Fen	2,023.92	3.58	12.31
Heathland	5,955.66	10.54	36.23
Mire	669.32	1.18	4.07
Swamp & Inun'd	24.56	0.04	0.15
Open Water	103.08	0.18	0.63
Coastland	575.68	1.02	3.50

example off the Round Table. In the north, it occupies very large areas, the largest block being some 2654.60 ha. centred on Bienn y Phott and Snaefell. It is by definition species poor but nevertheless provides habitat for several important bird species, including Hen Harrier (*Circus cyaneus*) and Raven (*Corvus corax*).

Dry heath/acid grassland mosaic: This habitat type is a mix of dry heath and acid grassland. Relative proportions of each have been estimated where possible and figures allocated accordingly, otherwise a 50% split has been assumed. In the north there are some quite large areas, for example, at Lhargee Ruy and above Sulby Reservoir but in the south there is very little. This habitat forms when sheep grazing and/or burning causes the dwarf shrub vegetation to be replaced by grasses. Typical species include mat-grass (*Nardus stricta*), wavy hair grass (*Deschampsia flexuosa*), heather (*Calluna vulgaris*) and bilberry (*Vaccinium myrtillus*).

Wet heath/acid grassland mosaic: This habitat was recorded only below Cronk y Vaare on the eastern edge of the northern hills.

Mire: Mires generally occur on deep peat, over 0.5m thick, with the water table at or just below the surface, but flushes and springs, which occur over shallow peat, are also included in this category. The other main habitat types in this category are bogs and fens, the latter being of less relevance since they are fed by ground-water and almost by definition do not occur in the hills. Bogs are characterised by the presence of deep peat, arbitrarily set at a depth of 0.5m to distinguish them from wet heathland, and are ombrotrophic i.e. dependent only on precipitation for peat formation. Ericoids, cottongrass (*Eriophorum* spp) and/or *Sphagnum* species are normally dominant, although on occasion purple moor-grass (*Molinia caerulea*) may dominate. Unmodified bog includes blanket and raised bog while bogs modified by human activity are divided into wet or dry categories according to the amount of *Sphagnum* species present. Only a small amount of wet modified bog occurs in the hills, whereas dry modified bog, comprising 0.41% of the total area of semi-natural habitat only occurs in the northern hills on the lower slopes of Beinn y Phott and Snaefell. The former area is still being cut for peat.

The total areas of all these habitat types are shown in Table 2, although it should be remembered that a small proportion of some habitat types exists outside the hill land area.

Table 2: Analysis of upland habitat types in the Isle of Man

Habitat type	Total area hectares	% of Island	%semi-natural habitat
Dry d. shrub heath	5,645.72	9.99	34.34
Wet d. shrub heath	309.94	0.55	1.89
Flush	455.24	0.81	2.77
Blanket bog	105.72	0.19	0.64
Dry modified bog	67.36	0.12	0.41
Wet modified bog	26.08	0.05	0.16
Acid grassland	3,152.88	5.58	19.18

The ecological survey, and the habitat maps which accompany it, therefore form an important first point of reference in beginning to consider which areas may be designated for protection under the Wildlife Act. Certain practical problems remain, however, including how much land we may wish to designate and where any boundaries might be drawn.

The United Kingdom used to have a target of having 10% of the land designated, a figure arrived at from biogeographical principles, namely island biogeography theory. The latest figures suggest that they have actually achieved something over 8%, but that is not necessarily 8% of each habitat type. Some habitats might be viewed as more important than others and this could be said of upland moorland because of the increasingly recognized importance of heather moor in European terms. Since the British Isles have a greater proportion of the whole, then we may have increased responsibility to conserve it.

Actually delineating boundaries of sites in the uplands also might prove problematic. There are few convenient ownership boundaries to follow as might be the case, for example, with a hay meadow. It is also an accepted principle that ecological units should be designated as a whole so that, for example, a whole watershed might need to be defined to encompass the catchment area supporting an area of blanket bog.

These lines of reasoning begin to argue for designation of the greater proportion of the hill land but this approach may then encompass artificial habitats such as the conifer plantations. The Department of Agriculture is also responsible for forestry in the Isle of Man and consideration will have to be given to this aspect before designation can take place. Designation is ultimately at the discretion of the Department, even if it is of the opinion that a particular site has high conservation value. These are political decisions, to be taken after the Wildlife Committee has offered its scientific advice.

Regional indicative forestry strategies and their implications for the Isle of Man

Dr MAIRI D COOPER
Vertebrate Ecology and Conservation Branch, Joint Nature Conservation Committee

Forest and woodland currently covers 10% of the land surface of the UK. In 1987, the UK Government announced a target to increase this area by 33,000 hectares of new planting per year but not all land is suitable for forestry, and new planting currently shows a marked geographical trend towards the northern and western uplands where land prices are low, soil is poor, the climate is wet and agriculture is less profitable. However, these areas often have large expanses of natural and semi-natural open ground including bogs, moorland, mountains and rough grazing, and consequently support a correspondingly high natural value. One of the main threats to nature conservation in the UK is the loss and fragmentation of such biotopes and subsequent replacement by large-scale afforestation, a practice which has now become the principle factor in the loss of semi-natural habitats in the UK.

Such dramatic changes in land use highlight the need for an integrated approach to land use planning. In recognition of this, in 1987, the Council of Scottish Local Authorities (COSLA) recommended that each Regional Council should prepare a Regional Indicative Forestry Strategy as part of their Regional Structure Plan to inform decisions for future proposals. These recommendations were subsequently enshrined in a Scottish Development Department circular (No. 13/1990: *Indicative Forestry Strategies*) which defined the aims of the plan as:

"*.... to present a broad assessment, at a Regional level and on an outline basis, of the opportunities for new planting...[taking]....account of the environment and other factors*".

Recommendations were made that areas subject to the assessment should be described according to their suitability for afforestation, that is *preferred*, *potential* or *sensitive*. These recommendations have been adopted subsequently, in a modified format, for England and Wales through circulars issued by the Department of the Environment and the Welsh Office (Nos. 29/92 NS 61/92 respectively).

The impact of forestry

Forestry practices are similar throughout Britain although the amount of preparation depends largely on local conditions. Initially the area to be planted is fenced off to exclude sheep, deer and goats. Depending on the usual level of grazing, this may alter the dynamics of an area forcing grazing animals on to adjacent land. The area is then ploughed deeply with a continuous furrow and fertilisers and herbicides applied in the upturned ridges. By approximately 10 to 15 years after planting, the young trees have grown to thicket stage and the canopy is closed, resulting in the loss of ground vegetation and potentially adverse effects on the soil ecosystem. Apart from thinning, which may take place at 15 to 25 years, the plantation is left to be clear-felled between 30 and 50 years, after which the area will not be re-stocked for a minimum of three years when the management regime is repeated.

Afforestation on open ground habitats has a profound effect on the local ecology, with an accelerated succession from open ground habitat to closed plantation. Ornithologically, the net result is the loss of high interest bird assemblages dependant on a mosaic of habitat types, in favour of species characteristic of scrub and woodland ecosystems. In particular, predatory and scavenging birds, upland waders, grouse and several small passerine species are all adversely affected by afforestation in the uplands.

The effects are both direct and indirect. Direct effect manifest as loss of feeding areas and breeding sites, particularly for upland waders which are displaced almost immediately following planting, and territory desertion and non-breeding which occurs in a number of predatory and scavenging species. Species with dispersed populations, for example the Golden Eagle and Merlin, depend on large areas of moorland and hill for feeding and breeding, and these species are, consequently, highly vulnerable to habitat fragmentation. Indirect effects can also occur. These may be illustrated by acidification of water bodies and the effects of plantations on bird species breeding on adjacent open-ground: new plantations hold larger populations of predatory species than open areas, resulting in reduced and nonbreeding in those species nesting on adjacent areas.

Fragmentation of sheep walk or grouse moor may also disrupt the management practices in the remaining unplanted areas. This causes changes in the vegetation which may not favour species preferring a short sward, but may favour others, for example the Hen Harrier, which prefers an uneven sward. While the possibility arises, therefore, that some species may use the early stages of the new planting and moorland succession to their advantage, this is temporary until conditions surpass the favourable habitat and cannot, therefore, be considered an advantage of afforestation.

International obligations

Under the terms of the EC Directive on the Conservation of Wild Birds (EC/79/409 - the "Birds Directive"), the UK is required to maintain populations of naturally occurring wild birds including the designation of Special Protection Areas (SPAs) and measures taken to prevent damage to, or deterioration of, the habitat of these species *outwith* these designated areas (Article 4). The UK is also Signatory to the EC Habitats Directive (EC/92/43) which requires States, where possible, to protect landscape features which are essential for the migration, dispersal and genetic exchange of wild species (Article 10). Clearly the maintenance and protection of important open ground habitat is an international responsibility which should be taken into account when locating areas for new planting. For this reason, it is important that information is made available to ensure that strategic planning of afforestation takes account of the requirements of nature conservation. In 1987, the COSLA recommendations defined a need for full assessment of the nature conservation interest of each area and it was for this reason that the analysis described in this paper was undertaken.

Ornithological evaluation

The purpose of the analysis was to evaluate the ornithological interest of open ground throughout each Scottish Region. This is described in terms of the abundance, distribution and nature conservation value of the birds present in each 10 km National Grid Square. Each region was stratified to show the importance of the open ground bird assemblages each 10 km square supports and the degree of sensitivity of that assemblage to future forest development. To date, reports have been prepared for nine Scottish Regions.

The work was undertaken by the Vertebrate Ecology and Conservation Branch of the Joint Nature Conservation Committee (JNCC), in collaboration with Scottish Natural Heritage, the Royal Society for the Protection of Birds, the Vincent Wildlife Trust and local Raptor Study Groups. Data were collected between 1990 and 1992 and were passed to JNCC for analysis. The results of the analysis were subsequently passed to the relevant Regional Council for incorporation into the Regional Forestry Strategy and, thereafter, contributed to the appropriate Structure Plan.

The work was based on three aims:

i) To maintain or enhance the species diversity of bird assemblages characteristic of natural and semi-natural open-ground habitats:

ii) To maintain, within the limits of normal fluctuations, populations and breeding densities of all open ground birds:

iii) To maintain the biogeographic range of open ground birds, particularly those species for which the UK has both national and international responsibility.

Methods

The analysis used bird species which are adversely affected by afforestation or have the potential to be adversely affected due to their dependence on open ground habitats. It focused on species on Annex I of the Birds Directive as those requiring special protection measures, but was restricted to upland sub-montane open ground species and excluded species such as Dotterel and Ptarmigan because they rely also on open ground habitat above the line of commercial afforestation interest.

Information on the numbers of breeding pairs of each species was collected in a 10 km square basis (for all except the Western Isles which was collected on a 2 km tetrad basis). This was selected as the level at which the ecological requirements of widely dispersed species may be assessed without compromising the security of nest locations of internationally important and threatened species.

These data were then used to evaluate the relative importance of bird species between squares using an ornithological index designed for this purpose. The index estimated the importance of each square based on the importance of each species it contained relative to the British population.

The level of importance attached to each square was proportional to the number of breeding pairs it contained, e.g. a square containing 8 pairs of Golden Plover was valued at four times more important than one containing only two pairs of birds. These values were then summed together within each square to produce a single, cumulative index of importance:

$$OI = \sum_{s=1}^{M} [1000(Ks / Ns)]$$

where

Ks = maximum number of pairs of a species per 10 km square
Ns = most recent estimate of the British population of a species
M = number of species found in 10 km square.

In order to represent the relative importance of each 10 km square in a form which could be used more readily, each square was identified with a level of ornithological interest. These were as follows:

Category	Score per 10 km square
High interest	> 67
Medium interest	10 - 66.9
Low interest	<9.9

Results

The primary output from this analysis was a series of maps illustrating areas of high, medium and low ornithological interest. These maps are indicative and do not set precise boundaries to the analysis beyond the administrative boundaries which are implicit in the approach.

High ornithological interest
Commercial afforestation is considered to pose a major threat to the species dependent on open ground habitat in these areas. A presumption against afforestation is recommended in these areas which should be classified as *sensitive* to future afforestation in the Regional Structure Plan. There are exceptions to this recommendation, where expansion of seminatural woodland by natural regeneration would enhance ornithological interest. This has the potential to increase overall bird density within the Region provided this type of expansion is well controlled and limited in extent.

Medium ornithological interest
These are generally located between - and fringing - high interest areas. Although these areas still contain important populations of vulnerable species, it is accepted that they can reasonably accommodate some commercial afforestation, albeit on a small scale. These areas have the potential for afforestation and it is recommended that strategic planning should direct future new planting away from any raptor home ranges where they consist of predominantly open ground species, locating it instead on biotopes of limited conservation value.

Afforestation often includes the practice of in-fill planting where new trees are planted between existing blocks of forest. This is also destructive in terms of open ground bird interest and often destroys the haven for species already displaced by previous forest development. This practice is, therefore, not recommended but it would be more beneficial to direct these resources away from such areas which are already heavily forested.

Low ornithological interest
These areas may reasonably be expected to be the location for future new planting. A presumption for afforestation is made in these areas which equate to the *preferred* areas of the SDD circular. However, while this technique identifies areas which are of limited value for bird species, it does not imply that they are of low interest to nature conservation in general. The conservation potential still exists for other reasons and many of the areas may contain biotopes of interest, some of which may have been designated for protection. It is important to note that this evaluation provides an analysis based purely on the ornithological interest of each area and should be integrated with similar evaluations for other interests to gain a more comprehensive analysis of the effects of afforestation.

Figures 1 and 2 illustrate the type of map resulting from the analysis. Figure 1 presents the results from an analysis of Dumfries and Galloway where, despite some areas of high bird interest, the region is predominantly low interest with hotspots of high interest. This may be contrasted with the results from Highland Region (Figure 2) where the map presents an illustration of predominantly sensitive areas, fringed with low and medium interest areas. As this map has also been prepared for an area which is targeted heavily for new planting, it provides a strategic illustration of the importance of the habitat in this area for bird assemblages.

Agriculture

A criticism which has been levelled at the use of Indicative Forestry Strategies is that the land identified as 'preferred' for afforestation is often agricultural. For example, in 1992, objections raised by Perthshire farmers claimed that Scottish Natural Heritage were trying to 'sterilise' the land by recommending the replacement of farmland with trees. While it may be preferable to recommend a replacement of agricultural land with trees in some areas, it should be recognised that the greatest benefits to biodiversity in the UK are derived from maintaining a mosaic of land-use types. The problems of wholesale substitution of existing land uses may be illustrated by the problems currently facing farmland passerines, where dramatic population declines have been attributed to changing farmland practices and the loss of low intensity habitats such as the overwinter weedy stubble fields. The new habitats created are not compatible with the life-cycle of these species, leading to rapid losses in populations. Replacement of existing management with new methods often creates as many problems as it addresses.

Implications for the Isle of Man

The main purpose of this work was to provide a method of evaluating ornithological interest within Scottish Regions and, subsequently, to incorporate this information into rural policy. Apart from establishing a basis for effective maintenance of the range and numbers of open ground birds, the inclusion of this type of information in rural policy will have great benefits which are not restricted to the bird species at the focus of the analyses: ornithological interest often relies on, and reflects, the health of the habitat in which they live and, as little is known of some other taxonomic groups, consideration of bird species in the rural landscape and afforestation programmes will benefit other species and communities relying on similar habitats.
The methodology described here was specifically designed to provide information for incorporation into rural policy. As such there are several benefits to this approach:

Rapid assessment
This method provides a useful - and rapid - evaluation of the potential effects of forestry. The algorithm requires information which is readily obtainable, although the time taken to collate this information may be the most consuming aspect. However, where there is an existing ornithological interest in the area, the time for this collation will be considerably reduced.

Flexibility
The technique may be tailor-made to fit the circumstances under which it will be applied. For example, the scale chosen for the evaluation may be selected relative to the area to be covered, or the level of detail required to make subsequent decisions. Also, the species chosen for inclusion in the analysis should reflect the importance of the area, for example the Chough on the Isle of Man.

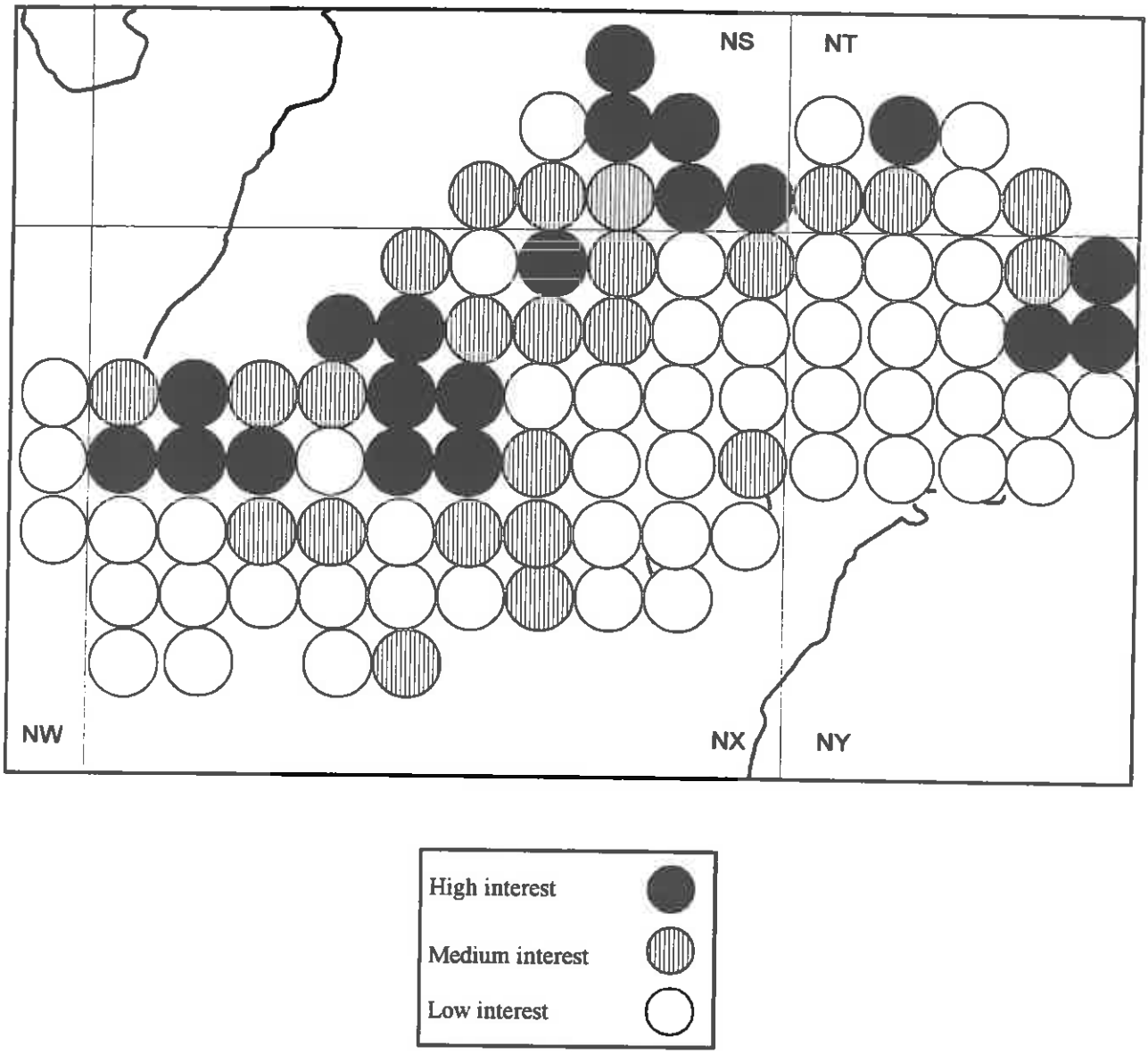
Interpretation of information
The primary output from the assessment is a readily interpretable map depicting areas recommended, and areas not recommended, for future development. This is readily accessible to specialists and non-specialists alike but may also be supported by further data if required.

Updating information
The maps presented here were prepared in 1992 for the initial development of Regional Indicative Forestry Strategies. However, the versatility of the technique allows for periodic updates of the information merely by the collation of new data. This is an essential aspect of ensuring that local authorities and other recipients of the information are kept up-to-date with current situations.

Woodland
Regional Indicative Forestry Strategies are not purely about the opportunities for new planting. A similar process of evaluation may also be carried out to ascertain the potential impacts of re-designing existing woodland using the potential impacts of individual activities. The technique is one of quantifying effects - whether this is applied to the creation or redesign of forestry plantations.

It is clear that greater pressure is being exerted on the environment and on conservationists to protect vulnerable species and habitats. This can only be done through sympathetic countryside management, including appropriate strategic planning for nature conservation interests. This technique provides a rapid and easily used method of integrating this information into this process.

Figure 1: Results of ornithological evaluation for Dumfries and Galloway



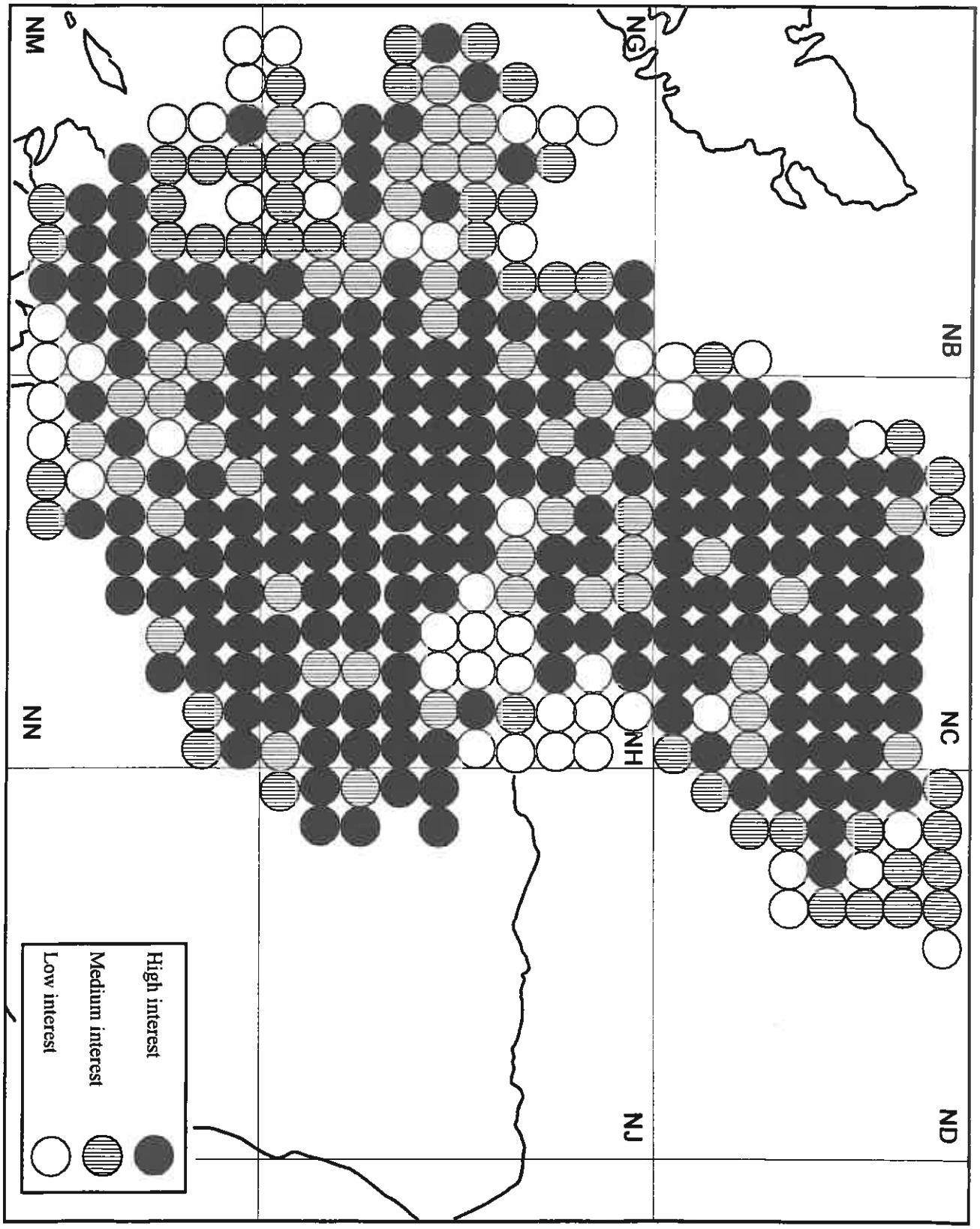


Figure 2: Results of ornithological evaluation for Highland Region

The Role of the Department of Agriculture Fisheries and Forestry (Forestry Division) in the Management of the Manx Hill Lands

R G POLLARD
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There is a long history of the management of the Manx uplands by the present Department and its predecessors. The Forestry Board was established by Act of Tynwald in 1931 and became the Forestry, Mines & Lands Board in 1950. The functions of this Board were in turn incorporated into the Department of Agriculture Fisheries and Forestry in 1986. The hill lands which were previously under the ownership of the Crown were transferred to the Forestry, Mines & Lands Board in 1949. During the whole of this time a strong land stewardship ethic has prevailed, which has resulted in the generally unspoilt nature of the hills, woodlands and glens managed by the Department today.

1 Make-up of the estate in 1995

The Forestry Amenity and Lands Division owns and manages an estate of approximately 26,000 acres (10,526 ha) equivalent to about 18% of the area of the Island.

This land ownership is predominantly in the uplands and comprises:

7222 ha	17,836 acres	Open hills and farmland
2227 ha	5,500 acres	Established Plantations
673 ha	1,664 acres	Afforestation post 1985
404 ha	1,000 acres	National Glens, Parklands and Amenity Sites

1:1 The "open hills and farmland" category breaks down into twelve main grazing tenancies, ranging in size from just 36 ha (90 acres) to 1323 ha (3270 acres). All of these tenanted lands are grazed by sheep, providing in some cases the sole livelihood of the tenant.

Since 1985 stocking densities on the majority of holdings have not significantly altered. It is important to note a major difference between the U.K. and the I.O.M. systems of Government support for hill grazing. Headage payments in the U.K. have resulted in very heavy stocking densities, and correspondingly, in some circumstances, overgrazing. On the I.O.M. payments are made per breeding ewe at a maximum level of one ewe per two acres. There is therefore a reduced financial incentive for tenants to increase stocking. In 1994 it was understood that all the main hill tenancies had stocking densities at or below this theoretical maximum, in some cases markedly below the maximum.

1.2 The "Established Plantations" category refers to all those forest and woodland sites planted, and in some cases replanted prior to 1985.

1.3 The afforestation category refers to land planted between 1985 and 1994 under the current Forestry Expansion Programme. This has averaged about 80 ha (200 acres) over the period, although the initial planting rate was considerably higher.

1.4 In order fully to understand the department's current policy of expanding the forest estate, it is necessary to have a detailed knowledge of the make-up of the forest plantations. Space and time do not permit a comprehensive summary here, but Fig. 1. shows the Age Class Distribution, in 5 year periods, as at 1994. From this it can be seen that the planting carried out between 1956 and 1970 resulted in a marked imbalance in the overall age structure. The aim of the planting programme since 1987 has been to correct this imbalance whilst providing a sufficiently large forest resource to provide for the Island's likely future requirements of agricultural/construction timber. (Note: A forest comprised of an equal area of each age class is known as a "Normal" forest, or one that has reached "Normality". The area under each age class which would be required to reach normality on the island is shown by the dotted line in Fig 1. Planting since 1991 more closely reflects this goal).

2 Brief history of forestry in the Isle of Man

The historical pattern of forest cover on the Island has broadly followed that for Great Britain as a whole, but due to several factors the island's woodland cover fell below that of the U.K. by the turn of the century to a figure of less than 1%.

Within Britain, a gradual loss of tree cover occurred over a very long period, followed by an expansion during this century, mainly after the establishment of the Forestry Commission in 1919. Available evidence suggests that the proportion of Britain covered by woodland and forest was once around 80%, but fell below 50% probably more than 2000 years ago, below 20% by 1000 AD and had reached a level of about 10% by the middle of the fourteenth century.

Although offset by some planting in the eighteenth and early nineteenth centuries the total area of woodland continued to fall, and was only 5% by 1920.

The first plantations on the Island were created on the then Crown Lands, starting in 1883. These were at South Barrule, Archallagan and Greeba. Much of these crops were clearfelled during wartime, with replanting occurring post-1946.

In 1906 a volunteer body acquired land and planted at Slieu Whallian and Gob-y-Volley. These sites were well chosen, being north-facing sheltered aspects.

The Crown Lands were transferred to the Isle of Man Government in 1949. In the same year the Government commissioned a report on the potential for forestry on the island by the then Director of Forestry for Wales, Mr. A.F. Long, OBE. Mr. Long advocated a policy of establishing 16,000 acres (6,400 ha) of plantation. In 1955 Mr. Long reviewed the programme at the request of government and adjusted the target to 12,000 acres (4,800 ha). A survey of suitable land was carried out and the availability of plantable land confirmed. Afforestation began with a 5-year programme of 400 acres per annum.

In 1960 Mr. W.A. Cadman (Deputy Surveyor of the New Forest) reported upon the 3,345 acres of plantations and 120 acres of National Glens then planted. At about this date the planting rate declined.

By 1962 the plantation area was about 4,000 acres, and by 1977 had reached the current acreage of older established plantations of about 5,000 acres.

A complete census of plantations was carried out by the U.K. Forestry Commission in 1978/79, following a report by Mr. J.H. James, Conservator of Forests, N.W. England, in 1978.

In 1980 the then Head of Forestry, Mr. I.E. Stephen, submitted a report to the Forestry, Mines and Lands Board which eventually resulted in the resolution passed by Tynwald in 1985 to double the area of plantations by the addition of 5,000 acres planted over a ten year period. This was subsequently re-evaluated in 1986 and the area of plantable land scaled down to about 3,800 acres, to be established over a longer period of about 15 years.

The factors taken into account in reaching this new programme figure were many, but included:

1) A reassessment of the silvicultural potential of each site.

2) A reassessment of the future liability for roading requirements to extract timber.

3) A reassessment of the perceived impact on the landscape.

4) A reassessment of the available records of sites of archaeological interest.

5) A reassessment of the available evidence of sites of nature conservation interest. (This preceding the Phase I Ecological Habitat Survey carried out by the Department between 1991 and 1994 under the Wildlife Act 1990).

6) The age structure of the established forest estate and forecasts of future timber production.

7) The anticipated future Island requirements for timber and timber products.

8) A reassessment of the impact of the proposed planting on the future viability of each of the Department's upland tenancies.

A further major review of the afforestation and hill land improvement programme was carried out in 1994 following a public consultation exercise. This review resulted in the removal of three proposed afforestation sites, reducing the total area of the afforestation programme begun in 1985 to 3,300 acres. (1,330 ha) The net result of these various policies and reviews, assuming the completion of the current afforestation programme, will be a forest estate of about 8,300 acres (3,360 ha) overall.

Figure 2 shows a comparison of the areas of moorland, established plantations and afforestation since 1986. It clearly shows how, given the full implementation of current afforestation proposals, an area equivalent to 17% of the unplanted hill land in 1991 would be planted, leaving 83% of the uplands as moorland. The Department feels that this level of planting maintains a satisfactory balance with the need to preserve substantial areas of the hills for landscape and conservation purposes. (This percentage equates to 16% of the uplands as they were prior to the start of the current afforestation programme).

3 Enabling legislation and current policy

The 1984 Forestry Act defines various statutory duties of the Department. The functions of the then Forestry, Mines and Lands Board are stated as follow:

"It shall be the duty of the I.O.M. Forestry, Mines and Lands Board to promote the interests of forestry, the development of afforestation and the production and supply of timber in the Island".

The importance of the multi-benefits which forestry can provide were recognised on the island as early as 1917, when the Head of Forestry at the U.K. Board of Agriculture and Fisheries, Mr. R.L. Robinson, met the Lt. Governor. Mr. Robinson's report noted that "the insular government are apprehensive that the fellings of timber which are now proceeding will seriously impair the beauty of the island and render it less attractive to visitors". Improving the appearance of the landscape has therefore been a relevant factor in Manx forestry for over half a century.

In Section 2 I have briefly discussed the background history of the current forest estate, which resulted in Tynwald approval being obtained in 1985 to carry out a forestry expansion programme up to a maximum expenditure of £1.5 million.

Moving to the present.....

The 1994 Government "Annual Review of Policies and Programmes" contained the following policy statement:

"Any new planting will be undertaken with the benefit of appropriate advice to ensure a sympathetic approach to the landscape, having due regard to physiographical features, wildlife conservation, safeguarding items of archaeological interest and to secure effective integration with agriculture".

Early in 1995 the Department approved a Forestry Policy Statement which listed the principal policy objectives as:

1 To provide a sufficient supply of timber to meet the Island's likely requirements for agricultural and basic constructional grades of timber for the foreseeable future.

2 To enhance the economic value of the plantations to a level where their productivity is maximised within the silvicultural constraints of topography, soil and climate.

3 To improve the scenic value of the plantations where modern landscape design practice permits.

4 To expand steadily the tree cover to increase the many diverse benefits that forests provide.

5 To obtain the maximum sustained financial return by sound silvicultural practice.

6 To secure good land use by effective integration with agriculture.

7 To produce a sustained yield of timber to support a local wood using industry.

8 To safeguard areas of archaeological interest.

9 To conserve and enhance biodiversity.

10 To protect forest resources.

11 To conserve and enhance the physical environment.

12 To develop opportunities for recreational enjoyment.

13 To promote a greater public understanding of the forest industry.

14 To encourage the regeneration of existing privately-owned broadleaved woodland.

15 To encourage the planting of new areas of broadleaved trees and woodlands.

16 To control the felling of healthy trees where this would result in an unacceptable loss of amenity.

Building on this policy is the acceptance by the Department that it should follow best current forest practice. To this end it has informally adopted the practices set out in the U.K. Forestry Authority "Guidelines", in particular the Forest Landscape Guidelines and the Forest and Water Guidelines.

Within the U.K. all Forest Enterprise and private sector planting grant schemes are required to conform with these guidelines, and as with many other sectors of Manx Government practice, the Department intends to follow this guidance wherever possible.

The management of an estate of 26,000 acres is inevitably a complex enterprise, requiring flexibility and understanding of many diverse factors and interests. The old adage "you can never please all of the people all of the time" will always be true in this context. It is important to recognise that the Department has many differing aims and objectives in achieving an "acceptable" level of management of this estate, and that these have been the subject of frequent changes in policy over many decades. What may be considered a correct policy one year may be seen as quite inappropriate 10 or 20 years later, yet this level of timescale is very short in forest management terms. Governments do, however, have the opportunity to ensure that rapid changes in policy do not occur to the detriment of the estate as a whole, an option frequently unavailable to private landlords where changes may be forced upon them due to tax liabilities, inheritance of property etc.

4 Current management issues

Given the nature of the landholding it is not unexpected to find that many interest groups, clubs, societies and members of the public have a view on how the uplands should be managed, and for what purpose. The Division handles over a hundred requests and enquiries each year from many private organisations wishing to hold events on the Division's land. Amongst the activities and interests covered are: shooting, orienteering, hang gliding, mountain biking, trail biking, car rallies and four wheel drive events, horse riding, industrial archaeology, public ramblage and provision of facilities for "one-off" events such as barbecues.

In considering accommodation of all of the above public access issues, the Division has first to consider the interests of those parties who pay for a legal right to occupy the

land. This primarily involves the Division's grazing and shooting tenants, but may also involve neighbouring landowners, for instance those who might have a Right of Access to their own property.

The day to day management of the uplands also involves consideration of many diverse, and sometimes conflicting, management issues. Amongst these are the treatment of the vegetation, whether it be heather, bracken, gorse or a pocket of rare plants deserving special recognition. The implementation of plans for hill land improvement in conjunction with the grazing tenant. The expansion of the forest estate onto open hill land. The influence of public access on the management of game stocks and hill sheep flocks. Peat Cutting. Protection of areas of archaeological interest. Maintenance of stone walls and other historically interesting items such as mining remains. Protection of water catchments.

It has been suggested that the Manx hills are suffering from over-grazing. Whilst the level of grazing which is most desirable from a nature conservation viewpoint may be different from that resulting from the current stocking density, those with a professional interest in sheep management have reported quite the reverse. The Farm Director for the M.A.F.F. Experimental Husbandry Farm at Redesdale, Otterburn, Northumberland, Mr. Thompson, visited the island in 1985 and reported that the low stocking rates equated to those existing in the U.K. in the 1960's. A typical comment on some of the tenancies inspected was that they were so understocked that the proposed transfer of land to forestry would have no effect on stocking rates. Mr. Thompson felt that the proposed afforestation programme was, in his view, "the best thing that could happen to the sheep industry".

In all of the above, the Division, as landowner, has a fundamental role to play. Some issues, such as access onto the hills by four wheel drive vehicles purely for fashionable and dare-devil amusement can be relatively straightforward to resolve in terms of policy decisions, but often very difficult to enforce. The initiative taken by the department in July 1994 in conjunction with the Department of Transport to impose weight restrictions on the upland "green lanes" was an example of where the Department considered the previously informal arrangements had become inadequate and additional legal powers were required.

Whilst some individuals protested loudly at the proposed weight restrictions, this is a good example of where, occasionally, government has to act for the benefit of the "silent majority", and not be side-tracked by a vociferous minority. In this particular instance, it was interesting to note that those who were objecting to the new restrictions, acknowledged the damage that their pastime was causing, but passed responsibility for the cost of making good this damage onto others.

The above brief scenario is all that time and space permit here, but is provided to give a broad base to the wide-ranging topics which management of the uplands covers.

The following issues are some of those raised during the course or a review of the afforestation programme in 1994, which I feel should receive further comment here.

4.1 Afforestation and Sustainable Forestry: 1994 Policy Review

During the summer of 1994 the Department, for the first time since 1985, invited comment from the public at large on its afforestation proposals for that year. Whilst a report was prepared and accepted by Government on the outcome of the subsequent review, the changes this review brought about may not be so well known. Briefly the main outcome of the review was :

a) Maintenance of the afforestation programme, but on a reduced scale. Three afforestation proposals totalling about 500 acres (200 Ha) were withdrawn from the programme. One site was withdrawn primarily because it was known to be a particularly valuable area for the future management and maintenance of grouse stocks. All were considered to be "sensitive" on landscape grounds

b) Replacement of the initial proposals for the afforestation of part of the Montpelier holding with a revised scheme involving the establishment of a reduced area of "semi-natural" woodland. This revision was carried out in the knowledge that the Montpelier holding was always seen as a site which lended itself to this treatment. It was recognised that subsequent afforestation sites may not provide an equal opportunity for increasing the area of broadleaved woodland. (The Montpelier holding was in fact purchased by the Department with a view to part being developed, in the long term, as an additional National Glen).

c) Confirmation by Government of the important role played by the island's plantations in the enhancement of the landscape and the provision of sites for informal public recreation.

d) Confirmation by Government of the need to maintain an afforestation programme in order to ensure long term sustainable management of the forest resource and future timber yield. The total afforestation programme was reduced to about. 3,300 acres. about. 1400 acres of which remains to be carried out.

It is interesting to note that outside the various "interest groups" who responded to the 1994 consultation, only a total of five individuals wrote to the Department to express their views, and some of these were in support of further planting.

During the course of the review Tynwald members considered a number of factors relevant to the afforestation programme. Included in this assessment was discussion of the following:

a) The current make up of the forest estate, containing many fragmented units spread throughout the Island and often managed on a multi-benefit and not purely commercial basis.

b) The value of plantations as venues for recreational activities.

c) Future demand for timber. Whilst it is not possible to forecast accurately what demand levels will exist in thirty, forty or fifty years' time, it is generally accepted that in these years world demand for timber is likely to exceed supply. Having regard to the forecast increased world wide competition for fuel and other basic resources, it is considered prudent for the Island to develop its own few natural resources. (Recent forecasts of world population growth predict a doubling over the next 60 years - the timespan required to produce a mature crop of timber on the Island).

d) The realisation in 1985 that to embark upon an afforestation programme without maintaining a consistent level of planting to give long term continuity of supply was considered likely to create future management problems of some magnitude. (Afforestation over a short period only creates an added imbalance to the already heavily imbalanced age structure of the plantations).

e) The requirement to maintain tenancies as viable farming units; where land was required for afforestation the Department, in conjunction with the tenant, to consider carrying out hill land improvement to maintain overall productivity.

f) The landscape and wildlife implications and the requirement to achieve an acceptable balance between areas of open hill and forest.

4.2 The Management of the Uplands for Red Grouse

The Department plays an important role in maintaining and encouraging game species through its involvement with shooting tenants on all the main holdings and its control of the various game seasons.

The Department has been aware for a number of years, especially since 1980, of a gradual decline in the population of Red Grouse. This problem was considered in some depth by the Department most recently in 1994 and a voluntary shooting ban was eventually agreed by the majority of the department's shooting tenants on an annually renewable basis.

Prior to the 1980's there was no firm evidence available on the island's grouse population. Enquiries indicate that the population was considerably higher than at present. Those involved in shooting in the 1960's and 1970's apparently gave little thought to conserving numbers or limiting bags due to the abundance of the species. There appeared to be no reason to suspect or predict the decline that ensued. It is understood that similar declines have been recorded on grouse moors elsewhere in Britain.

The Department invited J.D. Jackson of the Game Conservancy to inspect and report on the situation in 1980. He found stocks at a very low ebb i.e. one pair to 400 acres as opposed to one pair to 66 acres on similar land in Cumbria and North Wales. This was the situation a full 6 years prior to the current afforestation programme, which has been indicated by some as the cause of the decline in grouse numbers.

Mr. Jackson made a number of recommendations which can be summarised as follows:

a) Extension of the burning season.

b) Introduction of strip and block burning systems on a 20 year rotational basis and consideration of other means of heather control such as swiping/bush-hogging.

c) Improving predator control.

d) Restriction of shooting.

e) Encouragement of shooting tenants by offering security of tenure to those who undertake active moorland management.

All of the above were acted upon by the Department over the period 1980-1994 with the exception of item d), which was brought in during 1994. In spite of these measures, the grouse population did not recover over the period, except perhaps during 1986 when, according to returns of numbers shot, the population increased for just one season. In comparison with commercial keepered shoots in England and Scotland, no Manx hill now carries substantial grouse stocks.

In recognition of the problem faced by the department's shooting tenants, and in addition to carrying out heather management by swiping free of charge to assist the tenants with strip burning, the Department agreed to cut the annual rental paid by its shooting tenants by 50% during 1994, on the condition that the monies saved would be used specifically for the purposes of achieving improved grouse stocks. There is no evidence to date to show that the predicted loss of interest by the tenants in the management of the hills for grouse is occurring. The Department will continue to encourage and assist shooting tenants wherever possible to increase numbers and restore them to something approaching those of former times whilst monitoring the overall grouse population. To assist in this task a small consultative panel made up of a representative sample of the Department's shooting tenants was formed in June 1994 to strengthen liaison with the Department.

In conclusion on this topic I would like to quote from a report submitted to the Manx Nature Conservation Trust in February 1994 - "The moorlands of the Isle of Man are in quite a fair state generally and are being subjected locally to an excellent management regime that could - with advantage - be much more widely copied". (John Phillips).

4.3 Water catchments and afforestation

During the course of the review, various comments were received regarding the effects of afforestation on water catchments. Most of these comments were based on information received from the U.K. press and from other U.K. sources not scientifically linked to the Island situation.

For instance, claims were made that the island's Water Authority is faced with increased costs in the treatment of water and loss of supply from areas with plantations in their catchments.

Such claims are entirely without foundation. The Water Authority stated that they have no direct concerns regarding the potential for acidification of supplies, or possible losses in total yield, when commenting on the original conifer planting proposals for Montpelier. This subject was considered during the review, and the Water Authority Chairman confirmed the Authority's position in this respect.

The Water Authority calculated that the conifer planting proposals for Montpelier involved afforestation of about. 4% of the catchment, which was considered "not likely to significantly affect the interests of the Authority, either in respect of the potential effects on water quality or loss of yield, taking into account their limited scale and location". Regarding the potential loss of yield, "a figure of 0.5% or less seems realistic. From the viewpoint of loss of reliable yield the proposals cannot be considered as of major concern".

Regarding water quality, the Authority commented

"it is clear from the water quality information which is available, that a principal influence on runoff water quality is the base-deficient nature of the soil cover in the upland areas, particularly in the main catchment areas north of the central valley. Water draining the upper parts of these catchments is characteristically very soft, slightly coloured, acid, and with some natural aluminium, iron and manganese. These characteristics apply to those catchment areas which have not been afforested as much as to those which have."

The Authority further commented that the term "acid" needed qualification:

"All waters abstracted for water supply in the Island are very low indeed in dissolved minerals. This means that their buffering capacity is exceptionally low; very small amounts indeed of added alkali (lime or whatever) are required to neutralise these waters. The possible effects of present afforestation proposals on raw water quality is not a significant factor in this need for enhanced treatment; it applies equally to those catchments without any afforestation as to those with."

The views of the professionals in the island's water supply industry illustrate the importance of a full understanding of the island's supply characteristics when commenting on the possible affects of afforestation within water catchments.

5 Hill Grazing: Role within the agricultural industry

The Department, in the light of this background, has implemented the afforestation programme in a manner which has maintained each tenancy as a viable hill sheep unit. In many cases, the development of the land for afforestation has resulted in direct benefits for the Department's tenants. An injection of capital has enabled tenants to manage their hills more cost-effectively. Forest access roads have also opened up areas for the tenant and assisted directly with everyday stock management.

Internal fences have been erected to aid controlled grazing and hill land improvements have been carried out to improve overall productivity. The afforestation and hill land improvement programme is therefore playing an important role in on sector of the island's agricultural industry.

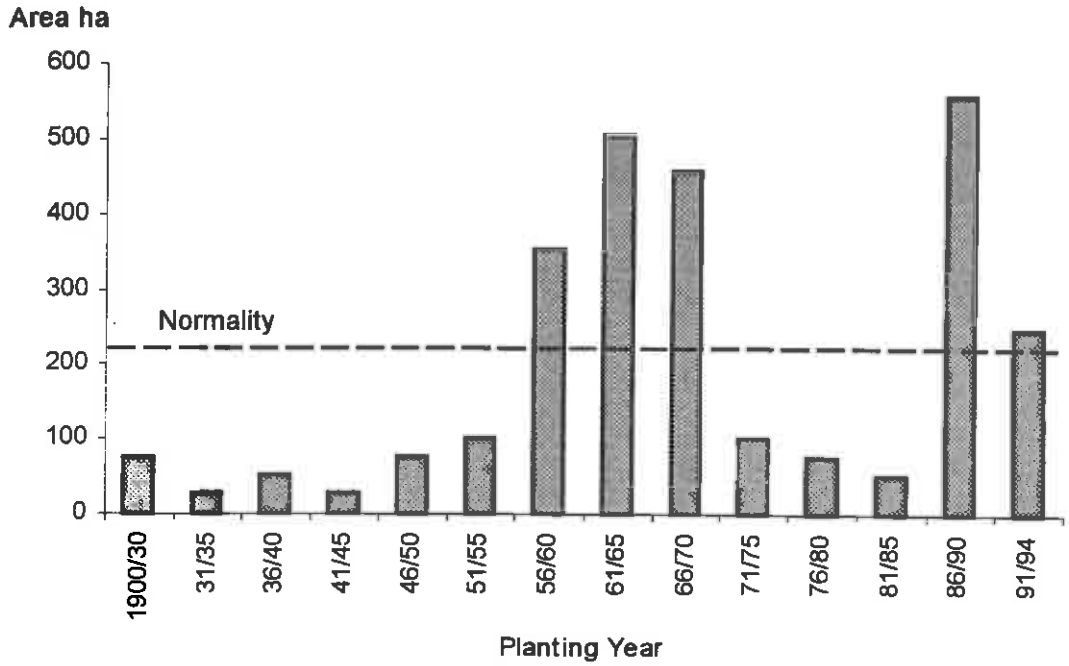
Conclusion

The Manx Hills are an important part of the government's land holdings. They are a workplace for the agricultural industry and provide the only available land for the future development of the island's timber resources. They are enjoyed by a large number of visitors and residents, both as part of the island's natural landscape and as a means of escaping the pressures of modern life. They provide a strong contrast to the lowland scene and as such are part of the varied geology, climate, topography and ecology of the Island which many find one of its most attractive features.

The Department and its predecessors have managed the hills for over half a century, whilst several of the older plantations were established on hill land over a century ago and are now coming through their second rotation.

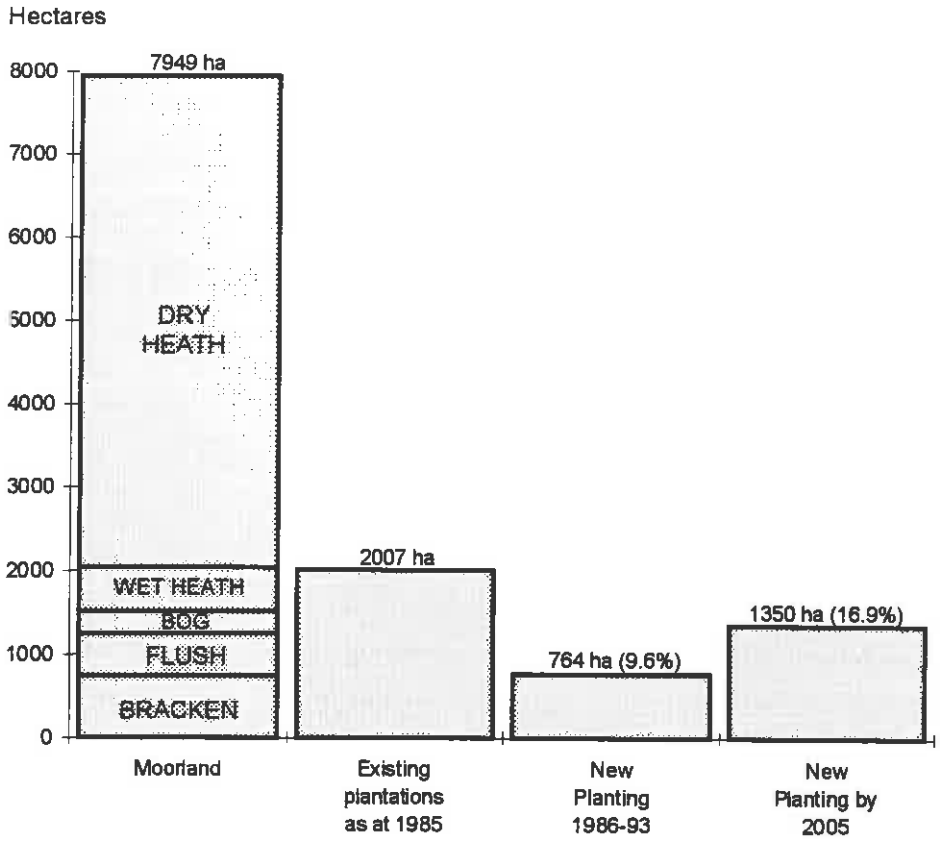
The future management of this valuable resource is a subject close to all those with an interest in the countryside. This seminar is seen as a useful forum for an exchange of views on the policies which are to shape its ongoing role in the island's history and economy.

Figure 1 Age class distribution, August 1994



Normality: this is the position reached when there is an equal area of crops within each 5 year age class. Many advantages follow, including maintenance of a sustained yield.

Figure 2 Manx Uplands: comparison of moorland established plantations and afforestation.



Upland birds of the Isle of Man and their habitats

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In this paper we seek to outline the interest of the Manx uplands for birds; assess their importance in a Manx national, UK/CI/IoM and European context; propose some objectives for upland bird conservation; and, arising from these, draw some conclusions for future land use policy. In preparing the paper we have drawn on three main sources of data:

i. Data gathered over many years by the Manx Ornithological Society (MOS) by systematic survey and submission of individual bird records. Data for the period up to the mid-1980's are summarised in 'Birds of the Isle of Man' (Cullen and Jennings, 1986). The Isle of Man has been fortunate in having many enthusiastic birdwatchers who have compiled data on key species such as Raven, Chough, Peregrine and Hen Harrier since at least the 1930's.

ii. Data on land use change and bird populations compiled by GW in 1987 (Williams 1989, 1991 a and b) from Isle of Man Government sources, original survey and the MOS, as part of a comparative study of the implications of land use policy in an EU country (the UK) and non-EU country (the Isle of Man) for birds.

iii. A 1990 RSPB survey of moorland breeding birds in the Isle of Man, undertaken primarily to provide data to enable assessment of the impact of the DAFF afforestation programme on upland birds, and especially Hen Harrier (Campbell et al 1994).

Factors affecting upland bird populations

The distribution and density of upland birds is related to four key factors (Ratcliffe 1990):

Solid geology
The chemistry, permeability to water, resistance to weathering and erosion of underlying rocks account for many of the contrasts between the regions of the British Isles. The form and elevation of the hills has a strong influence on birds. Montane species such as Snow Bunting and Ptarmigan are restricted to high altitudes, found mainly in Scotland. Rocky outcrops attract cliff nesting species. For Boreal/Arctic species - the true upland birds which breed elsewhere in Tundra and marshes, their occurrence in the British Isles reflects the restriction of 'tundra' equivalent habitats to higher altitudes. Nearly all upland breeding waders require gentle slopes of less than 15°. Hills with gentle contours and broad plateau tend to support the greatest number and diversity of upland birds.

Climate
Climate is partly determined by topography, but also latitude and the oceanic position of the British Isles. Conditions can be harsh in the uplands, especially during winter. Temperature is critical to plant growth. The combination of temperature, wind exposure and rainfall provides a great range of climate within the British Isles, with a depression of altitudinal zones of hill vegetation towards the north and west, and the associated development of peat bogs (due to low temperatures and high rainfall).

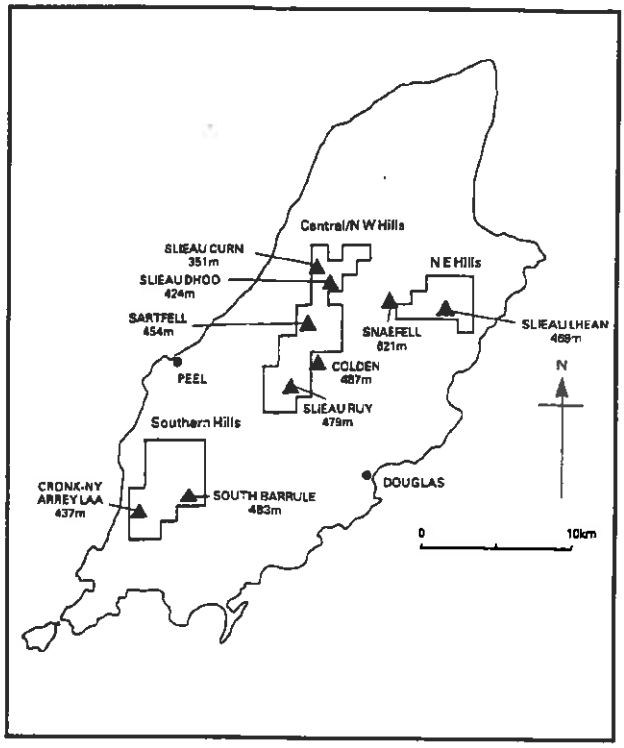
Soils
These vary according to present material, climate, steepness of slope and surface vegetation. A key factor is the amount of available calcium in the soil, which helps determine soil acidity and thus the breakdown of organic matter. The more acidic soils tend to be biologically inactive. Wetness causes leaching. Combined with low temperatures and water logging from high rainfall, this encourages peat formation as blanket bog - favoured by many upland breeding waders.

Vegetation and land use
A key factor in determining bird communities is the extent of woodland cover. In much of upland Britain, the loss of native woodland cover has caused the replacement of their bird communities with open moorland bird communities associated with open, short vegetation plant communities. Conifer afforestation programmes have had a strong influence, replacing open moorland species by woodland species - although often not those typical of original native woodlands.

So how does the Isle of Man fit the above profile? The main parent rocks are Ordovician Manx Slates with small granitic intrusions, and of low productivity. This has

produced a hilly relief with 21 peaks in excess of 400m, set in a generally smooth rounded topography. There are few plateau areas. The island enjoys an Atlantic climate, with cool summers, comparatively high rainfall in the hills of over 150cm per annum, and mild winters. The soils are silaceous podzols - poor in substance and low in nutrients. Upland vegetation communities have been significantly altered by man. It is believed the Isle of Man was once well wooded, probably with deciduous species, which were steadily cleared starting with Neolithic settlers in 2,500 BC. Deafforestation was almost complete by the 11th Century. This permitted the development of acidic, mainly dry, vegetation communities. Damper communities are scarce due to the rounded topography and subsequent lack of broad plateau. At the upland margin, areas of moorland vegetation have been enclosed for more productive agricultural use. In more recent years areas of upland have been afforested, mainly with conifer species (Garrad 1972).

Figure 1: Location of areas surveyed by RSPB in 1990. Source: Campbell et al 1994



Upland bird habitats in the Isle of Man

A land use survey undertaken by Williams (1989) to assess change in the extent of Manx upland habitats in land over 150m, which sampled 5% of 268 upland 1 km squares found (table 1):

the area of unenclosed moorland steadily decreased between 1868 and 1987, primarily due to conversion to conifers.

the area of enclosed farmland remained stable, but cropping patterns altered dramatically, with switch from arable cropping to permanent pasture.

the area of rough grassland fluctuated within the area of enclosed farmland.

The reduction in the area of open moorland and rough grazings has been less in the Isle of Man than UK. Agricultural census returns made to UK agriculture departments and the Isle of Man Department of Agriculture, Forestry and Fisheries (DAFF) for freehold rough grazings for the period 1946-81 show a decline of 12% for the Isle of Man, compared to 17% for the UK. The UK figure masks a much higher rate of loss for some countries: Wales underwent a reduction of 41%.

Table 1: Upland land use change. Mean area of land use type in ha per km square for a total sample of 13 squares. Source Williams (1989).

	1868	1956	1987	Test (a)
Moorland	38.10	35.53	26.41	1.88 ns
Rough grazing	6.94	11.47	9.47	8.58*
Crops and grass 2	43.55	39.31	40.82	4.77 ns
Divided into: crops	41.25		4.21	13.00***
grass	2.30		36.61	11.08***
Urban	1.74	1.81	1.85	0.12 ns
Semi-natural and broadleaved wood	0.30	0.52	0.87	3.85 ns
Conifer afforestation	0	1.99	11.22	1.08 ns

Note: (a) Test: Friedman two-way analysis of variance. ns = not significant. *p>0.05. ***p.0.001

Table 2: Upland vegetation communities for 64km² selected for the 1990 RSPB survey: Percentage cover. Data calculated from Campbell et al 1994.

	Central/NW	NE	S	Overall
Coniferous plantation	13	0	20	13
Unimproved acid grass	5	25	0	7
Imp./semi-imp. acid grass	12	1	21	14
Bracken	3	1	1	3
Acidic, dry dwarf shrub heath	41	56	56	46
Acidic, wet dwarf shrub heath	1	>1	2	1
Acid heath/grass mosaics	17	17	0	12
Acidic flushes	3	.1	0	1
Improved grass/acid flushes	2	0	0	1
Marshy grass/acid flushes	2	0	0	1
Acid wet heath/acid flushes	1	0	0	1
Total area (ha)	2,900	1,300	2,200	6,400

As part of the 1990 RSPB moorland survey (Campbell et al 1994), a generalised qualitative survey was made of vegetation within the 64 1 km squares selected for survey, using National Vegetation Classification methods. Of these, 22 1 km squares were in the Southern Hills, 29 in the Central/NW (Michael) Hills and 13 in the NE Hills (see figure 1). Each km square was split into four 250m x 250m blocks and the extent of vegetation in each square scored using NVC. The results are given in Table 2. Key points to note are:

the extent of dry dwarf shrub heath communities.

the scarcity of 'wet' habitats, including blanket bog, wet dwarf shrub heath and flushes.

the absence of conifer plantations in the NE hills.

the smaller area of acidic grass and acid heath/grass mosaics in the S hills, compared to the central/NW and NE hills.

The effects of ecological over-grazing by sheep were noted throughout, but particularly in the Michael hills.

The importance of Isle of Man upland vegetation communities

Two vegetation communities occurring in the Isle of Man are of intrinsic global conservation importance. Blanket bog communities (of which 105 ha of blanket bog and 93 ha of modified bog was recorded in the recent whole Island DAFF phase 1 survey (Sayle et al 1995)) are scarce on a global scale: the UK and Isle of Man holds about one tenth of the world resource (Cadbury 1987; figure 2). *Calluna* dominated dry and wet dwarf shrub heath communities are also highly restricted. Only found in limited parts of north and west Europe (figure 3), they are best represented in the moorlands of the UK, Republic of Ireland and Isle of Man. The pattern of fine-grain burning for grouse management is unique (Thompson et al 1995). The phase 1 survey recorded 5956 ha of dwarf shrub heath, of which only 310 ha was of wet communities. Outside Europe, dwarf shrub Ericaceous communities are only found in South Africa; elsewhere these are replaced by tree heathers.

Upland bird communities

In the UK, Red Grouse, Skylark and Meadow Pipit are the most abundant breeding birds and, together with Wheatear, are probably the most widespread in the uplands. In winter, the uplands are inhospitable: most of the characteristic breeding species are summer visitors or partial migrants to the uplands. The most typical wintering species are Red Grouse, Wren, Kestrel, Meadow Pipit and Raven (Fuller 1982).

Upland bird communities of the Isle of Man

The 1990 RSPB upland breeding bird survey focused on areas which might be affected by the DAFF forestry expansion programme, plus a wider survey of Hen Har-

Figure 2: Distribution of the major peat bog areas in the world. Source: Cadbury

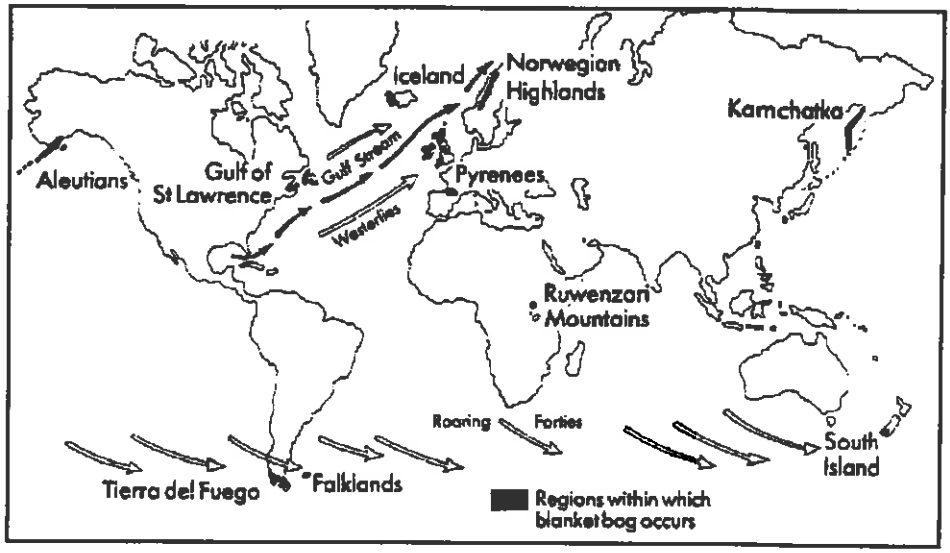
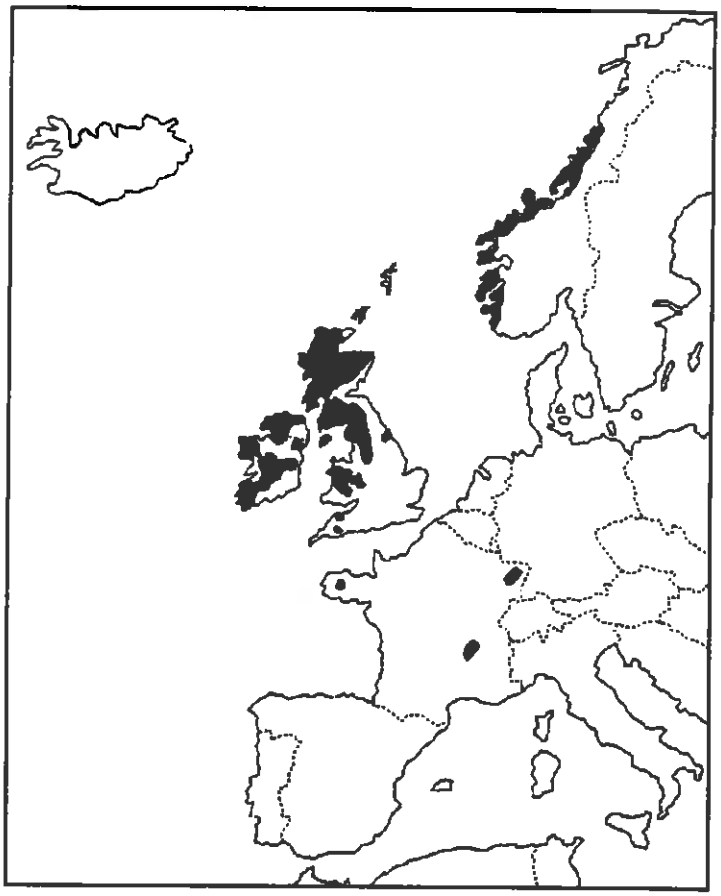


Figure 3: European distribution of heather *Calluna vulgaris* dominated upland moorland. Source: Thompson et al 1995



rier. Sixty-four 1 km squares were subject to detailed survey, using transect methods. Each 1 km square was divided into four 250 m wide transect bands and uniform systematic coverage obtained by two observers walking together down the centre of adjacent bands within groups of squares. Each area was visited twice and data recorded on 1:10,000 maps.

A wide range of typical moorland breeding species was recorded. Most notable, compared to other upland moorland blocks in the British Isles were the numbers of breeding Hen Harriers.

The data obtained from this survey, together with whole-island population estimates made from MOS records are given in tables 3-5. The data are presented according to the provisional revised UK/IoM/Channel Islands Red Data List for Birds (Avery et al 1995). This places bird species occurring in these countries into one of three categories on the basis of:

degree of threat in the UK/IoM/CI as shown by recent or historic population declines in numbers or range; rarity; or, localised distribution,

the international significance of the UK/IoM/CI population in a European context, global or European conservation status.

The three categories are:

'red'	those of high conservation concern
'amber'	those of medium conservation concern
'green'	those of satisfactory conservation status

The 'red' and 'amber' categories taken together are comparable to the 'Red Data' and 'Candidate Red Data' categories contained in the first British red data list for birds (Batten et al 1990).

Five species contained on the UK/IoM/CI 'red' list are found in the Manx uplands (table 3). Hen Harriers have undergone a severe historical decline in the UK; the Manx population represents a significant proportion of the UK/IoM population as a whole (c.6%). The Merlin has also undergone a major historical decline in the UK, although recent surveys indicate signs of a recovery. The Isle of Man population is small, although may be underestimated. The remaining three species - Skylark, Linnet and Reed Bunting - may be a surprising inclusion, but reflect a decline by over one half of the populations of these species during the last 25 years primarily due to agricultural intensification and specialisation in the UK lowlands. Securing the future of these species is becoming an element in UK agricultural policy. To date it is probable that declines of farmland birds in the Isle of Man have not occurred to as great an extent, given that agricultural land use on the Isle of Man relative to the UK is less specialised and less intensive (Williams 1989).

Twelve species found in the Isle of Man uplands are contained on the 'amber' list (table 4). Several are worth special comment. The Isle of Man Peregrine population has, in common with the UK, recovered following banning of organo-chlorine pesticides. The Isle of Man population is significant in a UK context. The Curlew is the only abundant breeding wader in the Isle of Man: Golden Plover and Dunlin are absent, and Snipe scarce, probably due to rounded topography and absence of extensive wet heath/blanket bog habitats. The Stonechat is a typical bird of gorse and heath; the Isle of Man has a significant population, primarily associated with coastal heath. Finally, the Isle of Man Chough population is of great importance in a British Isles context, holding c.22% of the UK/IoM breeding population. Although mainly of coastal distribution, associated with coastal heath and low intensity farmland, there are three inland upland breeding pairs associated with old buildings/mines and the uplands are used extensively by feeding flocks of Chough during winter.

Table 3: Upland birds of the Isle of Man.
UK / IOM / CI 'Red' list species of critical conservation concern

	RDL*	RSPB 1990 Survey		Habitat		Island total
		Pairs	Km² seen	Open moor	Conifer	
Hen Harrier	HD	19	17	*	*	40-45
Merlin	HD	-	2	*	?	0-2
Skylark	BDp	-	58	*		-
Linnet	BDp	-	14	*		-
Reed Bunting	BDp	-	8	*		

*Reasons for inclusion in RDL
HD = Historical population decline during 1800-1995
BDp = >50% decline in UK/IOM/CI breeding population over previous 25 years

Table 4: Upland birds of the Isle of Man.
UK / IOM / CI 'Amber' list species of particular conservation concern

	RDL*	RSPB 1990 Survey		Habitat		Island total
		Pairs	Km² seen	Open moor	Conifer	
Kestrel	BDMp	4	19	*		25-40
Peregrine	Eur	1	9	*		12+
Lapwing	WI	4	5	*		-
Curlew	BI/WI/Eur	29	41	*		180-300?
L B-b Gull	BI/BL	0	1	*		c90
Herring Gull	BDMp	0	1	*		-
S-e Owl	Eur	2	3	*	*	c5
Redstart	Eur	0	1			0-1
Stonechat	Eur	14	14	*		100-150
Ring Ouzel	BDMr	0	1	*		0
Goldcrest	BDMp	0	4		*	-
Chough	BL/Eur	2	13	*		63-69

Reasons for inclusion in RDL
BDMp Moderate (25-49%) decline in breeding populations
BDMr Moderate decline in breeding range
BI >20% of Eur breeding population in UK/IOM/CI
WI >20% of Eur or E. Atlantic flyway non-breeding population in UK/IOM/CI
BL >50% of breeding population in 10 or fewer sites
Eur Species with European unfavourable conservation status

Table 5: Upland birds of the Isle of Man.
UK / IOM / CI 'Green' list species of satisfactory conservation status

	RSPB 1990 Survey		Habitat		Island total
	Pairs	Km² seen	Open moor	Conifer	
Mallard	2	2	*		-
Sparrowhawk	0	2	*	*	20-30
+Red Grouse	19	19	*		60-90
Snipe	2	3	*		-
G B-b Gull	0	2	*		-
Tree Pipit	0	3	*		0-3
Meadow Pipit	0	64	*		-
Grey Wagtail	0	6	*	*	-
Pied Wagtail	0	12	*		-
Whinchat	0	13	*		10-15
Wheatear	12	44	*		20+
Wren	0	39	*	*	-
Coal Tit	0	3		*	-
Great Tit	0	2		*	-
Hooded Crow	17	49	*	*	-
Raven	5	5	*		30-40
Chaffinch	0	16		*	-
Goldfinch	0	4	*	*	-
Siskin	0	2		*	-
Redpoll	0	8		*	-
Crossbill	0	2		*	0

+ but of critical concern in an Isle of Man context

The remaining species of satisfactory conservation status at UK/IoM/CI level includes a wide range of typical upland species, including those most commonly associated with coniferous woodland such as Sparrowhawk, Coal Tit, Chaffinch, Siskin and Redpoll (table 5). Of special note is the Whinchat: in the Isle of Man as in the UK, this species is often associated with bracken/grassland mosaics with song posts (such as those provided by hawthorn bushes). Although Whinchats have declined over much of lowland UK, numbers and range have remained stable in the uplands. The Manx population is focused on the north-east hills.

This list also includes some species which although regarded as of satisfactory status at UK/IoM/CI level, are not of satisfactory status within the Isle of Man. Red Grouse in particular has undergone a severe decline from an estimated 300-500 pairs during the 1930's to 60-90 pairs now (Walker pers comm), and should be regarded as of critical conservation status in a Manx context. The breeding population of Snipe is also believed to have undergone a severe decline, although quantitative data are not available to support this.

Upland bird conservation priorities for the Isle of Man

So what are the conservation priorities for upland birds in the Isle of Man? It is suggested that highest priority should be given to those which are threatened at UK/IoM/CI level, and for which the IoM holds an important proportion of the UK/IoM/CI population, ranging to those which are not of UK/CI conservation concern, but which are in serious decline in the Isle of Man. On this basis, nine "priority" species may be identified (table 6).

Hen Harriers have undergone a long term decline in the UK, the Isle of Man population is important in a UK/IoM/CI context, being some 6% of the total.

Corncrakes are associated with late-cut grass meadows, with vegetation of greater than 20cm in height. A migratory species, the breeding population of the British Isles has been in decline since the turn of the century: the Corncrake population of the UK/IoM is now under 500 singing males, the core population being found in the Hebrides and Orkney, (Green 1995). The main declines in the Isle of Man occurred in the 1930's and 1950's and Corncrake ceased to breed regularly during the 1970's (Cullen and Jennings 1986). The species is now regarded as globally threatened. The reasons for the decline are loss of their hay meadow breeding habitats primarily to arable and permanent pasture, and introduction of mechanical cutting and earlier cutting associated with silage production. The occasional singing male - and potentially breeding Corncrake - is still recorded in the Isle of Man associated with low intensity in-bye meadows. The status of the species is so critical that the farmers managing land with Corncrake should be encouraged to delay cutting of meadows until after 1st August and, even then, to cut them in a Corncrake friendly manner - in strips or from centre-out, to enable adults and young to escape the mower (Green and Williams 1994).

Table 6: Upland bird conservation priorities for the Isle of Man

1	Species threatened in the UK/IOM/CI, where the IOM holds an important proportion of the UK/IOM/CI population. Hen Harrier
2	Globally threatened species, where the IOM does not hold an important proportion of the UK/IOM/CI population. Corncrake
3	Species seriously threatened in the UK/IOM/CI, where the IOM does not hold an important proportion of the UK/IOM/CI population. Merlin Skylark Linnet Reed Bunting
4	Other species of national conservation concern where the IOM holds an important proportion of theUK/IOM/CI population. Peregrine Chough
5	Species not of UK/CI conservation concern, but which are in serious decline in the IOM Red Grouse

The Merlin has undergone a long term decline in the UK/IoM/CI, although in the last decade its population shows signs of recovery. Breeding in the Isle of Man was not confirmed until 1986, and its population may still be under-estimated at 0-2 pairs (Cullen and Jennings 1986). Its primary requirement is the retention of Calluna moorland. Although merlins have taken to using crows nests located in conifer forests in several areas of Britain, they still need access to extensive moorland for foraging (Petty, 1995).

Skylark, Linnet and Reed Bunting have all undergone major declines in the UK of over 50% in the last 25 years primarily due to the intensification and specialisation of lowland agriculture. A key objective of agricultural policy should be to ensure that UK declines in these species are not parallelled in the Isle of Man.

In common with the UK, the Manx Peregrine population has now recovered from the impact of organo-chlorine

pesticide use. The Isle of Man population - 1% of the UK/ IoM/CI total - is of conservation significance.

The importance of the Isle of Man Chough population is well recognised. Although mainly associated with the coast, the inland breeding population of Chough should be considered in relation to upland conservation policy. In the past the inland breeding population was higher than the current population of 2-3 pairs. Management measures to ensure maintenance and provision of breeding sites (such as old mines and buildings) are of importance.

Conservation measures for Red Grouse are addressed by Newborn in this volume. The original Manx population became extinct between 1835 and 1847 probably as enclosure of land for cultivation moved up the hill and the intensity of stock grazing on the remaining unenclosed moorland, which was then held as commonland, also increased (Williams 1989). Red Grouse were reintroduced in the 1880's following a reduction in the intensity of land use and the population recovered to a peak in the early 20th century. Since then, the Red Grouse population has declined again, probably due to lack of habitat management, loss of habitat, habitat fragmentation and predation. Although increasingly intensive habitat management for this species has been undertaken in recent years, continued special conservation effort, at policy and practical levels, will be required if this species is not once again to be lost to the Isle of Man.

The Hen Harrier in the Isle of Man

Until 1963 Hen Harrier were only recorded in the Isle of Man irregularly. Between 1963 and 1971 regular reports were received on spring and autumn passage from the Calf of Man, and from 1972 records were received increasingly from the Manx mainland - associated with a period of increasing range in Britain. Breeding was first confirmed in 1977, increasing to *c*6 occupied sites by 1980. Numbers remained at around this level to the mid 1980's (Cullen and Jennings 1986). The 1990 RSPB survey identified 46 occupied sites, with breeding confirmed at 34. The total number of territorial pairs was estimated at 40-45, from which 48 young fledged (figure 4). Six polygamous and two polyandrous associations were suspected (Campbell et al 1994).

Hen Harriers were found to be distributed over a wide range of moorland and farmland fringe habitats. Most nests were found between 210-365m, which mainly reflects the altitudinal distribution of suitable moorland habitat. Seventy one per cent of nests were found close to streams or wet areas which at least partly reflects the association of dense stands of heather and *Juncus* with such areas. Details of nest site habitats are given in table 7.

Some recording of prey items was undertaken during 1990 using a combination of pellets, prey remains and direct observation. The results suggested harriers were opportunistic feeders: of 143 different prey items recorded, most (54%) were birds of which small passerines - notably Skylark and Meadow Pipit - were most frequent. The remaining 46% was mainly made up of rabbit (35% of all items) and brown rat - together the highest proportion of diet by prey weight. The frequency of rabbits reflects the absence of voles, an important food source elsewhere.

Table 7: Nest site habitat of Hen Harriers on the Isle of Man 1990. Source: Campbell et al 1994

Open heather moorland	14	(41%)
Wet acidic grassland	7	(21%)
Forestry		
Young (1-5 yrs)	6	
Failed	5	
Mature (>20 yrs)	2	
Total forestry	13	(38%)

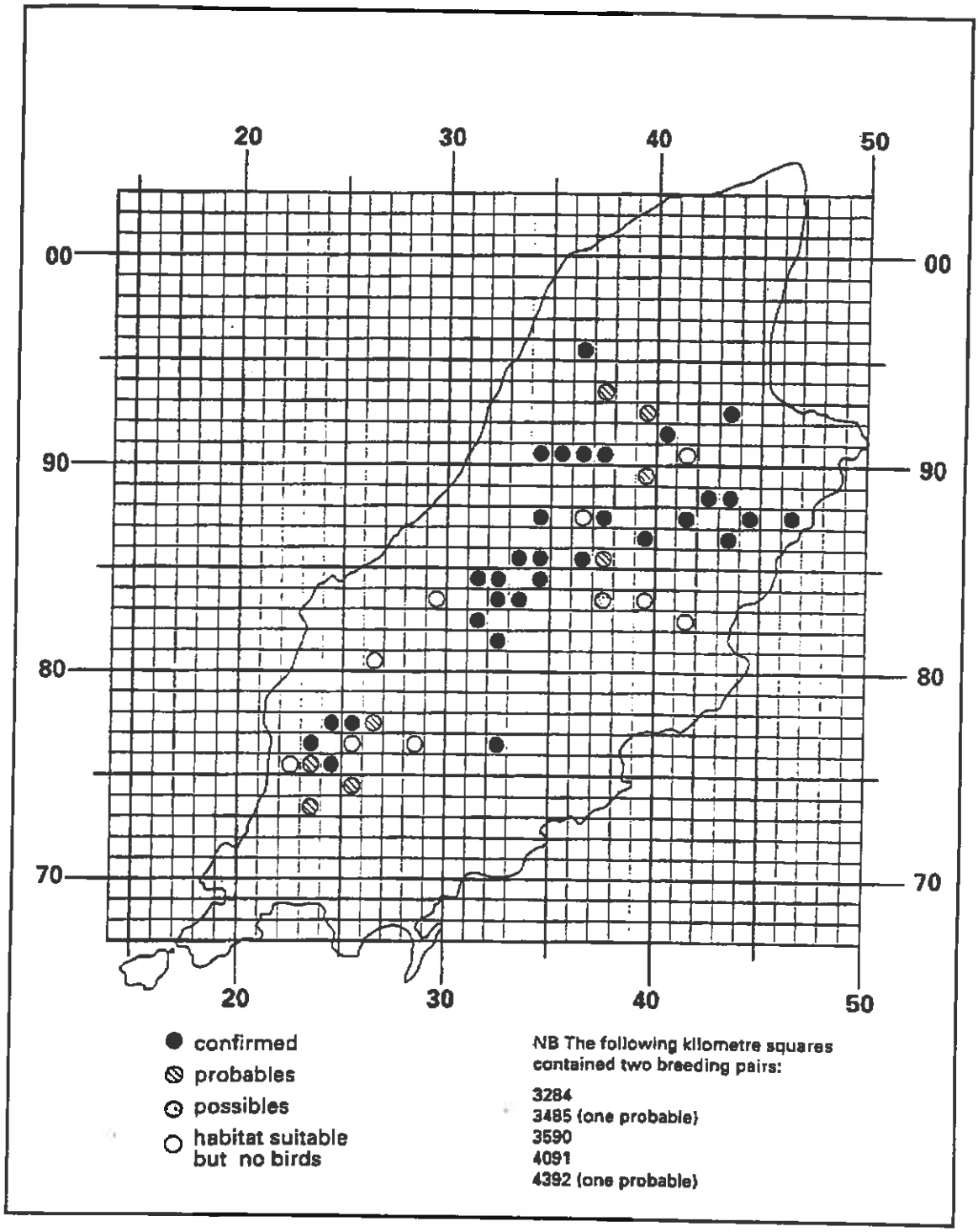
Conclusions for future upland land use policy

So what are the implications for upland management of meeting the bird conservation priorities identified above?

For open moorland, it will be important to maintain and enhance the management of existing heather moorland, and to restore heather to some areas of acid grass moorland, especially areas with degenerate heath in heather grass mosaics. This will require agricultural policy initiatives to limit ecological over-grazing of existing heather, through management of stocking densities and promotion of shepherding. To promote heather regeneration, stock removal may be required in some areas additional to these measures. In other areas, seasonal adjustments to grazing may be required: for example, heavier grazing in summer may be needed to remove *Nardus*, followed by much reduced winter grazing. Game management syndicates have a key role in heather management, especially through promotion of rotational burning. Steps to retain and enhance the extent of wet flushes (eg by blocking moor grips) would aid moorland birds.

In relation to conifer plantations, it is apparent that in bird terms there is little conservation benefit from forestry expansion: greatest bird conservation gains will be achieved through the retention, and enhanced management, of open moorland. Some forestry expansion could probably be accommodated, but careful targeting will be required to direct new plantings to areas of least interest and with the

Figure 4: Distribution of breeding Hen Harriers in the Isle of Man in 1990 by kilometre square. Source: Campbell et al 1994



least potential for restoration. Care will also be required in relation to re-planting of failed plantations - some areas of heather and *Juncus* within these plantations are of high bird importance. If expansion of forestry involves compensatory hill improvements elsewhere in the uplands as in the past, there is clear potential for additional damage. Habitat fragmentation caused by planting has created a significant problem for open moorland bird communities: the removal of some existing plantations could be of considerable ecological benefit. Restructuring of existing plantations, for example, to enhance the proportion of broadleaves, to increase ride widths and offer additional protection to streamsides, may also benefit bird communities.

Finally, in general, the enclosed farmland of the Isle of Man has retained higher ecological interest than the British mainland because Manx farming is relatively less specialised and less intensive. In future special policy measures may be required to promote retention of lower intensity, mixed farming systems - the achievement of which is now the subject of several UK agri-environment schemes.

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The political conservation situation of upland management in England, Scotland and Wales

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Management of uplands enters the realm of politics when we perceive conflicts either between man and his fellow human beings or between man and the environment. Uplands cover extremely large areas: approximately 5.43 million hectares of hill land exist in England, Scotland and Wales. This figure may increase to 7 to 7.5 million hectares depending on how much marginal land is included.

Uplands are an important part of the economy; landowners derive income from stock grazing, sporting interests and afforestation. Stock grazing tends to be a tenuous existence principally reliant on product-related subsidy mechanisms that encourage farmers to intensify in order to stay viable. However, moorland schemes and Environmentally Sensitive Areas can provide payments for less intensive stocking.

Sporting interests are important. There are approximately 460 grouse moors in the UK covering 1.5 million hectares. The return to the landowner or holder of the sporting rights may be economic or sporting. Afforestation, promoted by government grants (formally tax concessions), can be more economically attractive than grazing or game management and this creates environmental concerns.

Uplands are important for nature conservation. Mountains and moorlands form the largest extent of semi-natural habitat in Britain and their wildlife value is extremely high. Moorland reached its maximum extent around 1920 after which plantation forestry and conversion to pasture steadily reduced the areas. In 1988 the rate of afforestation (since 1950) was running at an average of 30,000ha per annum.

Our uplands are unique because of human influence and our climate; no other countries have moorlands covered so extensively by heather, or, as conservationists know it, Dwarf Shrub Heath.

The heather provides an important habitat for our unique Red Grouse, an endemic sub species of the willow grouse. Red Grouse in the UK are of international importance. Other bird species of importance include the Hen Harrier and Merlin, waders such as Golden Plover, Greenshank and Dunlin, and also Black Grouse and Ptarmigan.

The emperor moth depends on uplands and more than 50 species of ground beetle may be found on open burned areas of moorland. Mammals such as the red deer and mountain hare also depend on uplands, particularly in Scotland. As a nation the UK has international responsibilities to maintain and improve our moorlands.

In England, Scotland and Wales moorland may be covered by various conservation designations. Special Areas of Conservation (SACs) designated under the European Habitats Directive protect habitats such as raised and blanket bogs in the Cairngorms in Scotland and Stiperstones in Shropshire. Special Protection Areas (SPAs) are designated under the European Birds Directive, and areas of moorland such as the Forest of Bowland are protected by SPAs. In the UK, under the Wildlife and Countryside Act 1981, Sites of Special Scientific Interest (SSSIs) may be designated by the conservation agencies. In upland areas these tend to be large but not disproportionate to the extent of hill land available. It is important to note that wildlife does not recognise the boundaries of the SSSIs and undesignated areas may still have important wildlife value.

The SSSIs mechanisms also provide the "protection" for SPAs and SACs. Owners and occupiers have to notify the statutory agencies of any operations that they wish to undertake that might potentially damage the site and agreement has to be reached with the statutory agency for the operation to proceed or compensation to be paid.

National Nature Reserves may be designated in upland areas; these statutory reserves are either owned or managed by the statutory agencies specifically for their nature conservation value. Non statutory reserves, for example created by the RSPB or the RSNC, might also exist.

Upland areas are also important for their landscape value. The spaciousness of upland areas gives a sense of peace and solitude away from urban areas and uplands are perhaps the only areas in Britain where wilderness can be found. Large areas of upland are designated for their landscape value through National Parks or AONBs.

National Parks such as the Peak District National Park, may cover upland areas in England and Wales and these provide planning controls. Likewise Areas of Outstanding Natural Beauty (AONBs) might be given a landscape designation, with implications for planning.

Upland areas are also an important leisure resource. Casual recreation such as walking and enjoying the scenery is important, and the importance of shooting has

already been mentioned. Uplands also provide a resource for hang gliding, off road vehicles, camping, farm trails, mountain bikes etc etc.

With competition for use and resources, uplands are under threat. There are many uses and the effect of these on the conservation importance of the uplands can result in conflict of interests. For example, overgrazing by graziers or overburning can have serious impact on a heather moor. There is no doubt that we are losing moorland unique to the UK and some associated species are not faring well. Subsidies for hill farming are changing and there are increasing pressures from those seeking recreational access onto upland areas.

A very brief look at the current policies and the political situation reveals that in some areas stocking densities are being reduced through payment schemes such as the Moorland Scheme under Agri-environment Regulations. This scheme and headage payment encourages graziers to take positive measures to protect and improve the environment. Environmentally Sensitive Area schemes provide income for farmers through a tiered system of prescriptions for good environmental management including appropriate stocking densities.

In the recreation and conservation sector we are hearing increasing demands for open access. Landowners and the access lobby are working on a site by site basis to move towards local solutions to local issues. Importantly, there is increasing widespread recognition of the value of grouse management in conservation terms and there is also the recognition of pest and predator control as not just good for grouse but of value for many other moorland species. The benefits of good moorland management supported by the sporting interest is widely recognised.

The future for our uplands is in our own hands as well as the policy makers. There must be an understanding, from all those involved in upland management, over the importance of their environmental and economic values, coupled with the need for good management. There needs to be continuation and growth of support for extension of grazing but this must be linked to appropriate habitat advice. There has to be greater cooperation of all interests involved in upland management on a site by site basis and increased recognition of the need for financial or other incentives to achieve best management.

Sporting shooting and grazing are two of the most important uses of our uplands and they are not necessarily mutually exclusive. The economic and environmental benefits that accrue from good management should not be overlooked or threatened when policies for other forms of recreation such as increased access are taken into consideration. Examples exist of well managed multi-use upland areas and these should be used to highlight good practice to other moorland managers to ensure a sound future for one of our most important natural resources.

Hill sheep in the Isle of Man
(In comparison with Northern England)

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The Manx Hill land is vested in the Crown and let out to specialist hill sheep farmers in blocks subdivided by stone walls. Altogether there are 29 flocks, of which 10 carry more than 300 ewes. The three biggest hill sheep farmers (two of them with more than one block) farm 2,800, 2,300 and 1,800 hill ewes respectively. There is a total of 12,000 ewes on 30,000 acres of hill land (approx).

There are considerable differences between blocks (most of which lie above 900') in terms of potential productivity and snow risk, but the biggest difference is between the large block of Northern hills (c. 26,000 acres) and the smaller block of Southern hills (c. 4,000 acres). Northern hills are generally grassy (agrostis/fescue/nardus), with some areas of rushes, molinia and heather and bracken, while the Southern hills have a much bigger proportion of heather on shallower soils.

Heather burning is carried out in a rather haphazard manner depending a lot on when and where the opportunity arises. Some is over burned, and much is burnt rarely, if at all.

Rents are £2 to £2.50 per ewe (about £1 per acre). None of these blocks has any in-bye land naturally pertaining to them, though since tenant security came in 1969, one or two farmers have managed to buy adjoining land and use it as in-bye. This, however, remains one of the biggest handicaps to further development.

The sheep that graze the hills are of Swaledale type, with the occasional use of Scotch Blackface tups to improve conformation. The Swaledale is probably the best possible ewe given the conditions. Tups are purchased at Kirby Stephen and other marts in that area; Blackface are bought mainly from Lanark. There are a few Rough Fell sheep on one block.

Ewes spend the whole time on the hill in the vast majority of cases, and winter feeding is only resorted to in extreme conditions. Lambing success ranges from 60% on a poor hill in an unfavourable year, to 100% in exceptional circumstances and with very good management. All hill sheep farmers realise that higher lambing percentages are possible if in-bye land could be used for flushing, twin grazing and lambing, and regular winter feeding was carried out.

The replacement rate is from 20 - 25%, and subsidy is paid normally on sheep stocked at 1 sheep to 2 acres. Since hill sheep subsidy is a big part of the returns per ewe, most hill sheep are run at this stocking rate on the Manx hills. Depending on the replacement rate needed, (using pure "Scotch" tups), a proportion of the flock is put to Border Leicester or Blue Face Leicester tups, for breeding "Mule" gimmers for sale.

Sales from a typical flock would be:

Swaledale Wethers
"Mule" Wethers
"Mule" Gimmers
Cull ewes (much lower price than U.K.)
Wool

Giving a gross output per ewe per year varying between about £18 (with 60% lambing) to about £28 (with 100% lambing); this also includes £6/ewe hill sheep subsidy. The subsidy was introduced in 1969, the year that tenant security came into being. Previously, the blocks were let on a 7-year lease, and there was no guarantee that the lease would be available after that. On at least one occasion the hill stock had to be sold at "give away" prices when the lease was not renewed.

I have mentioned only sheep on the hills because neither cattle, horses or any form of reseeding are allowed.

Much of the Northern hill land *would* carry far more than ½ ewe/acre during the summer months certainly up to 1½ acre - but there are the twin limitations of the winter carrying capacity and the hill sheep subsidy limit. Consequently, our hills are never overgrazed, and I am sure that the hill sheep do not present any hazard ecologically.

The U.K. Situation

A completely different situation exists in much of the U.K., particularly in the hills of the North of England, for four main reasons:

(i) Almost all blocks have a good area of in-bye attached, historically.

(ii) The subsidy system is worked out in a completely different way, which encourages heavier stocking (or at least does not discourage it).

(iii) A great deal of research and advisory work has been done, particularly through the influence of Redesdale EHF in Northumberland, showing the advantages to be gained in intensifying hill sheep where a good block of in-

bye land is available, with twin grazing, flushing, lambing and grass conservation, and use of modern wormers.

(iv) The anticipation of sheep quotas in the immediate future has encouraged farmers to stock heavily so that a good quota can be obtained.
The results of all these are:

1 Much more *profitable* hill sheep units.

2 Much *heavier* stocking, leading to overstock in many fragile situations.

A note on profitability: for England and Wales, J.S. Nix (1990) mentions a gross output of £37 per ewe (cf. £18-£28 in the Isle of Man), and the Scottish Agricultural Colleges (1992) quote £39-£43 for the 4 systems. Even when variable costs of £7 (Nix) or £10 (S.A.C) are deducted (only £2 - £4 in the Isle of Man), these flocks remain a lot more profitable than ours, even without considering their higher stocking rate.

The biggest difference however lies in Government support. Both U.K. and I.O.M. Governments pay a Hill Sheep subsidy or its equivalent of about £6 per ewe - but in the U.K. all breeding ewes are eligible for a headage payment of £18 per ewe, made up to £24 per ewe for hill sheep.

The Manx Government also pays out a generous amount to support our sheep industry, but our headage payment goes on the lamb, rather than the ewe, so as to benefit the lowland producer of finished lamb (either his own breeding or stores from the hills).

Theoretically this should mean that Manx store lambs should make that much more than U.K. store lambs in the open market, but for various reasons there has been little difference in price between U.K. stores (which attract no further headage) and I.O.M. stores (which receive headage if they grade satisfactorily,which is by no means certain with hill breeds).

Until sheep quotas are introduced, there is no restriction on the number of hill sheep carried on the U.K. Hills. The Redesdale advice has been carried out very widely and, with developments in wormers and investment in winter sheep housing, has made these intensive hill units really practicable and profitable. The knowledge and incentives are still there. In the future there is even more to be gained from having a sheep quota (a saleable asset on retirement) and also from the various extensification schemes being belatedly introduced to the U.K.

Hill vegetation has started to suffer from the heavy stocking in many areas, and soil erosion has become more and more obvious because of stocking rates on this delicately balanced land which can be 4 times as heavy as those in the Isle of Man.

To sum up it is my contention Manx hill sheep farmers pose no problem at all to our upland ecosystem, perhaps because of purely political decisions! The real problem is in the low level of profitability of our hill sheep in comparison with U.K. farmers. One look at the equipment on U.K. hill farms - 4-wheel drive tractors (for sheep feeding), 4-wheel ATV bikes, Range Rovers and sheep housing - shows a profitable industry, yet Manx farmers have to compete for stock with these same farmers, from a completely different stand point.

Red Grouse management in the north of England

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The Red Grouse *Lagopus lagopus scoticus* is regarded by naturalists, sportsmen and scientists as a particularly British bird. Once considered the only species of bird restricted entirely to the British Isles, it is now classified as a subspecies of the widely distributed Willow Grouse. The Red Grouse differs from other subspecies of Willow Grouse in not moulting into a white plumage for the winter months and feeding mainly on ling heather *Calluna vulgaris*. Under favourable conditions Red Grouse can reach very high densities of up to 650 birds per km^2. This ability to reach such large densities under favourable management has lead to upland land owners to manage their grouse stocks to produce a surplus of birds which can be harvested in the autumn. Historically grouse shooting was mainly a sport of the aristocratic landed gentry but, with increased economic pressures and a high level of demand, many estate owners now let their grouse shooting for commercial gain. Grouse moors cover 1.5 million hectares of Upland Britain and commercial grouse shooting is an important and profitable land use in many upland areas; on some estates north of the border the sporting enterprises are the primary land uses.

Habitat requirements

Red Grouse live in and on heather, 90 % of their diet is heather, their distribution is restricted to the heather-dominated moorlands of the British Isles and they are rarely found in appreciable numbers on other types of vegetation. The vegetation community and productivity of these moors for Red Grouse vary from the drier eastern moors and Pennines with high densities in the order of 50 pairs per km2 to the wetter less productive moors on the western side and Ireland where grouse densities can be as low as 2.5 pairs per km^2. Heather, along with other components of the moorland habitat mosaic such as *sphagnum* flush areas for invertebrates, is essential for grouse management, and its maintenance and management is fundamental to grouse production.

On most British moorland, heather dominant vegetation is a successional stage which developed over the past 2500 years following large scale burning and destruction of natural upland woodland. In the majority of upland areas the re-establishment of woodland is prevented through controlled burning and careful grazing of the heather by domestic stock and deer. If these practices are neglected or badly managed then the heather can be replaced by grass and other vegetation species which are of little or no value to the grouse and of poor value to the sheep farming. Almost all grouse moors are used as rough grazing for sheep as well as for grouse shooting, and when both enterprises are correctly managed they are not mutually exclusive. Heather is not a preferred food of sheep with grasses taken in preference. However, as the grasses die back in the winter months, then the sheep have to switch to the evergreen component of the sward which is the heather. Under optimal grazing conditions, heather can withstand moderate rates of tip removal. Excessive heather tip removal does, however, lead to a reduction in the quality and quantity of heather. Continued high levels of tip removal can result in the total loss of heather from the sward. The suppressed shoot production reduces the plants' reserves and gives them the characteristic gnarled appearance of heavily grazed heather. The effects of overgrazing, in combination with the uprooting of young plants and the mechanical damage caused by trampling, can lead to the rapid loss of heather (Hudson, 1985, Hudson 1992).

Regular burning can help to rejuvenate and maintain the heather stand, but frequent large-scale or careless burning in combination with a high grazing intensity can lead to the replacement of heather by other vegetation.

Nutrition and grouse production

The production of young birds has a big influence on the number of grouse harvested from a moor. A good breeding season can produce a large bag and moors with high productivity harvest above-average bags (Hudson 1992).

Males become territorial in the late winter or early spring. During this same period the hens are spending a lot of their time feeding to improve their body condition and get themselves into breeding condition. A clutch of eggs represents a considerable investment in energy, with the average clutch of 8 eggs representing approximately 30 % of the hen's body weight. Incubation takes 22 days, after which time the chicks only stay in the nest site to dry out. After this time they accompany the adults foraging in suitable habitats. Insects are vital for chick growth and development in the first 2 weeks of their life; heather and other vegetable matter are also taken during this period with the amount increasing as the chicks increase in age.

The chicks are born from mid-May on the early moors to mid-June on the later moors. By the age of 2 weeks the chicks have the ability to flutter a few yards and by the time the chicks are a month old they have the power of flight. The chicks are almost fully grown by the 12th August, which is the start of the grouse shooting season. The Red Grouse is the only bird which has become adapted to feed predominantly on ling heather *Calluna vulgaris* all year round. Work in the North of England by the Game Conservancy Trust Upland Research Group comparing estates on the relatively rich moors in the North of England found no association between the burning regime, underlying rock and the bag records. Instead there was a correlation between bag records and the density of keepers, indicating that some other keeper-related factor, other than burning, such as predation, could be important in limiting the grouse production.

Predators and parasites

Red Grouse numbers can show remarkable fluctuations in the population from one year to the next (Potts *et al.*, 1984). Population crashes of 80% of the winter population are not uncommon on well managed moors. Most of these crashes are caused by the parasitic threadworm *Trichostrongylus tenuis*. These parasites reduce the condition and breeding productivity of the birds and lead to poor August stocks. A detailed analysis of the bag records demonstrate that the numbers of grouse shot fluctuate in a fairly regular manner, with peaks every four or five years. Field experiments have demonstrated that the disease is important in reducing the breeding performance and bag size. The sheep tick *Ixodes ricinus* is an ectoparasite of sheep and grouse and it transmits a number of diseases. One of these, known as louping ill, is a virus infection of the central nervous system, transmitted to grouse after the tick has fed on the blood of another infected host. Studies have shown that up to 80% of grouse chicks infected with louping ill can die. This results in a reduction in the over all bags (Duncan *et al.*, 1978). Control of ticks is principally by the dipping of sheep during periods of tick activity so that all ticks coming into contact with sheep are killed. In theory, sheep dipping could reduce or even eliminate the population of ticks, but in practice the poor persistence of the dipping chemical, the presence of alternative hosts and compensatory tick survival appear to prevent extermination.

Grouse show a variety of predator-avoidance tactics, which suggest the importance of predation as a factor reducing survival and production. It is often the opportunistic predators such as the fox and Carrion Crow, which are most effective in reducing production. These predators are generalists, frequently feeding on man's refuse and sheep carrion during the winter, but change their diet as the relative availability of the food type changes. In the spring when hen grouse start laying and incubating, their relative availability as a food source increases and the predators switch to the birds and their eggs and chicks, so reducing the potential harvest of grouse. Grouse production requires the employment of keen, active keepers, ideally one to every 3000 acres. The more keepers there are in an area the greater their effect on the predators is and the greater the average bags tend to be. When few keepers remain in an area it is difficult for them to control the principal predators of grouse - the fox, Carrion/ Hooded crow and stoat.

Value of moorland management

In the North of England, the subsidies to hill farmers have encouraged an increased grazing intensity on heather ground, leading to a loss of heather and a decrease in grouse stocks. Once the valuable shooting rights are lost, land values fall and many moors are then planted with conifers. Replacement of moorland with commercial forestry can have far- reaching repercussions on the area's environment, landscape value and the social fabric of the upland communities. The ecological effects of loss of heather habitat and afforestation can also be far reaching. An increase in the density of breeding passerine birds may result but most of these birds are already common and this change is often to the detriment of many of the specialised moorland breeding species such as waders and birds of prey (Hudson 1992). Plantations tend to fragment the populations of upland birds, provide refuge for predators and put curbs on management procedures such as heather burning because of the risk of fire spreading into the wood. Grouse shooting interests certainly play an important part in maintaining nature conservation and economic values. Once these values disappear then the habitat can rapidly degenerate, resulting in a loss to the whole ecosystem.

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Upland ground beetles and afforestation

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The ground beetles (Carabidae) are one of the major families of Coleoptera, with 349 species in Britain, nearly 10% of the total beetle fauna. Because of their medium to large size, taxonomic stability and availability of keys for identification (e.g. Lindroth 1974; Forsythe 1987) they are well studied by many entomologists. Most species are carnivorous predators or are omnivorous, although a minority feed on plant material, sometimes being seed predators. The life cycle is usually annual, with either spring/summer or autumn breeding, but a number of the larger species live for two or more years, and breed in more than one season. The biology and ecology of the family is reviewed by Thiele (1977), and in an agricultural context by Luff (1987). There have also been a series of symposium volumes devoted solely to carabids (e.g. den Boer *et al.* 1986, Stork 1990, Desender *et al.* 1994).

Most species of temperate carabids are active on the ground surface, and can readily be caught by simple pitfall traps set into the soil. This has lead to many studies which assess the ground beetle fauna of a particular site or habitat by pitfall trapping (see general references above). The ground beetle assemblage in any geographical region depends on environmental factors such as soil moisture, soil texture and drainage, vegetation cover type and altitude (Luff *et al.* 1989). A classification by these authors of all available ground beetle records in north east England identified 10 ecologically meaningful habitat groups, including uplands (two types) and woodland (one type).

Upland carabid assemblages have been further subdivided by Butterfield and Coulson (1983), Luff & Rushton (1989), Rushton *et al.* (1989) and Holmes *et al.* (1993); the important common factors identified by these works were substrate moisture, nutrient status, and management including grazing regime and soil disturbance. The ground beetles of woodland/forest habitats in Britain have been analysed by Butterfield (1992) and Butterfield & Malvido (1992) who show a clear distinction between the carabid fauna of forest and that of moorland. Within any particular wood however, the species present are largely a subset of those present in the surrounding open habitats, and are determined more by altitude and surrounding habitat type than by features of the wood itself (Eyre & Luff 1994). Both Butterfield (1994) and Butterfield *et al.* (1995) show that the species richness of ground beetles is substantially affected by afforestation of upland habitats.

The purpose of this paper is to outline the limited knowledge of ground beetles of the Manx uplands, to present more detailed data on some effects of afforestation on upland Carabidae, and to consider whether these effects might also apply to the Manx ground beetle fauna.

Manx ground beetles

Historical

The Manx list of Coleoptera (Britten 1943-46) includes 120 species of Carabidae, about one third of the British fauna: further recent additions (Luff 1987, 1989, 1990, 1995) bring the total to 136 species. Of these, only 11 species occur either only, or typically, in the uplands, either on the island or mainland Britain (Table 1), but this is more than half of the 19 or so 'upland' specialist species

Table1: Upland ground beetles previously recorded from the Isle of Man, with their typical habitat. Sources of records: B (Britten 1943-46), L1 (Luff 1987), L2 (Luff 1989).

Species	Source of record	Typical habitat
Carabus arvensis Herbst	B	wet moor and grassland
Carabus nitens L.	B	wet flushes
Nebria gyllenhali (Schoenherr)	B	dry, open ground with stones
Patrobus assimilis Chaudoir	B	dry moor and grassland
Bradycellus collaris (Paykull)	L1	heather moor
Bradycellus ruficollis (Stephens)	B	heather moor
Trichocellus cognatus (Gyllenhal)	B	heather moor
Pterostichus adstrictus Eschscholtz	B	open moor
Pterostichus aethiops (Panzer)	L2	moor and grassland
Pterostichus diligens (Sturm)	B	wet moor and grassland
Olisthopus rotundatus (Paykull)	B	heather moor

that occur in northern England. A further 65 Manx species are ubiquitous, occurring at a range of altitudes, so that the possible upland ground beetle fauna on the Island comprises at least 76 species. It is notable that none of the upland species in Table 1 normally occurs in woodland, and only three species of carabid listed in Britten (1943-46), namely *Leistus fulvibarbis* Dejean, *Bembidion harpaloides* Serville and *Calathus piceus* Marsham are typically thought of as occurring solely or mainly in woodlands. The common (in northern England) upland woodland species *Agonum assimile* is listed in Britten (1943-46) as 'no definite record', implying that Britten would have expected it to occur, but it is apparently absent.

Pitfall trapping

Sites and Methods

From August to mid-September 1994, sets of nine pitfall traps were operated by the Manx Nature Conservation Trust on two upland sites at the head of Druidale. The sites were on dry heather moor at 335m altitude near Sartfell plantation (NGR SC345868) and wet open grassland with rocky outcrops at 260m near Montpelier wood (NGR SC352879) respectively. At each site, nine plastic pitfall traps, 8.5cm diameter x 10 cm deep, part filled with commercial blue antifreeze (as a preservative) were installed on 1st August 1994, and operated until 27th October. They were emptied, and the pooled catch from each site stored in 70% alcohol, on August 10th, 26th, September 7th, 29th, October 12th, 27th. All beetles in the catch were sorted at Newcastle, and identified by the author, although only the Carabidae (identified using Lindroth 1974) will be considered here.

Results

Table 2 lists the numbers of Carabidae caught on each site on each date. Fifteen species were found, but only eight were common to both sites, which had 11 (dry) and 12 (wet) species respectively. Surprisingly, *Patrobus assimilis*, the commonest species at the dry site, was completely absent from the wet site, only just over 1 km distant. The remaining commoner species occurred at both sites, although the large species *Pterostichus niger* (Schaller) was much more numerous in the 'wet' traps, as was the late autumn-breeding species *Leistus rufescens* (F.). *Pterostichus rhaeticus* Heer, which was trapped (in small numbers) only on the wet site, is a wet grassland species previously included under the name of *P. nigrita* (Paykull) (Luff 1990a). It has been found on Langness (Luff 1990b) and elsewhere on the Isle of Man (Luff 1995) and is probably widespread. Only three of the upland species listed in Table 1 were found: one of these, the single specimen of *Pterostichus aethiops*, is only the second record of this species from the Island.

Both the numbers of individual beetles trapped, and the numbers of species recorded, decreased on each trapping date from August to October (Fig. 1). The decrease in total catch in part reflects lowering temperature, and the consequently reduced beetle activity. The smaller number of species caught in the autumn is probably because many carabids are spring/early summer breeders, whose activity peaks in May-June: such species would not be active as adults at the time when these catches were made. This suggests that the assemblage of ground beetles caught in this small survey will be an under estimate of the species actually present at the sites.

Table 2: Numbers of ground beetles collected in pitfall traps in Druidale, August to October 1994. For details of sites and trapping dates see text.

Species	Date													
	Dry site							Wet site						
	1	2	3	4	5	6	**Total**	1	2	3	4	5	6	**Total**
Carabus arvensis	2	0	0	0	0	0	**2**	1	1	0	0	2	0	**4**
Leistus rufescens	1	4	2	8	3	2	**20**	0	4	2	9	13	17	**45**
Nebria salina	0	0	0	0	0	0	**0**	0	1	1	0	0	1	**3**
Notiophilus biguttatus	0	0	0	0	1	0	**1**	0	0	0	0	0	0	**0**
Patrobus assimilis	18	11	5	3	2	1	**40**	0	0	0	0	0	0	**0**
Trechus 4-striatus	0	0	0	0	0	0	**0**	0	0	0	0	1	0	**1**
Pterostichus aethiops	1	0	0	0	0	0	**1**	0	0	0	0	0	0	**0**
P. diligens	0	0	0	0	0	0	**0**	0	0	0	0	2	0	**2**
P. madidus	1	0	0	0	0	0	**1**	1	0	0	1	0	0	**2**
P. melanarius	5	2	1	1	0	0	**9**	1	0	0	0	0	0	**1**
P. niger	3	5	1	0	0	0	**9**	12	15	7	1	0	3	**36**
P. rhaeticus	0	0	0	0	0	0	**0**	2	2	0	2	0	1	**9**
Abax parallelepipedus	10	7	4	0	0	0	**21**	12	4	1	0	0	0	**17**
Agonum fuliginosum	0	1	0	0	0	0	**1**	1	0	0	0	0	0	**1**
Harpalus latus	1	0	0	0	0	0	**1**	1	0	0	0	0	0	**1**

Fig. 1: Numbers of species (bars) and individuals (points) of ground beetles caught on two upland sites in Druidale, Isle of Man, August - October 1994

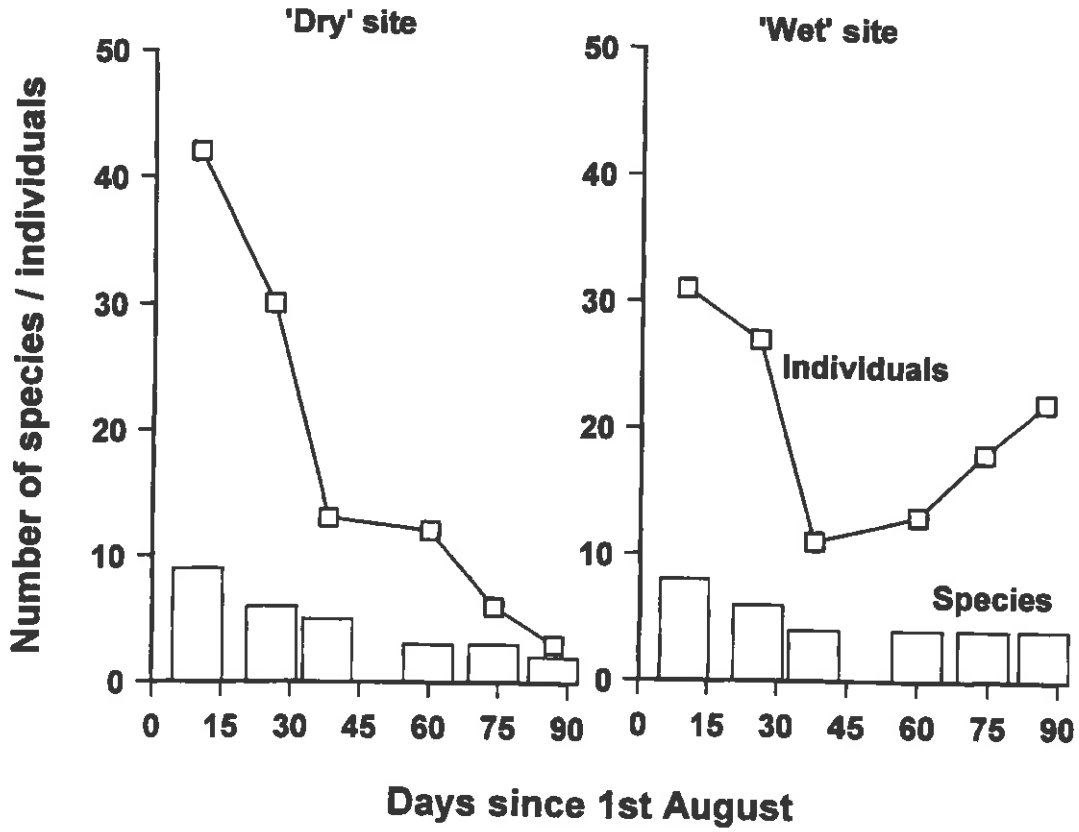
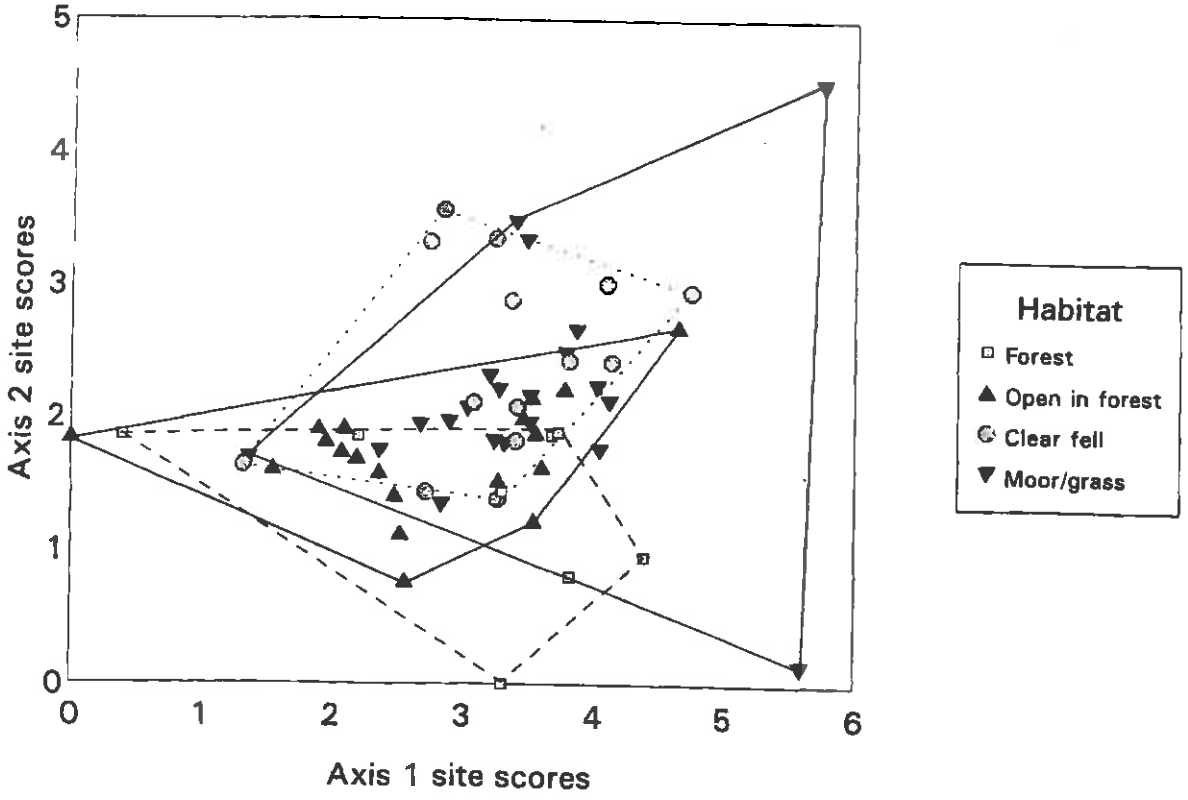


Fig. 2: CANOCO ordination of upland sites in Kielder Forest and Redesdale, Northumberland, based on the percentage contribution of each ground beetle species to the totals caught at each site. The sites belonging to each habitat type are enclosed in polygons.



Comparison with mainland upland Carabidae

The fact that the Manx upland traps were only operated in the latter part of the year, complicates comparisons with whole season pitfall catches from the mainland. Within grassland habitats as a whole, the presence of *Carabus arvensis* and *Patrobus assimilis* clearly indicate a typically upland fauna (Luff *et al.* 1992): *Nebria salina* (found on the 'wet' site) also occurs on lowland sandy sites and *Pterostichus niger* (abundant on the 'wet' site) occurs in most types of grassland (Luff *et al.* 1992). Coulson & Butterfield (1983) grouped upland non-forest carabids from northern England into five communities typical of peatlands and three of grasslands: the dry Druidale site, with many *Patrobus assimilis*, relates to their peat communities II and III, but the other two 'dominant' species, *Abax parallelepipedus* and *Leistus rufescens* did not feature prominently on any of Butterfield and Coulson's sites. On the 'wet' site at Montpelier, *Pterostichus niger* appeared to replace *P. assimilis*: this species was characteristic of their peat community IV. In a more recent classification of the carabid communities on the north Yorkshire moors, Gardner (1991) found *Agonum fuliginosum* and *Pterostichus 'nigrita'* (probably actually *P. rhaeticus*) to be indicative of wet bog habitats. But many of the ubiquitous species that occurred on all the English upland sites were not found at all, possibly, again, because of the lateness of the season's sampling.

Effects of afforestation

Methods

Because of the absence of any information on ground beetles from Manx upland plantations, inferences will instead be drawn from comparisons between moor/grass and forest carabid assemblages in northern England. Butterfield *et al.* (1995) compare the carabids of afforested uplands at two sites, Kielder and Hamsterley, in northern England. The present paper uses the same moorland data, obtained mainly by the author from Redesdale, Northumberland (NGR NY8396), together with forest pitfall data from Kielder Forest, Northumberland (NGR NY6688) and small plantations in Redesdale. Full descriptions of the habitats sampled are given in Butterfield *et al.* (1995). There were 46 sites within the forest: 12 were mature, closed canopy coniferous forest, 14 were clear-felled areas, 11 were unplanted grass/moorland and 9 were oligotrophic mires. Outside the forest there were 21 grassland and moorland sites, and one area of mire.

Pitfall traps were used as outlined for the Manx sites, but were operated usually from May to October, with fortnightly or monthly servicing. All sampling took place between 1987 and 1992. In order to compare moorland and forest sites, the total numbers of species found were compared using analysis of variance (ANOVA). The actual species compositions of the sites were compared by ordination of the sites according to their ground beetle faunas, using detrended correspondence analysis (within the program CANOCO, Ter Braak 1988). This analysis arranges sites (and species) in a multi-dimensional ordination space in such a way that the primary axes of this space represent the major sources of variability in the site/species data matrix. A scatterplot of axis 1 versus axis 2 site scores, based on the carabid fauna at each site, therefore shows the main trends in the data, with sites having a similar ground beetle fauna being close together in the scatterplot, and *vice versa*.

Results

The mean numbers of ground beetles species caught in each habitat type are given in Table 3. There were fewest species in the closed-canopy forest, followed by the open areas within the forest. Open grass and moorland outside the forest had more species still, but the highest species richness was on the clear-felled sites within the forest. The differences between habitats were highly significant ($F_{3,63} = 15.01$, $P < 0.001$). It is noticeable that all the habitats except closed canopy forest occasionally had 25 or more species; only in the mature forest was the species richness always reduced. The moors and grasslands outside the forest were the most variable in species richness; the least diverse of these sites had fewer ground beetle species in a whole season (9) than the two Manx sites had in three months (11 and 12, respectively).

The fauna of any habitat is characterised not only by how many species it supports, but also by the identity of those species. Fig. 2 shows the ordination of the pitfalled sites, based on the percentage composition that each ground beetle species comprised of the total catch at each site. Despite the apparent randomness of the scatter of sites within the ordination space, several points can be concluded.

(a) Axis 1 essentially distinguishes within forest sites, with lower scores, from moor/grass (outside the forest) sites with higher scores.

(b) Axis 2 partially separates the three within forest habitats: coniferous forest has the lowest axis 2 scores, followed by open areas (grass, mires), with clear-felled sites having the highest scores.

(c) The most variation is seen in the moor/grass sites.

(d) There is only a small region of ordination space

Table 3: Numbers of ground beetle species caught in forest and open upland sites in Kielder Forest and Redesdale, Northumberland.

		No of species		
Habitat type	No sites	Range	Mean	s.e.
Closed canopy	12	2-14	7.50	1.17
Open in forest	20	5-25	11.80	1.28
Moor/grass	21	9-26	15.71	1.15
Clear-felled	14	14-27	19.43	0.88

where all four habitats coincide, so that the ground beetle fauna of most sites are to some extent characteristic of their habitat.

(e) But the fact that all the habitat polygons overlap to some extent does stress that all these upland habitats are essentially sharing rather similar carabid faunas, but differing in the relative proportions of each species according to habitat.

The occurrences of each ground beetle species in the four habitat types were expressed as percentages of the numbers of sites in that habitat. Table 4 shows that closed canopy forest not only had the fewest species that occurred regularly (i.e. in at least 50% of all sites in any one habitat) but also had only two species that occurred more frequently than in the other habitats. The moor/grassland outside the forest, and the clear-felled areas within the forest, both had most species in each of these categories. Other open areas within the forest were again noticeably poorer than those outside.

Table 4: Numbers of ground beetle species occurring in at least 50% of sites of each habitat type in Kielder/Redesdale (A) and occurring most frequently in each habitat type (B) (excluding species that occurred in fewer than 3 sites of any one habitat type)

Habitat type	A	B
Closed canopy	2	2
Open in forest	8	6
Moor/grass	11	19
Clear-felled	18	20

Applicability to the Isle of Man

The actual percentages of occurrence in Kielder/Redesdale, of the species that were also caught in the Manx pitfall traps (Table 5) show that five of the 15 species never occurred in closed canopy forest, while a further five occurred less frequently in the forest. Three occurred more frequently in the forest than in the moor/grassland, and two were not found in the moor/grass habitat at all in the Northumberland sites. On balance therefore, two thirds of the species found on the Manx sites might be expected to occur less frequently in conifer forest (excluding clear-felled areas).

The species that might disappear include the large and brightly-coloured *Carabus arvensis*, the only species of this genus found on the Druidale sites: other species (*C. problematicus*, *C. violaceus*) occur commonly on the island, however, and might be expected to occur on both moors and in woodland. The related but much rarer *Carabus nitens* has been found in the Manx uplands, and is also absent in forest habitats on the mainland. The other ground beetles likely to be absent from closed canopy

Table 5: Percentages of occurrence of ground beetles in four habitat types in Kielder/Redesdale: species that were found in the Manx pitfall traps

Species	Forest	Open inforest	Moor/ grass	Clear -fell
Carabus arvensis	0	5	28	0
Leistus rufescens	42	75	38	100
Nebria salina	25	5	71	93
Notiophilus biguttatus	50	35	43	71
Patrobus assimilis	25	80	95	86
Trechus 4-striatus	8	0	0	71
Pterostichus aethiops	0	0	43	0
P. diligens	0	95	90	14
P. madidus	33	40	9	78
P. melanarius	0	5	14	0
P. niger	33	60	62	100
P. rhaeticus	8	75	90	93
Abax parallelepipedus	8	5	0	0
Agonum fuliginosum	8	55	52	21
Harpalus latus	0	0	5	0

forest are *Pterostichus aethiops*, only known on the island from two examples; *Pterostichus diligens* and *P. melanarius* which are both common species, the former associated with damp upland grassland, the latter more ubiquitous (Rushton *et al.* 1991); and *Harpalus latus*, a widespread but seldom abundant species, found on rather dry moors.

The species possibly favoured by afforestation are the common and widespread species *Leistus rufescens*, *Notiophilus biguttatus*, *Trechus quadristriatus*, *Pterostichus madidus* and *Abax parallelepipedus*. The last of these is typically a woodland species in England, although it was one of the more abundant species in both the 'wet' and 'dry' Druidale pitfall traps. This reflects the fact that ground beetles are unlikely to perceive 'forest' as such; they are more likely to respond to local conditions of soil, and soil-surface microclimate and illumination. It is the author's experience that *Abax parallelepipedus* (and possibly other 'woodland' carabids) occur more frequently in open habitats in more mild and damp climates: thus in Ireland it is a common moorland species, as appears also to be the case in the Manx samples.

This emphasises the point that any conclusions from this work can only be hypothetical. We do not know the impact of afforestation on Manx ground beetles because there has been so little detailed study of the ecology of the insect fauna of the island. In northern England, Butterfield *et al.* (1995) concluded that afforestation of the uplands reduces ground beetle diversity in the closed canopy forest, and alters the species composition to some extent. Open areas within the forest have a reduced subset of the moor/grassland species occurring outside. Clear-felled areas, however, have a rich carabid fauna (mainly of highly mobile colonising species), and contribute largely to the overall ground beetle fauna of the forest, which is

therefore as species rich overall as is the surrounding moorland. But most of the notable or rare species are absent from the forest habitats, excepting those confined to very wet mires. Generally similar results were obtained by Baguette & Gérard in Belgium, where carabid species richness ranged from 13-32 in young plantations (up to five years old) but only 11-15 in closed-canopy forest. In northern Ireland, Day & Carthy (1988) again found a decrease in carabid species when blanket bog was afforested, but in their case there was no compensating increase in the numbers of species on clear felled areas. Only similar detailed studies on the Isle of Man can answer the question as to whether similar conclusions might apply here as well.

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Non-avian vertebrates and the implications of habitat change

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The classes of species involved are described and general points about the present Manx list noted. Species found on the hill lands which are the concern of this paper are then briefly examined species-by-species in terms of their distribution and ecology. A short review of the function of the different habitat types is provided and management techniques appropriate to the interests of these species in both new and existing forestry plantations - the principal land use replacing the open semi-natural moorland habitat of the hills - are considered. Those areas of open moorland which have been recently identified for possible new planting are noted to allow specific conclusions for habitat change to be drawn. Overall, whether or not the proposed planting of open lands takes place, the survival of most non-avian vertebrate species on the Isle of Man as a whole does not depend on their hill populations, although there are a few significant exceptions to this general picture. Many opportunities for positive enhancements to be made to the artificial environment of conifer afforestation are not yet being taken up and increased resources should be devoted to legitimate conservation interests in the context of hill land management.

The non-avian or, alternatively, the non-feathered vertebrates, are represented on the Isle of Man principally by mammalian species although there are significant populations of reptiles, amphibians and freshwater fish too. A considerable proportion of the land animals are nocturnal foragers and, as a consequence, knowledge of their prevalence or indeed their existence on the Island is not always widely held. Some - the hedgehog, *Erinaceus europaeus*, the bats, *Chiroptera* spp., the common frog, *Rana temporaria*, and the lizard, *Lacerta vivipara* - are winter hibernators and in Manx tradition figure variously amongst the 'seven sleepers'(Moore, 1891) depending upon the authority consulted.

The present Manx species list for these classes, provided in full in Appendix 1, is, unsurprisingly, somewhat restricted in comparison with Britain, especially central and southern Britain. It bears a considerable resemblance to that of Ireland, however, in that it includes a large number of species known or likely to have been introduced as a result of man's activities whether intentionally or otherwise (Corbet, 1961). Some of these arrivals appear to date back to pre-historic times. A new review is currently under way of all the evidence now available on the origin of the present-day non-avian vertebrate fauna of the Island (Pooley, in prep.). There are significant absences from this fauna in terms of the uplands with which this paper is primarily concerned, including most notably deer, Cervidae spp, (in particular the red deer, *Cervus elaphus*); voles, Arvicolinae spp., (in particular the field or short-tailed vole, *Microtus agrestis*) and the adder, *Vipera beris*.

The full list of species includes some which are subject to comprehensive legal protection under the terms of section 9 and schedule 5 of the 1990 Wildlife Act (Isle of Man Government, 1990) - common lizards, common frogs, and all species of bats. Bats, together with the hedgehog and the stoat, *Mustela erminea* are also afforded limited protection against certain methods of capture under the terms of section 11 and schedule 6 of the same Act. The terms of recent Game Orders made under section 9 of the 1957 Game Act (Isle of Man Government, 1957) continue effectively to acknowledge the status of brown hares, *Lepus europaeus*, as ground game, although their cousins, the mountain hares, *Lepus timidus*, are no longer included in these Orders. A number of other species qualify as pests or vermin. In some cases this definition is universally accepted, for example in the case of common rats, *Rattus norvegicus*, or for house mice, *Mus domesticus*, infesting buildings but in other cases such as mountain hares, rabbits, *Oryctolagus cuniculus* and polecat/ferrets, *Mustela putorius/furo*, whether a species is considered a pest or not depends entirely on the context. Farming, forestry and gamekeeping interests sometimes have a legitimate interest in artificial control. The freshwater fish fauna, as everywhere, has long been very strongly influenced by both official and unofficial intervention in the interests of angling, although there are some interesting exceptions to this.

Hill land species

Most species which occur on the Island in general make at least some use of the upland areas and many do so to a greater extent than has been recognised in the past. Nearly all freshwater fish species, and this class is an impover-

ished one anyway, are found only in lowland waters; the bats find little of interest in the relatively featureless terrain of open moorland and there is to date no evidence that the free-living house mice which are found in some rural low ground areas have ventured uphill. Various introduced amphibians do not appear to have strayed far from their places of introduction near human habitation. In total, the hill land list is made up of thirteen terrestrial mammals plus the flying ones (the bats), together with one species each from the reptilia, the amphibia and the freshwater fish; a species-by-species review now follows.

The pygmy shrew, *Sorex minutus*, is widespread throughout the Island in almost all habitats excepting the interior of exotic conifer plantations and the moorlands are no exception. There is a large lowland population of the species as in Ireland (Grainger and Fairley, 1978), perhaps a result of the absence from both islands of the common shrew, *Sorex araenus*, with which the pygmy shrew is typically sympatric throughout most of its range. Taking this population together with the 'normal' upland one (Yalden, 1981), which seems to be well suited year-round to the damp micro-climate at ground level on the moors and is presumably able to escape the excesses of exposure because of its small size, the non - burrowing pygmy shrew is, in all probability, the most populous Manx wild mammal across the Island generally as well as on the hills. This perhaps serves to highlight one of the many fundamental differences in large animal ecology between the Isle of Man and Britain where the field vole has recently been proposed as the most populous wild mammal in Britain (Harris, et al, 1995). Limited assessment of the upland terrestrial invertebrate fauna (Luff, in press) is confirming the view advanced over twenty years ago (Garrad, 1972) that ground beetles are an important faunal element of the surface litter zone. Since it seems likely that these insects form a significant proportion of the diet of hill land pygmy shrews, the direct evidence of their significant presence should come as no surprise. In upland habitat terms, the most interesting ecological aspect of the dominance of the hill small mammal population by pygmy shrews is the apparent absence of the shrew equivalent of the well-known cycles of fluctuation in vole populations, which can play such a major role in upland ecology elsewhere (Tapper, 1976). The opportunist carnivorous mammals - the stoat and polecat/ferret - are known to take pygmy shrews but it can be safely assumed that this is at a level which is unlikely to affect the prey species. Similarly, by direct observation and from pellet analysis, pygmy shrews suffer limited predation by both short-eared owls, *Asio flammeus*, long-eared owls, *Asio otus* and Kestrel, *Falco tinnunculus*, but in view of the limited numbers of all three birds on the Island (Cullen and Jennings, 1986), the prey function is again unlikely to be significant to the hill shrew population. This is not necessarily true in reverse, however; the availability of pygmy shrews may well be important to predators at certain times of the year.

The similarly insectivorous hedgehog is rather different in being a widespread lowland species but a relatively uncommon occupier of the open moors. This is especially true in winter and these animals are completely absent from within conifer and mixed conifer/broadleaved plantations. This limited occupation can be attributed to the combination of a lack of winter hibernation nest opportunities on the hills and a tendency towards relatively small hill populations of some of the insect classes seemingly favoured as food by what are nevertheless generally described as unspecialised insectivores. During the summer months, hedgehogs become relatively more commonplace at altitudes up to around 400 metres a.m.s.l.

Rabbits are again principally a lowland species but, as herbivores, are now recognised as being quite common in some upland areas. Above an altitude of about 300 metres a.m.s.l., they tend to be most often associated with grass moorlands which have at least some drier ground and soils suitable for the construction of the essential burrow systems. The slopes of Snaefell and the upper Laxey River valley are examples of areas where the upland rabbit population appears at its best to rival the populations of the other lagomorph present, the mountain hare. Bracken areas often hold hill rabbit populations since they indicate drier ground. On Snaefell, rabbits have bred in open areas close to the summit in recent years (Kneale, pers. comm.).

Brown hares have their main Island stronghold on the Northern plain and on the western and northern slopes of the Central hills up to an altitude of about 350 metres a.m.s.l.; there are only a few to the east but somewhat greater numbers on the southern slopes of the Central hills. The Southern hills still appear to have a very small brown hare population which receives limited support mainly from the lower ground to the north towards Peel. Despite the availability of heather within the area grazed on the Southern hills, the hares here seem to concentrate on grasses and herbs as this species has been widely found to do along with young arable crops where available which in this context they are not (Tapper, 1991). Resting places or 'forms' tend often to be close to hedges and plantation edges.

Mountain hares are the one species of terrestrial mammal which is exclusively found inhabiting only open moorland in the Isle of Man, a feature throughout their range in Britain although not in Ireland where they are widespread and not associated with any specific landscape type (Whelan, 1985). Although some artificial transfers of mountain hares within the Island have been made in the past, they continue to be found only on the Central hills where they are rarely observed below an altitude of 200 metres a.m.s.l. In the winter months, a partial or complete white coat is acquired which lasts through to the spring and in the Island's relatively mild climate, the frequent absences of snow from the ground make the animal easy

to spot. It is ling heather, *Calluna vulgaris*, rather than the other heathers which seems to be important in its diet as noted in Scotland (Hewson, 1962) Fairly young heather in small blocks is favoured, a situation broadly similar to the preferences of red grouse, *Lagopus lagopus* (Hewson, 1976). This is especially true in winter although, with present hill sheep stocking levels on the main tenancies below the maximum permitted density of one ewe per two acres, there is no evidence of competition for grazing between sheep and mountain hares. In spring and summer when there are lactating ewes with lambs at foot but also more available herbage, these hares are observed to graze grasses and sedges quite a lot too. At all times, hares tend to avoid sheep physically as reported from Scotland (Hewson, 1990) and to range widely over the open hill not only when grazing but also when journeying between their 'forms' in old heather, long grass or gorse and feeding areas. This wide ranging behaviour emphasises the requirement of the species for significant open moorland areas free of plantations in order to survive; wide open space is in any case a key ecological requirement for a species so dependent on vigilance and speed for its survival from predation. Also, since hares are known to act as hosts for the sheep tick, *Ixodes ricinus* (Fraser & Stamp, 1987), the fact that the present population of hares is substantially derived from introductions some forty years ago probably accounts for the reported rise over this period of the incidence of tick- related diseases in hill sheep. Evidence from observation generally and from shooting bags suggests that there has been considerable fluctuation in population levels during the past ten years, perhaps a variation of up to 250 either side of a mean of the order of 500 to 600 animals. To date, although there appears to have been an increase in instances of unexplained premature mortality, there is no direct evidence that the health or reproductive capabilities of the species have been affected by the deposition of radioactive fallout from the Chernobyl nuclear installation in May 1986. The principal persistent radionuclide deposited as a result of this incident - Caesium 137 which has a halflife of 30 years - continues to be found at high levels in the body tissue of sample mountain hares taken from higher altitudes in the Central hills (McKenna, pers comm). This is to be expected in view of the Island's position within the area of maximum Chernobyl deposition in the British Isles (Smith & Clarke, 1989) and given the acidic mineral poor soils which characterise much of the moorland area. These soils retain the Caesium and allow active vegetation growth, subsequently utilised by mountain hares, to draw supplies of it from the upper soil layers. Heather has been particularly identified as a plant species which accumulates radioactive Caesium (Kennedy, Horrill and Livens, 1990).

In some localities, the fringes of the Central hills are characterised by overlapping ranges of the two hare species between altitudes of about 200 metres a.m. s.l. and about 350 metres a.m.s.l. and they are not infrequently to be seen grazing within sight of each other on pasture, as in Scotland. The relative distribution of the two hare species continues to be broadly as it was reported to be in the early 1970's (Fargher, 1977), but the incidence of overlapping in recent years appears to have been greater than was found in that study. There continues to be an interesting similarity in the distribution of populations of the two species across the habitats of the English Peak District (Yalden, in press) and the Isle of Man, with the Dark Peak corresponding to the Manx Central hills and the Southern hills to the South-western Peak moorlands. Whilst rabbits have already been noted as occurring in some parts of the Central hills at all altitudes, they are generally found in reasonable proximity to, but not together with, mountain hares. They are, of course, a much more sedentary species. Hill dwelling brown hares are so relatively scarce that very few are shot on the hills during the declared open season, whereas bags of mountain hares tend to be in proportion to the opportunity provided by relative peaks in the population cycle and in good years have totalled several hundred; rough shooting is generally irrelevant to the survival of hill land rabbits. Significant natural predators of leverets and smaller size rabbits include the opportunist carnivorous mammals and, perhaps surprisingly, the Island's important and steadily increasing population of Hen Harriers, *Circus cyaneus*. Recently reported work (Campbell, et al 1994) has indicated that the increasing population of these birds on the Isle of Man may have a diet more heavily dependent on rabbits than a study of moorlands in Northern Britain has found (Redpath, 1991). As the only mammalian prey identified in this study, rabbits appeared to account for a much greater proportion of Hen Harrier food intake than the other principal prey - small passerine birds, although clearly the absolute number of rabbits lost to harriers is insignificant to the overall rabbit population, particularly when many of the animals taken will be from lower altitudes where they are found in large numbers.

The wood mouse, *Apodemus sylvaticus*, is another example of an essentially lower ground species which ventures onto and, in small numbers, lives on the hills, particularly in and around the plantations. As one of the few mammals to show much interest in venturing into the interior of the closed canopy, it has more generally been observed to populate a wide variety of habitats provided that conditions are not too wet, which corresponds with the results of research in Ireland (Fairley, 1972). It has been observed to make some use of stone walls for shelter on the hills where these are associated with reliable food supplies. It is truly omnivorous and consumes a wide variety of food items as seasonally available including fungi, earthworms, arthropods and tree seeds; the latter two categories have been shown to be particularly important to wood mouse populations in conifer plantations (Thomson, 1986). Densities in such plantations or those predominantly composed of conifers appear, as might be expected, to be very

low compared to those typically recorded in deciduous woodlands at lower altitudes. Casual observation over several years indicates little difference between population levels in areas of spruce, *Picea* spp., compared with areas of pine *Pinus* spp. which are both low compared to those of deciduous woodland. The wood mouse is taken as prey mainly by owls, Kestrel and feral and domestic cats and also less commonly by stoats and polecat/ferrets. For owls, wood mice constitute a much more important element of their diet than in Britain, where voles and common shrews, *Sorex araneus*, are available and widely found to be taken in preference (Glue, 1970).

The common rat has proved to be a particularly successful coloniser of the Island in general and although again a predominantly low ground species, it is more widespread on the hills than was once appreciated. Its association with the inland Herring Gull, *Larus argentatus*, colonies on the western slopes of Sartfell has been recognised for some time (Garrad, 1972), but in fact it has a widespread distribution all across the hills except within plantations, although the numbers involved are but a small fraction of those lower down on farmland and along the coastal zone. Its broad habitat preference is for dense ground cover close to water, the latter being, in contrast to mice, a key requirement. It depends on a diet very similar to the wood mouse and it falls as prey, particularly at the juvenile size in late summer, to similar natural predators. As vermin it is extensively poisoned in the Island generally and both this method and trapping have been used on the hills at times in attempts to control the population when this has been considered appropriate. No dangers to predators from taking animals containing sub-lethal levels of currently-used rodenticides has been demonstrated but this remains a possibility.

Polecat/ferrets are a long-established and common species on the Isle of Man. They are considered to be a widely variable species in both size and pelage and, although the view has generally been taken that most of the population is of the dark polecat type, (Garrad, 1972), the majority of specimens collected at the author's instigation during the early months of 1995 for use in a geographically wider study of the species have had the lighter head markings indicative of feral ferrets. The population is predominantly a low ground one, but the young and failed plantations and the edges of mature ones together with any associated hedges favour shelter and hunting as do stone walls across or along roadsides on open moorland. Prey items include common rats, small lagomorphs and sometimes birds. Pygmy shrews and mice are also taken. The hill population is perhaps best described as widespread but not common, much as has been said for what seems to be one of its main prey species on the hills, the common rat. The autumn post-breeding dispersal of adults and juveniles has traditionally been associated with a perceived increase in polecat numbers on farmland as they come 'down from the hills', but there is no hard evidence available of such an easily-categorised movement. There is virtually no evidence of any poultry being taken by polecats nowadays, although it may be that this has more to do with a rapid decline in the keeping of free range birds than any lack of basic interest in a food source by polecats!

Stoats in the Isle of Man are, on appearance at least, similar to the Irish sub-species, *M. erminea hibernica* and continue to be accepted as such (King, 1989) As in Ireland, where the true weasel, *M. nivalis*, is also absent, our stoats are frequently referred to locally as 'weasels'. They have never been known to turn white in winter, which is in line with wider investigation of the pattern of this tendency in northern parts of the British Isles (Hewson & Watson, 1979). In terms of size, they are comparable to those of southern Ireland, with similar detailed pelage features to those described from specimens there. Most Manx specimens over many years have been observed to have the distinctive irregular line dividing the creamy white under fur from the brown upper coat colour (Garrad, pers. comm.) as distinct from the straight line division universally found in the English animal (Sleeman, 1987). It has been considered that, as in Britain (Sumption and Flowerdew, 1985), their numbers diminished in the wake of the arrival of myxomatosis in the mid-1950's, but present reports seem to indicate a reasonable and well-distributed population . It seems quite possible that recovery from the sudden reduction in rabbits was assisted by the ready availability of an unusually large population of common rats, known to be taken with enthusiasm (Brodie, 1988) and which now seem to be as important as rabbits are as prey. On the hills, they are to be found in association with all forms of edge habitat including hedges/walls and forest internal and external edges as well as throughout young and failed plantations. All the signs, including the relative frequency of road traffic kills over many years, indicate that total numbers of stoats on the Island are only a small fraction of the figure for polecat/ferrets. Taking account of the unique ability of the stoat amongst the small carnivores to successfully tackle prey many times larger than itself (Hewson and Healing, 1971), together with its similar interest to polecat/ferrets in ground-nesting birds, the two species would appear to be relying on very similar food sources. The list includes rabbits and common rats as already discussed together with hares, small and/or ground nesting birds and sometimes their eggs. Instances of smaller mammalian prey, particularly pygmy shrews, being taken by stoats are known, as recorded in Ireland (Sleeman, 1992). On the hills, with both stoats and polecat/ferrets showing a marked preference for movement along or near hedges/walls rather than ranging over open areas, a limit on food supply is likely to be the main factor controlling the species' populations, which may be not be so widely different on the hills as they clearly are in the lowlands. The balance between these two carnivores

certainly presents an interesting opportunity for research into their comparative population ecology on the Island, particularly in terms of developing key conservation guidelines for the stoat and such work is planned (McDonald, pers. comm.).

Potentially the most significant enigma of the current Manx mammal fauna results from the recent anonymous introduction of red foxes. This appears to have taken place in 1987, but despite increasing circumstantial evidence, no reliably documented records were forthcoming until 1990. At and since that time, despite an initial rash of supposed sightings and other evidence and a study sponsored by the Insular government (Halliwell and Macdonald, 1990) which purported to have demonstrated the presence on the Island in 1990 of at least 100 and perhaps as many as 200 to 400 animals, there has at no time been, as far as the author is concerned, either hard or even serious circumstantial evidence to indicate the existence of more than a very small number of foxes. The publication of an edited version of the 1990 research noted above under the a title referring to the rapid spread of foxes in the Isle of Man (Macdonald and Halliwell, 1994) is particularly unfortunate insofar as it perpetuates the myth. In the opinion of the author, the deductions of this work were a result of insufficiently rigorous collection of evidence compounded by the use of an inappropriate sampling framework. However, to turn to the observed evidence concerning the present population of foxes, the only current activity centres on the southern part of the Island where some of the conifer plantations seem to be functioning as base areas from which seemingly infrequent excursions are made not only onto both the open hills of the south and neighbouring farmland but also across the Central valley onto the hills and lowlands to the north. Vertebrate prey, as previously reported (Halliwell and Macdonald (1990) has been observed to consist predominantly of rabbits, although vegetable matter appears to have relatively more importance during certain seasons as usual. It is the plantations on the lower hill ground which have the clear potential for fostering any expansion in the fox population but there is simply no evidence at the moment of any significant population growth which could take advantage of this opportunity. Indeed, it is perfectly possible that this introduction will either die out naturally or remain at a level capable of elimination. The potential for detrimental effects upon the partially protected population of stoats resulting from any future increase in the number of foxes has not been considered so far but elsewhere such an effect has been demonstrated (Mulder, 1990) and so it cannot be discounted. It is perhaps unfortunate that no steps appear to have been taken by the Department of Agriculture, Fisheries and Forestry during the current fox introduction to gain full scientific value from sighting and other data by attempting to distinguish reliable reports from unreliable ones. Although this would undoubtedly have been a time-consuming business, proper intelligence is the only way forward in this matter.

Feral cats, *Felis catus*, have been defined as cats of domestic origin living at least partly independently of humans (Macdonald, 1991). The Island is no different from elsewhere in having a significant population of cats which are not wholly dependent on their domestic roots and which interact both directly and indirectly with the genuinely wild fauna. An account of the hill situation, however, demands that the existence of at least a small population of truly feral cats be acknowledged. These animals seem to have no domestic ties at all and females have been observed on the open hill in company with a litter of kittens (Walker, pers. comm.). The ecological impact of such cats has not been assessed but may be significant.

Feral goats, *Capra hircus*, no longer roam the main hill areas, but until recent times were encouraged on the basis that they would eat the grass which might lure other animals on to ledges from which they could not escape. The last flock on the Central hills survived until officially-sanctioned extermination occurred in the 1960's when this was considered the only solution which would prevent damage to forestry plantations (Garrad, 1990). Now, the sole remaining flock, which seems to amount to 30 to 40 animals, is found on the precipitous and inaccessible cliffs between Laxey Head and the Dhoon on the north-east coast of the Island.

The list of terrestrial mammals found on the hills is completed by a marsupial, the feral red-necked wallaby, *Macropus rufogriseus rufogriseus*. These animals are members of an otherwise sedentary group of free-living wallabies resident in the Ballaugh Curraghs which are descended from escapees from a captive population nearby which achieved their freedom some thirty years ago. They have periodically been observed to make foraging excursions onto the heather hills above Sulby, often to the Mount Karrin area. In demonstrating a partiality to heather, they resemble the only other group of these animals currently free-living in the British Isles, those descended from the release from a collection in the Peak District in 1940 which continue in small numbers to occupy a predominantly heather moorland area full time (Yalden and Hosey, 1971; Yalden, 1988; Harris et. al 1995). Since the Manx population is also quite small, the chances of seeing a wallaby on the hills on a particular occasion are low, but those who have seen one and been unaware of the possibility beforehand have been quite surprised to learn that their sighting was not simply a recent escape from captivity!

Moving on to the flying mammals, bats, their food and roosting requirements in the summer period are met primarily by lower ground habitat and, with the exception of one species, they are only found in association with the significant shelter and prominent line features associated with the internal and external edges of plantations. Here,

flying insects take advantage of shelter from any wind and sometimes rain and what are sometimes slightly elevated local temperatures to congregate and provide efficient feeding sites for bats (Mayle, 1990). There are few opportunities for bats to roost during the daytime in summer on the hills, so foraging bats are generally visitors from lower down. Three bat species can be observed feeding in small numbers - the pipistrelle, *Pipistrellus pipistrellus*, the brown long-eared, *Plecotus auritus*, and the whiskered, *Myotis mystacinus*. For one of these species, it has been shown that favoured habitat for foraging is where insect abundance is highest (Racey and Swift, 1985) and it is likely that this principle holds good for the other two species as well. However, it has yet to be established whether it is the adequate availability of insect food in the lowland areas or the lack of sufficient insect concentrations along plantation edges which keeps bat numbers low. Either of these explanations would also account for low usage of bat summer roosting boxes which have been placed at some plantations. The natterer's bat, *Myotis nattererii*, is slightly larger and appears to be less constrained by the relatively featureless terrain of open moorland which the smaller bats appear to avoid because of apparent difficulties with navigation by echolocation over such a landscape. This bat has been observed to visit an underground food source in the southern hills which lies on open hill land at an altitude of 250 metres a.m. s.l. during the midsummer period. There are no records of the Island's other two resident bat species, the Daubenton's, *Myotis daubentonii*, and the Leisler's, *Nyactalus leislerii*, venturing onto the hills or even the fringes of them in the summer months. The Daubenton's bat is a specialist predator of concentrations of insects found over water bodies, whilst the Leisler's bat is the largest species of all and has a corresponding desire to prey upon larger flying insects which are not found in association with either conifer plantations or open moorland The story in respect of bats in the winter is slightly different, since efficient hibernation requires relatively cool, moist and undisturbed sites that, in respect of temperature at least, are not easy to come by on the Island. Natural and artificial crevices both above and below ground in the hills are sought by hibernating Daubenton's, natterer's and whiskered bats but they are rarely easily located and no large congregations of hibernating bats of these species have yet been located.

Reptiles on the hill lands are represented by the viviparous lizard, which is widespread but apparently not common; there is, in all probability a considerably more dense low ground population of these animals. Opportunist predation on lizards is likely to be only a small aspect of their ecology but a wide variety of both birds of prey and mammals are occasionally involved. Lizards themselves are unspecialised insectivores and most habitats can provide food. The main controlling feature of their distribution is the availability of suitable summer basking sites at which these diurnally-active ectotherms can warm up for periods of activity. Good hibernation sites in hedges, dry ground or perhaps piles of stones or crevices in stone walls are also needed not too far away from these summer sites. Since the amount of solar radiation received at higher altitudes is often reduced by cloud cover specific to the hills, it follows that habitat selection is likely to be a more critical process on the hills than lower down, although the importance of hill land populations of these lizards is emphasised by the most recent estimate of their distribution in Britain (Swan and Oldham, 1993).

Amphibians in the form of the common frog seem to be something of a rarity on both open moorland and in and around the plantations, despite the availability of suitable food for this unspecialised and opportunist invertebrate feeder. The extent of the interrelationship between the substantial population on the Northern Plain and a more scattered one elsewhere on lower ground is unclear. Hill numbers could be at risk because of their fragmented distribution, given what are usually relatively limited dispersal distances from water spawning sites, which are the key to frogs' life cycles. Permanent or semi -permanent ponds, wet ditches or other still water of suitable character for the quite demanding requirements of a successful reproductive cycle are irregularly and often sparsely distributed on the hills. There is also a problem on the hills with the loss of spawn laid in ephemeral water bodies such as wheel ruts which then dry out. Some water, despite having a suitable depth profile, access and surrounding habitat does not have the necessary chemical characteristics to support tadpole development. Water acidity, often naturally low in the hills, seems in some instances to have dropped below the level necessary for successful frog tadpole development, this species being apparently more sensitive to this characteristic than some other amphibians (Beebee and Griffin, 1977). It is unlikely that adult frogs suffer in any way from food shortage on the hills since most of their feeding and indeed most of their time, except for males in winter hibernation, is spent on land. Here, whilst the earthworms which are especially sought after on lower ground where they are plentiful, are not as common, their taste in invertebrates is nevertheless catholic and easily satisfied in most damp upland undergrowth by the variety of insects, spiders and slugs (Houston, 1973). A comprehensive survey and assessment of upland spawning sites with particular attention to adjacent lowland area site is needed in order to be able to assess the prospects for the survival of hill land frogs.

Freshwater fish interest in the headwaters of our rivers is represented by the only inhabitant, the brown trout, *Salmo trutta*. The trout population in Island rivers generally is dominated by the effects of angling-oriented fisheries management, which has over a long period resulted in a fairly limited and presumably native stock becoming very largely subsumed within a genetically diverse mass de-

rived from mixed insular catchment and imported origins. The interesting possibility in respect of upland streams is whether, given water chemistry conditions which make it theoretically possible for fish to thrive, there exist any genetically pure native stocks. Non-migratory fish in these situations are characterised by a relatively short life span (Maitland and Campbell, 1992) and, of course, as small fish, are vulnerable to sudden environmental disturbance however induced. Some streams have no fish present due to high levels of aluminium which is directly toxic to fish, or because of acidity levels which are too high to support the quantities of aquatic invertebrates which are necessary as food for fish that are too small to take other fish. It has been demonstrated that these two factors are related insofar as increasing stream acidity causes aluminium to become more soluble (Freshwater Fisheries Laboratory, 1989). Amongst the situations where introduced fish stock may not have affected native remnants, are streams cut off from lower down by sections which persistently dry out or by waterfalls above which there has been no interference. Genetic sampling of likely populations using the DNA sequencing techniques now becoming reliably available (Freshwater Fisheries Laboratory, 1994) would provide a definite answer.

Habitat use and function review

At its simplest, habitat function can be considered in terms of food and shelter, the latter representing protection from predators and more generally from disturbance and unnecessary exposure to adverse environmental conditions. In broad terms, notwithstanding the excellent information now available as a result of the completion of a new and detailed ecological survey (Department of Agriculture, Fisheries and Forestry, in press), the hills can be considered as three habitat types for our purposes. Firstly, the open moorland which includes both heather and grassland areas; secondly, the areas of closed canopy afforestation which in this context is assumed to be predominantly exotic conifers; and thirdly, new plantings up to the stage when canopy closure occurs (often referred to as the establishment and pre-thicket stages) taken together with failed plantations and all forms of peripheral or internal edge habitat associated with plantations of any age. The issues raised by the ecological disruption caused by the land use change involved in the preparation for and by the culmination of rotational forestry are complex (Natural Environment Research Council, 1990 & Ratcliffe, 1986) and cannot be fully considered here.

The open moorland has significant year-round resident populations of mountain hares (only on the central hills and nowhere off the hills), pygmy shrews (widespread everywhere else too), and viviparous lizards (again quite widespread elsewhere) on land and some small, possibly isolated, populations of brown trout in headwater streams. Resident throughout the year with rather less significant populations, which are greatly exceeded in all cases by lower ground numbers, are common rats, wood mice, rabbits, polecat/ferrets, stoats, and common frogs. All these animals find all their requirements in the moorland environment but some are dependent on man made structures as an integral part of their habitat requirements. The key food sources for the smaller animals are ground litter invertebrates and the vegetation itself. The presence of the specialist herbivores is also a result of the system of sheep grazing and shooting management presently practised. The smaller vertebrates fulfil the role of prey for both mammalian carnivores and avian predators. Year round visitors to the open moorland are the red fox (on only an infrequent basis given the present very low population) and the strictly localised excursions of a few red-necked wallabies to graze heather on the northern edge of the central hills. Of the bats, only the *Myotis* spp. have demonstrated any interest in venturing onto the open hill albeit only in small numbers, but then none of these bats has a large presence on the Island as a whole anyway. It is the lower temperature hibernation facility and not the summer feeding activity which is potentially the most significant, but it is not clear how much, if any, movement between the Island and adjacent shores is taking place to gain more attractive hibernation conditions elsewhere (Pooley, 1992).

Closed canopy conifer plantation is of almost no interest to any species under review here with the exception of the wood mouse. It has to be recognised, however, that the existence of the plantations creates the opportunity for the ecotonal edge habitats referred to below and, of course, for plantings to fail due to poor siting and/or vegetative competition, also included below.

Without voles, the establishment/pre-thicket phase of plantations does not constitute a trigger for 'vole plagues' and so it is convenient to group this temporary habitat phase with the somewhat longer stage offered by appropriately managed plantation edge habitat and the indefinite, relatively constant, state offered by heather-checked or otherwise failed plantations. The environment provided by these habitats is specifically favoured on a residential basis by all three carnivores, the brown hare, rabbit, hedgehog, pygmy shrew and viviparous lizard. Although there is no apparent low ground food shortage, small numbers of four of the bat species resident in lowland habitats visit in summer on night foraging trips in small numbers to take advantage of the concentrations of small flying insects often present in relatively sheltered places.

Positive plantation management

The habitat management principles appropriate to this class of species are no different from those associated with the best modern forestry practice taking account of nature conservation guidelines published, and increasingly practised, by the U.K. Forestry Commission (Forestry Commission, 1990). The 'operational guidelines' included in

this publication are a sound prescription for all forestry planning and management. They are based upon the principle of seeking to enhance natural diversity by maintaining or creating habitats which favour species native to the area (Good, et al, 1991). There is, however, a considerable way to go before full advantage is being taken of this soundly-based and thoroughly-researched guidance here on the Isle of Man, particularly in view of the specific policy of extending areas of planted hill land in recent years (Isle of Man Government, 1985).

Useful edge habitat needs to be both created and managed (Ratcliffe, 1991). This requires both valid techniques and the acceptance of ongoing as well as establishment costs (Currie, 1991). Management for wildlife does tend, of course, to yield more attractive forests for public enjoyment whether or not that public appreciates the less obvious benefits. Amongst key features in forestry management should be design for natural light penetration in unplanted areas (Yallop and Hohenkerk, 1991) and an even spread of tree ages distributed in small management and felling compartments so as to minimise disturbance during and particularly at the end of one production cycle and in the transition to replanting. Despite stated intention, sustainable planting rates were significantly not achieved in plantings between 1986 and 1990, which were at over twice the appropriate rate for long term 'normality' in age-class distribution of trees (Department of Agriculture, Fisheries and Forestry, 1994). The existence of a few limited areas of failed plantation is a positive advantage to many of the species considered here and they should not, therefore, necessarily be automatically considered as candidates for reinstatement of heather moorland.

Broadleaved planting is already being included within the most recent commercial plantings and this is a welcome development which will be able to produce increasing benefits as more research is completed on exactly how the conservation tree element should be integrated with the necessarily dominant planting of exotic commercial species, (Staines, 1986). It would be best if tree species native or long-established on the Island were exclusively used for the broadleaved element and it would just as importantly be appropriate to utilise the Island's own tree resource for this purpose rather than relying upon trees propagated in the U.K. using seed from all over Europe. In this way, the maximum food resource is likely to be directly or indirectly provided (Kennedy and Southwood, 1984). The fact that this is not at the moment the case is regrettable.

There has in the past been a clear lack of appreciation of the implications of the forest production cycle implemented on semi-natural open moorland upon life in watercourses. It is now recognised that the indirect effects (on aquatic invertebrates) and direct effects (on physical and chemical characteristics of the water) of forestry are both complex and potentially catastrophic (Maitland, Newson and Best, 1990).

Fortunately, the latest guidance from the U.K Forestry Commission (Forestry Authority, 1993) is extremely thorough and if followed would result in a leap forward in current practice here. The subject of still, rather than flowing, waters demands comment since there exists the opportunity to create a wide range of valuable pond and wetland habitat with suitable surroundings within the context of the commercial forest estate. This potential has barely been tapped. Significant benefits could be generated for protected common frogs and endangered bat species in particular, but it must be recognised that these animals, as for all the larger members of our fauna, are but the more obvious elements of a complex world so that the total benefits of the approach could be much more extensive.

All these remarks have been made without regard to the geography of the hills and the implications of particular patterns of basic habitat type on the fauna. Although such a review would demand a great deal more space and time than is available here, it is a vitally important aspect of hill land management that must receive careful consideration whenever habitat change - extended afforestation in this context- is being considered and this has not always, regrettably, been very obviously the case in the past. The situation in respect of the much smaller area of the Southern hills is particularly relevant in this respect.

The inescapable overall implication of comparing best practice guidance with what it has been possible to achieve to date is that the hill land and forestry agency for the Isle of Man urgently needs the full time services of a Field Ecologist to complement its core forestry management and practice skills.

Specific implications of current new afforestation proposals

The most recently available statement on new afforestation plans (Department of Agriculture, Fisheries and Forestry, 1994) envisages the planting of a total of 585 hectares of existing open hill land. Four specific areas are given but without the benefit of a map or the proposed relative shares of the total area to be planted. They are described as Glen Rushen, the Black Mountain at Ballaugh (Slieau Dhoo), Block Eary and Cornaa, Maughold. A 'full consultation process' is promised although the current situation is that there is no established format for such a procedure and no published assessment criteria or properly defined nature conservation guidelines to assist. In line with earlier remarks on this class of species and without regard to the geographical aspects of proposed new planting areas on overall habitat disposition, it follows that:

(i) no work in such connection should be commenced until a survey has been undertaken to establish whether any native brown trout stocks remain in the catchments which might be affected; if so the significance of such stocks

within the complete genetic picture of this species in the Island as a whole would need to be established.

(ii) an assessment should be made of the current mountain hare population and its full ecological impact and implications; this should be used to judge whether proposed new planting would be likely to have a significant effect and, if so, whether this was acceptable.

(iii) the implications which increased afforestation might have in encouraging the growth of the red fox population should be carefully considered; whilst the present small numbers give little indication that this land use change might make any difference, the matter should be kept under careful and informed review.

Conclusions

It has been shown that, in general terms, few non-avian vertebrate species stand to lose much if the presently planned additional afforestation of Manx hill lands proceeds. The exceptions identified must, however, be dealt with so that there is no risk of irretrievable damage. In the absence of detailed planting proposals, no account has been taken of the effect that the changed relative distribution of broad habitat types would have and this may in the event matter to the interests of these species. Finally, there is an indisputable need for increased emphasis to be placed in the Isle of Man upon improved and properly funded positive planning and action to meet worthwhile nature conservation objectives in relation to these species, and indeed generally. The present level of resources devoted to this task is inadequate and as a result, policies are being formulated and plans implemented in respect of hill land management in ignorance of the full extent of their likely effects.

Appendix 1: the Manx list of terrestrial non-avian vertebrates

R = recent introduction

MAMMALS	
Erinaceus europaeus	Hedgehog
Sorex minutus	Pygmy shrew
Myotis mystacinus	Whiskered bat
Myotis nattereri	Natterer's bat
Myotis daubentonii	Daubenton's bat
Nyactalus leisleri	Leisler's bat
Pipistrellus pipistrellus	Pipistrelle bat
Plecotus auritus	Brown long-eared bat
Oryctolagus cuniculus	Rabbit
Lepus europaeus	Brown hare
Lepus timidus	Mountain/Irish hare
Apodemus sylvaticus	Wood mouse
Mus domesticus	House mouse
Rattus norvegicus	Common rat
Vulpes vulpes	Fox (R)
Mustela erminea	Stoat
Mustela putorius/furo	Polecat/ferret
Felis catus	Feral cat
Capra hircus	Feral goat
Macropus rufogriseus	Red-necked wallaby (R)
REPTILES	
Lacerta vivipara	Common (Viviparous) lizard
AMPHIBIANS	
Rana temporaria	Common frog
Bufo bufo	Common toad (R)
Triturus vulgaris	Smooth newt (R)
Triturus helveticus	Palmate newt (R)
FRESHWATER FISH	
Lampetra fluviatilis	River lamprey
Salmo salar	Atlantic salmon
Salmo trutta	Brown trout
Tinca tinca	Tench (R)
Oncorhynchus mykiss	Rainbow trout (R)
Phoxinus phoxinus	Minnow
Anguilla anguilla	European eel
Gasterosteus aculeatus	Three-spined stickleback
Pungitius pungitius	Nine-spined stickleback
Perca fluviatilis	Perch

Note: Fish which enter tidal rivers are not recorded in the above list unless they have also been recorded in freshwaters.

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Introductory overview: the history of the Manx hill lands as a resource for understanding and managing the contemporary landscape.

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This final session of the conference will bring a range of new factors into consideration. The speakers so far have focused on the ecology of the Manx hills and discussed alternative uses and management policies in relation to economic and conservation issues. The perspectives of the contributors this morning is both that there is much more to the hills than the existing flora and fauna, however rare or significant individual species or eco-systems may be, and also, that a range of historical factors must be considered before satisfactory development or conservation policies can be proposed for those very species or systems. It is worth re-iterating what has been said in a variety of ways by many previous speakers, that is, that the hills are as they are today because of the interaction between the management or resource procurement policies of many previous human populations and the "natural" environment. They are not in their "natural" state now, and have not been so for at least six thousand years.

This morning's papers attempt to illuminate four different, but related questions. First, and leaving aside the present eco-systems which have been thoroughly discussed by earlier speakers, what are the essential attributes which define the Manx hill lands? Secondly, are these attributes worthy of conservation in their own right and would such conservation conflict with the activities of the present users of the lands or with nature conservation interests? Thirdly, how far is the possession of these attributes significant for the understanding and maintenance of the contemporary eco-systems? Fourthly, of what use are such landscapes and is such knowledge to the present and future inhabitants of the Isle of Man?

Dr Dackombe will consider the geological sub-structure of the hills, together with their present surface form. He will show that exposures of rock and drift are significant for research and for landscape appreciation. He will emphasize the importance of conservation of the geological resource, not just at specific points on the ground, but including the retention of long sinuous sweeps of glaciated hill-side.

Dr Tomlinson will consider the Manx hills as a repository of evidence not only for the vegetation history of the Isle of Man, particularly as preserved in hill-peat sequences, but also for providing a chronology and suggesting mechanisms for human exploitation of the hills over the last six thousand years.

Mr Johnson will demonstrate that because much of the hill land lay beyond medieval and more recent arable or improved farming, the evidence for later prehistoric and early medieval activity in the Island is uniquely preserved in the hills. In particular, shielings, round houses and early field systems are common in many locations. He will emphasize the archaeological value of the uplands and discuss the related questions of potential threats and means of conservation.

Mr Cowin will emphasize the importance of the built environment to the present day understanding and enjoyment of the hills. He will show what a wide range of buildings still survives, albeit mostly in a derelict state, and how this stock of historic structures helps explain the earlier management of the hills by farmers and their exploitation by quarriers and miners for building stone and minerals.

The overall impression is that, despite first appearances, the Manx hill lands are rich in sites of geological, palaeo-ecological, archaeological and architectural importance. Lack of detailed survey work and failure to use available legislation to protect, for example, archaeological sites, is a problem. All the speakers will emphasize the need for further survey and recording in order that the value of this resource can be properly assessed.

Many sites are uniquely preserved in the uplands and are, thus, worthy of conservation in their own right. The preservation of extensive areas of rough pasture and heather moorland for their ecological value would also protect and conserve much of the evidence described below. Further afforestation would deplete this heritage to a dangerous degree, particularly when new tree planting usually takes place on the lower and more protected slopes of the hills which are the very locations in which the blanket peats, drift exposures, archaeological sites and vernacular buildings are most concentrated.

In many cases the sites which form the subject matter for this morning's speakers, particularly those which contain palaeo-environmental evidence or evidence of earlier agricultural communities active in the uplands, are vital for the understanding of the present natural history of the hills. In particular, it is important to establish the precise vegetation sequence for the hills, and its chronology, and to relate this to the upstanding evidence of human activity, such as is represented by the shieling sites and early field systems.

It might be argued that the present state of the hills, largely consisting of rough, unimproved grassland and heather moorland, is not their "natural state", particularly as the pollen evidence is beginning to show the degree to

which they were covered by deciduous woodland up to the Bronze Age, when human interference, probably combined with climatic deterioration, set in train the formation of acid conditions and the growth of the hill peats. One line of argument might be that by removing grazing pressure and present heather management regimes, the hills should be allowed to regenerate naturally and become largely deciduous woodland again. Although such a change would be in line with historic precedent and would certainly increase species diversity substantially, it would be destructive of geomorphological exposures and profiles, damage or destroy many palaeo-environmental and archaeological sites and despoil the contexts for their appreciation. The international significance of the Manx moorland habitats has already been discussed by earlier contributors to the conference.

To return to the four questions posed earlier in this paper - this morning's speakers will define what is unique and essentially Manx in the hill lands. They will begin to establish criteria by which the range of surviving resources can be evaluated. In many ways the *status quo* would appear to produce the fewest potential conflicts between the present users of the hills and the national interest. The speakers will show that palaeo-ecological evidence, including geomorphology and archaeology, is a vital element for understanding and, therefore, managing, the existing resource. Finally, in their different ways, they will emphasize the significance of the hills for both the present and future inhabitants of the Isle of Man.

One common element in all of their contributions is the poor state of present knowledge of the uplands. Their geomorphology is poorly mapped and imperfectly understood. Their palaeo-ecology has to be inferred from only two samples. Their visible archaeology is inadequately surveyed; what is beneath the surface lacks any satisfactory assessment. Their large stock of derelict buildings stand crumbling and unrecorded. Until these resources are better known any large scale change of land-use in the uplands should be undertaken only with the greatest care. When a development, such as afforestation, is deemed necessary, in the national interest, a full evaluation should be carried out of all of the factors described this morning on the lines suggested by the writer in the *Manx Hill-land Report* (1995, 99-100).

The public enjoys and appreciates the Manx hills in different ways and for many reasons. At purely an aesthetic level, they constitute a vital element in perceptions of Manx geographic identity. The geomorphological, palaeo-environmental and archaeological evidence which they contain constitutes a major resource for research which is not replicated elsewhere on the Island. From the knowledge gained from studying these aspects of the hills will come many opportunities for education, from primary, through secondary to undergraduate, post-graduate and extra-mural studies. Unless the hills are maintained as open grassland and heath, many of these opportunities will be lost, some for ever, and a focal point for Manx cultural awareness will disappear.

Archaeological sites and fossil landscapes in the Isle of Man

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The purpose of this short paper is to draw attention to the archaeological value of the Manx uplands, describing the resource, suggesting reasons for the survival of evidence, considering threats, means of conservation, and methods of investigation.

It is in some ways beneficial to start in the middle, historically speaking, in order to understand why the Manx uplands are archaeologically valuable. The land division system of the Isle of Man (Davies, 1956), probably medieval in date, is a near perfect product of the equable apportionment of the natural resources of this island according to relief and topography. Thus, the Isle of Man is divided in two along the south-west to north-east axis of the upland massif, and then further subdivided into sheadings. Each sheading extends from the uplands to the sea, and is further divided into parishes; these in turn subdivide into commons and enclosed lands. The latter are split into treens and then into quarterlands, while the former may sometimes include lands enclosed under licence, and known as *intack*.

Crudely put, a land division system implies social organisation; enclosure a further intensification in the expression of ownership, tenancy or occupancy down to the individual family unit. In the time the current land division system has existed, most lands considered viable or worth cultivation have been enclosed. The remaining commons, historically at least, were similarly exploitable on a equal basis by the people, making use of pasturage and turbaries; there is some evidence at least that the parish boundaries have been deliberately arranged (particularly in the upper Sulby valley) to ensure that parishioners had access to these. Those parts of the commons adjoining the uphill limit of the enclosed lands, which were historically taken in under licence as *intack*, have, quite naturally, often been the first to be abandoned as soil fertility was depleted through over-liming. The effect has been to create three broad types of landscape and land use on the hillsides and unenclosed "Tops": the upper limit of the still-worked enclosed lands, the abandoned farmlands, and the unenclosed commons.

The latter two landscapes can, from the point of view of the archaeologist and historian, be regarded as fossil. Each has a characteristic, but not completely exclusive, suite of archaeological remains, both of which are vulnerable. Their past history has not only obviously contributed to these remains but, much less obviously, already led to the depletion of the archaeological record. This process is continuing today, but - and this is a most worrying trend - while it has been arrested in certain areas (such as many of the abandoned hill farms), in others (such as the unenclosed commons) it is accelerating.

To the uninitiated, the depopulated hillfarms may appear the uppermost limit of human endeavour - the word is used advisedly - and any notion of the unpeopled Manx uplands having supported a human presence appears unlikely. The reality is far from this: today's misconceptions are guided by a road system that is a pale shadow of the communications network which once flourished across the hills and by the blankets of peat and vegetation that mask so many archaeological features. We know of the impressive Bronze Age hillfort on the 483-metre summit of South Barrule, complete with over 70 round houses protected by a rampart, and considered so suitable a site that it was re-used and re-fortified with an even more impressive rampart in the Iron Age (Gelling, 1970a), but it should be understood that this most obvious of sites is exceptional rather than usual, and is by no means the earliest upland occupation site currently known.

Evidence for the early environment of the dManx uplands is currently sparse and until now has relied heavily on a single pollen core from Mullagh Ouyr south of Snaefell (Russell 1978). Further research as part of a programme instigated by the Centre for Manx Studies is published in this volume (page 60). Russell's single core implied peat developing by the late Bronze Age, and the spread at this altitude of acid grassland and heath for at leas the last two millennia. The more recent core shows that the environmental history of the uplands is considerably more complex than was perhaps first appreciated. The further investigation of both the drift geology and the palaeo-environmental evidence surviving in the Manx uplands is essential to the development of a clearer understanding of how the modern upland environment developed, and how it relates to the considerable body of archaeological evidence for its exploitation and occupation.

No early prehistoric finds have yet been made in the upland zone securely to prove human activity in either the Mesolithic or Early Neolithic periods, but there is clearly occupation and ritual/burial activity by the later Neolithic, approximately four thousand years ago. Almost all of this

evidence has been derived from painstaking fieldwork in the wake of forestry ploughing at locations such as South Barrule and Black Mountain. The presence of such sites and artefacts was largely unexpected, and their discovery marked the beginning of a steep intellectual learning curve equivalent to one undergone in the early 1980s when concerted fieldwalking started to reveal intensive prehistoric activity on the Island's Northern Plain. It is easy to be wise after the fact, but the difficulty of the terrain and the ground-cover effectively remove any sense of previous human activity in the remoter past from all but the most tenacious fieldworkers. There can be no doubt, however, that such remains on the unenclosed commons are excessively vulnerable to afforestation activities, and are likewise extremely difficult to identify beforehand.

Bronze Age remains appear more widespread than those of earlier periods: aside from the obvious monuments such as South Barrule hillfort, and the recently "accentuated" burial cairns on the Rheast opposite Montpelier, standing stones, burial mounds, and artefact spreads such as that at Rheast Buigh/Snuff the Wind, form a growing body of evidence for both occupation and burial. As upstanding monuments to the dead appear to have been a means of conferring the ownership of the neighbouring land on the living descendants of those thus memorialised from at least the Neolithic period, we should not be surprised to find a wide variety of monument types and artefact spreads from this period onwards. Such prehistoric remains are comparatively well-preserved because of the amount and type of disturbance (respectively little and light) they have suffered in the upland zone, on the unenclosed commons.

It is all too easy to focus on the lowlands for the evidence for the Iron Age in the Isle of Man: coastal promontory forts, giant ("Bersu-type") roundhouses set in marshes, and small, citadel-type forts such as that on Cronk Sumark, are all examples of easily visible, upstanding remains which inevitably draw the eye to the lowlands. We forget at our peril that South Barrule was re-fortified at this time, and that major monuments such as Manannan's Chair and Cashtal Lajer, although both within modern farmland, are verging on the upland zone. To the same general period can be ascribed a growing number of features, mainly small round houses and boundaries (Johnson, forthcoming), such as those on the Rheast opposite Montpelier and again further upstream opposite the major medieval shieling site at Brandywell (Gelling, 1962-63).

These later prehistoric features appear at similar altitudes to the medieval shielings just mentioned, which may lead to some confusion as to their age. There is a reasonably clear distinction, however, between the forms which the structures of the two periods take. Furthermore, the Iron Age sites always occur on open hillsides, whereas the shielings also occur in more sheltered locations close to stream gullies. This may reflect a difference in ground cover (were the earlier roundhouses better protected by some remaining woodland?) and also in functional priority (the sole purpose of the shielings was to tend stock during the summer months: a plentiful water-supply was therefore a pre-requisite). At Block Eary, excavation (Gelling, 1962-63) revealed that an earlier, apparently Iron Age, house underlay a much smaller medieval shieling hut, the latter's turf construction at complete variance with the several phases of careful build in stone which represented the remains of the earlier house. It is salutary to note that there was absolutely no indication of the larger structure above ground when excavation of the smaller hut began.

The medieval use of the uplands, coinciding broadly with the development and formalisation of the land division system described earlier, has left a range of site-types, which, it would be fair to say, are still imperfectly understood. The recognition of shieling sites in the later 1950s and early 1960s (Gelling, 1962-63) has led to the identification of approximately fifty of these temporary, seasonally-occupied settlements of huts. Characteristically, these huts were built with turf walls and roofs of turf, brushwood and heather which have long since collapsed, leaving mounds which can vary in height from no more than 20 cm to approaching 2 metres. Some of these settlements comprise over 30 such huts, others can have as few as two or three. Many of them have revealed no evidence whatever of associated boundaries, but others, such as the newly discovered site on the south side of the Block Eary reservoir (Johnson, forthcoming), have revealed quite complex systems of banks for the enfolding of stock and perhaps even to protect small-scale crop-growing.

Some of these shieling sites undoubtedly became permanent farms, and developed into intack farms, their ancestry betrayed by the Eary-element ("shieling") in their names. Some of these sites soon failed, as was revealed at Doarlish Cashen (Gelling, 1970b) following the excavation of a Norse farmstead. Others perhaps never quite succeeded in making the transition from a seasonal, extended community of people from the same parish to a smaller, permanent, family establishment: small enclosures with only two or three hut platforms appear to suggest attempt at the latter and may be found at Sartfell and Upper Glen Dhoo (Johnson, 1986), and also at Block Eary (Johnson, forthcoming).

The creation of the *intack* farms, and the exploitation until the last century of their marginal soils, has, on the one hand, masked the presence (or even destroyed) of earlier, prehistoric features, but on the other, resulted in a whole new range of historic features. Many of these are safe so long as a non-intensive, sheepfarming regime persists, but are intensely vulnerable to damage from hill-land improvement schemes and afforestation. For instance, the destruction, earlier this century, of the farm complex at Forester's Lodge in Druidale removed any opportunity of studying in detail an extremely important farmstead, the earliest occupants of which played a pivotal role in the management of the common lands. The

development of the upland farms, their boundaries, watermills, farm buildings, access routes, turbaries, flax dubs, even the relict ecology of their fields, are all imperfectly understood, and contain a wealth of information of interest to archaeologists, ecologists, vernacular architects and social historians alike. Even a cursory study of the neighbouring farm complexes of Close and Crammag in Sulby shows strikingly how the former developed earlier along "organic" lines, while the latter was laid out later in one phase of building (albeit with later alterations).

The latterday use of the uplands for grazing has given rise to one last set of features: sheepfolds. Some of these at least appear to be a continuation or development of the sites at, for instance, Sartfell and Glen Dhoo referred to above, although they tend characteristically, to be smaller; their locations, however, are similar. Several such sites have recently been identified in Druidale and the upper Lherghyrhenny valley (Johnson, forthcoming). The latter area is particularly interesting in that it appears to demonstrate near-continual use from the medieval period onwards, with examples of shielings; enclosures with single hut platforms; the early sheepfolds just mentioned; larger, rectilinear, stone-built folds associated with possible sheepdips; and finally, the well-built, late-19th century, circular sheepfold with four wing-walls to aid sorting and provide all-round shelter.

In conclusion, it is instructive, as shown by the list above, to think of the uplands not as *containing* a number of disparate sites but rather as *consisting* of features and land-uses which relate to each other spatially and through time. Obviously, some of these features and land-uses are more important than others in terms of rarity and what they may tell us of past activities. In order to reach some kind of understanding of their relative merit, however, as many of these features as possible need to be identified. This is relatively straightforward to the experienced, tenacious and patient fieldworker; what is less simple is the identification and recognition of those (often prehistoric) remains which lie hidden by blankets of vegetation and peat. For this to be satisfactorily addressed requires, on the one hand, detailed, scientific investigation of past environments, and on the other, the development of an understanding of *landscape* by fieldworkers. It is no longer sufficient to walk a hillside picking out the archaeological plums; the plum-picker has to understand why the plums are there in the first place, and to postulate where others are still hoarded away from sight. Such an ideal is not simply the lofty aspiration of the academic, but is the only way to attain a land management and development strategy for the uplands which is not detrimental to the archaeological resource.

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The Manx hill-land: the palaeo-environmental resource

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The organic deposits which occur in the Manx hill-land provide an invaluable research tool for the study of the history of the vegetation, not only during its early post-glacial development, but also over the period when human societies have used the uplands as a resource for timber, grazing and arable farming. These organic deposits are also potentially important in research at an international level, particularly in the study of climatic change.

The history of the Manx hill-land vegetation is known only in the broadest terms (Garrad 1972a, Allen 1984 and summarised by Hopson and Lamb 1995). Very little detailed analysis has been carried out to indicate precisely when, where and how fast the different changes which took place over the last 10,000 years have occurred.

The aim of this paper is to describe the research tools and methods used to reconstruct past vegetation communities, to summarize the evidence for the post-glacial evolution of hill-land communities in the British Isles in general and to consider the Manx evidence in particular. The results of the pollen analysis of a new peat core from Beinn-y-Phott will be presented, together with an assessment of the potential of the Manx hills.

Paleo-ecological principles, tools and methods

Succession

The most important ecological principle to bear in mind when studying the history of the hill-lands is that of vegetation succession. The notion of succession in the uplands of the British Isles is most simply understood as the way in which the bare ground left as the glacier ice melted was colonised first by mosses and grasses, then by shrubs and later by trees as the climate warmed up. This succession continued until the climate stabilized, more or less as it is today, and most of the land was covered in woodland.

Succession can be interrupted or even halted by human activities such as forest clearance, arable agriculture or intensive grazing. When human activity ceases vegetation succession may resume. For example, regeneration may occur and secondary woodland may eventually develop if grazing pressure is removed. In a given instance it may be very difficult to predict what precise succession will follow a period of intensive human impact in that both soil changes caused by clearance or agriculture, which may be irreversible, combined with even slight climatic variation, may greatly restrict the possible sequence and prevent 'natural' regeneration from occurring. In addition, it must remembered that the hill-land areas are complex mosaics of differing physical features overlain by varying patterns and sequences of human land-use.

Pollen analysis

The main tool of palaeo-environmental botanical research is the study of the pollen of trees, shrubs and herbs which is preserved in suitable organic peat and buried soil deposits (Moore *et al* 1991). Pollen released by plants each year becomes incorporated into peats while they are actively growing. When deep sequences of peat are preserved they provide a record of the temporal changes of the nearby vegetation, sometimes over several millennia. Peats, such as blanket bog growing on upland hill slopes, generally provide an indication of the vegetation of a wider area than for example, small infill deposits developing in valley hollows which will give a record of the vegetation growing locally on the slopes around the bog.

Organic deposits which allow research into vegetation history in the hill-lands are preserved in a variety of different places and in different ways. The important point is that the organic material incorporating plant and animal 'fossils' is preserved. Its decay is prevented either by a combination of water and acidic conditions, such as in a blanket bog, or by the anoxic conditions provided by waterlogging and subsequent burial such as in an organic soil preserved beneath an archaeological feature.

A vertical column of peat is removed to the laboratory. The grains of pollen are washed out of the sample and are counted in order to produce a diagram which represents the proportion of pollen of different types existing at a particular time or level in the peat. One of the main problems in the interpretation of pollen diagrams is to decide, for a particular location, what proportion of the pollen received by the peat was derived from plants growing close to the site. This may be particularly difficult on the upper slopes of hills which provide locally variable habitats and are exposed to extreme wind conditions. In addition to the pollen record, hill-land peats provide a number of other forms of evidence:-

Peat stratigraphy

The stratigraphic sequence within the peat itself can provide a gross indication of changing conditions with time. Peat columns often provide evidence for dryer and wetter conditions during formation, as well as for periods of erosion and accretion.

Macro-fossils
Macro-fossils, such as leaves, roots or even tree stumps also occur within peat deposits and can provide unambiguous evidence for what was actually growing on the site at different times.

Relict species
A further source of evidence may be provided by relict species of plant or animal which can be studied within the contemporary ecosystem, but which clearly occupied the site in response to a different vegetation cover, climatic regime or human management system.

Other biological remains
Other biological remains are also preserved in peat deposits, most notably insects which can be useful in combination with pollen data in studying vegetation change and are an important tool in studies of climatic change (Buckland 1979).

Dating techniques and proxy climate studies
Recent concern about future climatic change has initiated research on past climates using peat bogs as sources of 'proxy climatic data' (Blackford 1993). For peat stratigraphy to be useful in this research it is vital that the layers can be securely dated, either by radiocarbon-dating, dendrochronology, tephrochronology or, preferably, for calibration purposes, a combination of these. Bog oaks with sufficient annual rings are often used for dendrochronological studies in conjunction with radiocarbon dating (Baillie 1985).

The study of tephra, which are very fine grained airborne particles from Icelandic volcanic fallout, form time-parallel marker horizons useful for dating purposes (Dugmore 1989, 242). These layers are geochemically distinct and can be linked to specific eruptions.

Archaeological sites
Archaeological sites may be important in two ways. They may bury and subsequently preserve old ground surfaces such as plough soils or peat layers. Materials may be preserved which were used in the construction of the monuments, such as wood, charcoal or turves. They may also provide a firm chronology for anthropogenic events in the uplands, particularly when material for dendrochronology or radiocarbon-dating is available.

Post-glacial vegetation history in the British Isles

The characteristics of the vegetation cover in the British Isles by the time of the maximum post-glacial expansion of woodland, probably about 8,000-5,000 years ago, have been well studied. Bennet has produced a provisional, inevitably very generalised, map of woodland types for the British Isles 5,000 years ago. This is based on available pollen work in conjunction with soil, climatic and topographical information (Bennett 1989). It shows a complex pattern of different woodland types each dominated by either lime, ash, oak, alder, birch, hazel or pine. Each of these woodland ecosystems would have contained a variety of other tree species. The Isle of Man is shown to have oak dominated woodland in the lowland areas and birch in the uplands.

The history of the vegetation of the uplands from at least 5,000 years ago, and in some places much earlier, has been dominated by the effects of human activity.

There is much evidence from many parts of the British Isles for the early clearance of woodland by prehistoric man. In some places such as the North York Moors (Simmons and Innes 1988), this was as early as 7,000 bp. This clearance activity appears to have been a major factor in the initiation of blanket peat (Moore 1988, 117) often coinciding with the climate becoming much wetter. Areas of the upland woodland were burnt by hunter-gatherers to encourage grass growth for the grazing animals they hunted. Charcoal has been found in many locations in association with the pollen evidence for this early clearance. In South Wales very detailed sampling in an area of blanket bog showed clearance by fire of hazel woodland around 6,000 bp (Smith and Cloutman 1988).

Disturbance of deciduous woodland in Arran, Scotland (Robinson and Dickson 1989), perhaps more comparable with the Isle of Man, also took place in the Mesolithic period.

On the Isle of Lewis, in an area thought to have had no woodland, pollen analysis of blanket peats has shown the existence of *Betula/Corylus* (Birch/Hazel) woodland, which was cleared about 3600 bp, by Neolithic farmers (Newell 1988).

In other parts of the British Isles it was not until the Bronze Age that such woodland clearance took place. Five pollen diagrams from the Carneddau area of northern Powys showed that blanket peats began to form in the area during the Neolithic period but the first indications of human impact on the vegetation cover date from the Bronze Age (Walker 1993, 182). These pollen diagrams taken from different types of peat deposits in an area of heather moorland and pasture provide a sequence right up to the post-medieval period. Major clearance of woodland is shown in the Romao-British period, pastoralism in the Medieval period and a short-lived period of woodland regeneration in the post-medieval period.

Once blanket bog or moorland had developed over much of the hill-land area, continued grazing would have maintained the vegetation as a mixture of grassland and moorland. But when, for whatever reason, the human activity was reduced, regeneration would have taken place. The vegetation which regenerated would depend on the intensity of previous activity and the nature of the soils in the area.

In later prehistoric and historic periods arable farming was taken much further into the hills and the activities of ploughing would again alter the subsequent succession after abandonment.

Paleo-ecological studies in the Manx hill-lands

Although there is considerable evidence from the region to indicate the history of the vegetation in broad terms, very little research has been carried out on the Manx hill-lands themselves. Many questions remain to be answered.

In the Manx uplands the following types of deposits are found:

Blanket bog peats occur particularly on the north-facing slopes of several of the hills, in the north of the Island. There is sufficient precipitation in this area for the blanket peats to be maintained. The Manx blanket bog is relatively shallow partly because it has been used by successive generations for turbary. Its extent has also been reduced by grazing, burning and drainage.

The acid soils which cover most of the hill-land area have some potential for analysis as pollen may well be preserved. Although they would not provide a complete temporal sequence they might contain answers to specific questions. Where a soil has been buried by an archaeological feature such as a boundary hedge or wall evidence of past land-use may be found.

Valley infill deposits also occur, especially valley mires of which there are at least three locations in the northern hill-lands. On a smaller scale basins or minor depressions formed within corries are potentially useful.

The main types of deposit which do not occur in the Manx hill-lands are those associated with lakes. Small upland lakes such as those found in Cumbria, where silts and muds have been deposited since the beginning of the post-glacial period would provide a continuous record of vegetation history.

Pollen analysis

The only previously published pollen diagram from the upland blanket peats is from Mullagh Ouyr (Russell 1978). Russell took samples from approximately 300m south-east of the Bungalow at an altitude of 442m OD on the northern slope of Mullagh Ouyr.

The pollen of the sub-soil interface was dominated by Ericales (heather) and the transition to peat proper was marked by an increase in Cyperaceae (sedges) and a decline in Gramineae (grasses). The peat itself appeared to fall into two almost equal zones characterized by the subdominant species. The lower part had increased values of *Betula*, *Sphagnum* (moss) and *Alnus* (alder), whilst the upper zone showed a marked decline in all three species together with an increase in Cyperaceae and Gramineae.

A sample of peat was taken for radio-carbon dating which produced a date of 2865 ± 45 bp for near the base of the column which places the initiation of mire development in the late Bronze Age.

Macro-fossils

There are several records of oak and pine logs found within peat (Garrad 1972a, 161), some as high as 300m. Hazel branches have also been found in the hill peat around 300m near Snaefell (Allen 1956). Russell's core included the macroscopic remains of *Eriophorum* (cotton grass), Ericales, and *Sphagnum*, at many levels (Russell 1978, 41, Fig 4.2). He also took samples of wood fragments occurring within the peat at a depth of about 1m. These were identified as birch with growth rings suggesting that a thin scattering of poorly-growing trees was re-colonising on the blanket bog surface (*ibid*, 46).

Relict species

A number of possible relict woodland species have been recorded at high altitudes in the Isle of Man. Over the years the summit of Snaefell has produced a range of suggestive finds: a beetle, *Salpingus ater*, which normally inhabits burnt twigs was found in 1906; two woodland species of earthworm, *Lumbricus rubellus* and *Dendrobaena subrubicunda*, discovered in 1907; *Oxalis acetosella* (wood sorrel) was most recently reported there in 1951. On the summits of both North and South Barrule *Melampyrum pratense* (cow-wheat) has been regularly recorded, at the latter site as early as 1898 (Allen 1965). Whilst some of these occurrences may be regarded as examples of lowland species being transported to altitude by high winds, it is difficult to sustain this argument for the presence of the earthworms.

Historical evidence

Hints from the early historical record are somewhat inconclusive as to how much woodland there was in the hill-lands in the later periods (Garrad 1972b, 668). There is evidence that arable farming extended much higher up the hills than it has done in the last few hundred years (see Johnson, this volume, page 54). There are abandoned fields in many parts of upland Man which are now covered by *Pteridium aquilinum* (bracken) or *Ulex europeaus* (gorse) or *Ulex gallii* (western gorse) or *Calluna vulgaris* (ling) or a combination of these, such as the extensive areas of 'gallic heath' in the south of the Island. The reason for these different species colonising may be due to the timing, nature or extent of past agricultural activity as much as to other edaphic and topographic factors. The dominance of 'gallic heath' in the southern hills may have been produced by the greater extent of turf cutting in this area (Garrad 1972a, 166). In a number of different places on the lower slopes of the hills the vegetation succession has been able to continue to secondary woodland.

The 1995 core from Bienn-y-Phott

In 1995 Drs J J Blackford and J B Innes of the Department of Geography, the University of Durham, collected a peat core from Beinn-y-Phott as part of a wider survey they were carrying out on the Island.

A watershed blanket peat site such as this can provide an 'overview' of vegetation change, as it has been shown that hill-top sites collect pollen from a wide catchment area.

The following account has been extracted from the unpublished report by Blackford and Innes (1996) and reproduced by kind permission of the authors.

Blanket peat from the north side of Beinn-y-Phott at approximately 430m OD, at Grid Reference SC 386867, was sampled. Monolith tins were used to collect material from a cleaned peat cutting. The rest of the profile below the cut surface was sampled using Russian and gauge augers. In addition, wood fragments protruding from or lying in the eroded/cut over area were collected. Wood was identified as follows:

Taxon	No. of fragments collected
Pinus (pine)	6
Betula (birch)	5
Indet. roots	11
Indet. wood	5

This indicated that birch and pine trees were growing in this area at some time.

Stratigraphy

A depth of 2.6m was sampled (Fig. 1), showing alternating bands of darker and lighter peat. These changes are due to changes in the species composition of the peat and also to the degree of decomposition of the material. The lithology shown on Figure 1 is described as follows:

1 Very dark brown, well decomposed peat with no identifiable fragments. Occasional thin beds of reddish brown peat.

2 Reddish-brown fibrous sedge peat.

3/4 Interbedded, alternating, very dark brown, well humified peat (3) and dark, reddish-brown, well humified peat (4).

Pollen data

To date only three samples have been analyzed from this sequence in this very preliminary study.

Two samples were analyzed from near the base of the profile (200 and 250cm). Of the trees and shrubs, only *Betula* (10%) and *Coryloid* (27%) are of sufficient proportion to suggest local presence although percentages of ferns (Filicales) also suggests shaded habitats. It is thought that because of the location and quantity of *Coryloid* pollen present that *Corylus avellana* (hazel) rather *Myrica gale* (bog myrtle) was the species which was locally abundant. It is possible that the wood fragments found correspond to a later phase of tree growth, or that the sampled site did not cover the period of high altitude tree growth. The dominant blanket peat vegetation, similar to that now found, included *Calluna*, Cyperaceae and Gramineae, *Sphagnum* and *Potentilla* (tormentil).

One sample has been analyzed from the upper layer of the profile (20cm). By this time, trees and shrubs had declined to only 15% of the total, with grasses, sedges and heather dominating to an even greater extent. No tephra fragments have been recovered from any of the three samples.

A single Accelerator Mass Spectrometer radiocarbon date from the base of the profile yielded an age estimate of 6,240 ± 60 bp. The depth and decomposed nature of the peat are consistent with this being a full and continuous record of the vegetation in the area.

Discussion of the pollen evidence from Mullagh Ouyr and Bienn-y-Phott

The two extant pollen diagrams described above compare and contrast in a number of ways which may help the interpretation of the vegetation sequence in the Manx hills. They are similar in that the dominant vegetation implied for both sequences is essentially similar - Ericales, Cyperaceae and *Gramineae* - with some shrubs in evidence, particularly *Corylus avellana* and smaller proportions of tree pollen, principally *Betula*. They differ in that, although geographically and vertically close - 1.3km apart, and Beinn-y-Phott is 12m higher than Mullagh Ouyr - peat formation at Mullagh Ouyr begins over three thousand years later than it does on Beinn-y-Pott.

This may partly be explained by detailed differences in the locations themselves. The site at Mullagh Ouyr is much the more exposed of the two, particularly to the prevailing winds. It is on a steep and even slope with a continuous peat cover of roughly the same thickness over a wide area. The core from Beinn-y-Phott was from a more sheltered watershedding site and was located on fairly level ground. It was selected in order to obtain as long a peat profile as possible and to increase the likelihood of the recovery of tephra fragments. In both cases there is some evidence of anthropogenic activity which may both explain the inception of mire conditions and the chronological differences between the sites. Russell's macroscopic diagram (Russell 1978, 41, Fig 4.2) has substantial charcoal deposits at its base. This would seem to suggest that, at this location, clearance by burning took place during the Late Bronze Age. Quite nearby, at Beinn-y-Phott, one of the two lower samples also included charcoal fragments. This indicates that, at this slightly lower and more sheltered location human communities began to clear the vegetation in the later Mesolithic period. Both periods of upland clearance by fire can be paralleled at many locations in the British Isles. Their discovery in close proximity on the Isle of Man is an indication of how

many more sequences will need to be studied before a convincing chronology and geography of the human exploitation of the hills can be elucidated.

Summary of the Manx evidence

Thus it seems that around six thousand years ago the upper parts of the Manx hill-land vegetation was dominated by birch with a mixture of other species, including pine, oak and juniper, depending on such factors as soil type, drainage and slope. This was not dense woodland and there would have been a mosaic with open areas of grassland and heath. Further downhill there would have been more dense, mixed deciduous oak woodland, including other tree species, with hazel understorey and alder dominating the wetter areas. Evidence from pollen cores in the Dhoo Valley substantiates this (Innes 1995).

It seems very likely that Mesolithic people would have started woodland clearance in the Manx uplands. The presence of charcoal in the sample from Beinn-y-Phott suggests this. There is plenty of archaeological evidence, consisting of flint scatter sites, for the presence of hunter-gathers in the lowland areas of the Isle of Man (McCartan 1990) and occasional finds from the hills. The hill-land vegetation would have been a mosaic of light woodland, scrub and open grassland/moorland supporting all manner of wildlife - ideal conditions for these people. The initial activities of the hunter-gathers probably increased the ecological diversity. Unfortunately, because the removal of trees had a direct affect on the water-table and the climate was also rather wet, once areas had been cleared, and grazing continued, they were not able to regenerate and peat began to grow instead.

The fact that the initiation of blanket peat development is dated to the late Bronze Age at Mullagh Ouyr and from the later Mesolithic at Beinn-y-Phott emphasizes the idea that a mozaic of vegetation types may have been present at any one time and that for any realistic reconstruction of vegetation history and human impact on the Manx hills to be attempted, many more samples from a range of locations, altitudes and environments will be required.

Although there is some evidence for the existence of woodland in Man as late as the 11th century, it is not clear how much of this was in the hill-lands, perhaps very little (Garrad 1972a, 147; 1972b, 668).

The upland vegetation history for the south of the Island may be substantially different from what has been described above. At present there is no evidence on which to base any assessment.

The importance of the natural resource

The palaeo-environmental resource contained within the Manx hills is, therefore, extensive and variable in context and quality. A few macro-fossils and possible relict species have been recorded over the years; only two pollen diagrams have been produced, one of these still at a preliminary stage of investigation. There has been no study to date of pollen or macro-fossils from the considerable resource represented by the valley infill deposits and acid soils which exist over much of the area where blanket peat has not formed. There have been no studies of fossil insect remains, no recovery of tephra and no extensive stratigraphic studies. There has been no attempt to examine preserved or fossil soils associated with the many archaeological sites of all periods which survive in the hills.

The consequence is that there are still many unanswered questions concerning the vegetation history of the hill-lands. It is clear that this history is closely linked to the human use of the upland areas both in prehistory and in later periods. The chronology of this impact, its specific nature and long-term effects remain clothed in mystery.

Some of the studies described above from other parts of the British Isles have demonstrated the very close sampling which is required from a large number of borings, from different types of organic deposits in a hill-land area before any detailed questions could be answered.

For the Isle of Man the first priority must be to properly map the resource and to assess its significance. The organic deposits located in the hill-lands, preserving as they do everything from pollen and plant macro-fossils as large as tree stumps to charcoal from human interference, are an important resource for pure research in order to establish a convincing vegetation history of the uplands. In the context of the threat of any large scale development in the hills, such as afforestation, which would damage or destroy almost all of the palaeo-environmental resources in the areas affected, their proper evaluation should form an essential element in the full environmental impact assessment which it is hoped will become mandatory on such occasions.

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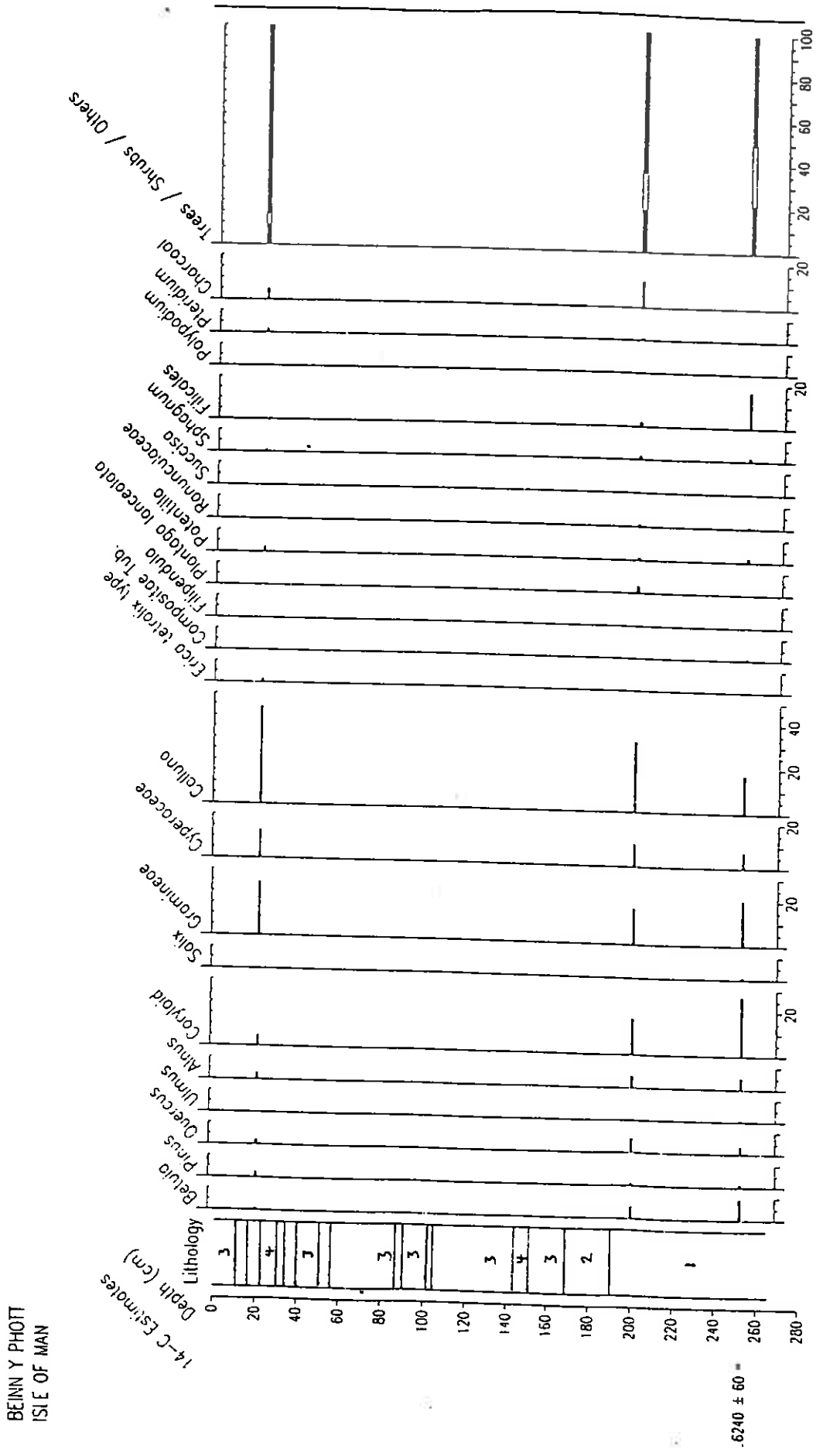


Figure 1: Preliminary pollen analyis from Beinn-y-Phott, Isle of Man (Blackford and Innes 1996).

Buildings in the Hills

FRANK COWIN, FRICS

Our first thoughts are usually that the hills are wide open spaces of great beauty and grandeur but entirely bare of buildings. Second thoughts perhaps bring to mind the Snaefell Summit Hotel, the Bungalow, various assorted marshals' huts and just probably the Shepherd's cottage at Brandywell, all but the last relatively modern.

There are however two distinct groups of other buildings - those associated with mining and quarrying which can be anywhere, almost at random, and the upland farm buildings. These last are rarely on the true uplands but are usually to be found at the head of valleys or at the upper edge of the hill slopes on the rim of the upland proper.

The mines buildings include houses, offices and stores as well as the shafts, machine houses and wheelcases we expect to find.

Mines chimneys exhibit two distinct traditions: the north of England/Welsh tradition of square chimneys and the Cornish tradition of circular chimneys. Despite local popular tradition associating Laxey with a strong Cornish presence all chimneys connected with Laxey and its predecessor, the Lonan Mining Association, are square. This backs up the census returns which show the Cornish influence to be both limited and late. Circular chimneys are, however, common at the Foxdale group of mines with outliers at Glen Rushen and Ellerslie.

The building stone used was obtained locally but, because of the specialised requirements for supporting machinery, granite was carried for greater distances. Its use on the 'face' of the buildings follows a broadly similar pattern to that found in the farm buildings.

The farm buildings show a greater variety of use of material and design than do the mines buildings. Stone will in general have been carried for less than three miles and usually for less than three fields! Because of this there is very little use of either limestone or sandstone, but the colours and texture of slate are endlessly variable. There is localised use of greater amounts of quartz culminating in the 'salt and pepper' stonework of South Barrule.

The use of granite can be seen at its greatest in the buildings on the south facing slopes of South Barrule. It was used for quoins elsewhere, less frequently in proportion to the distance from which it had to be carried from its sources.

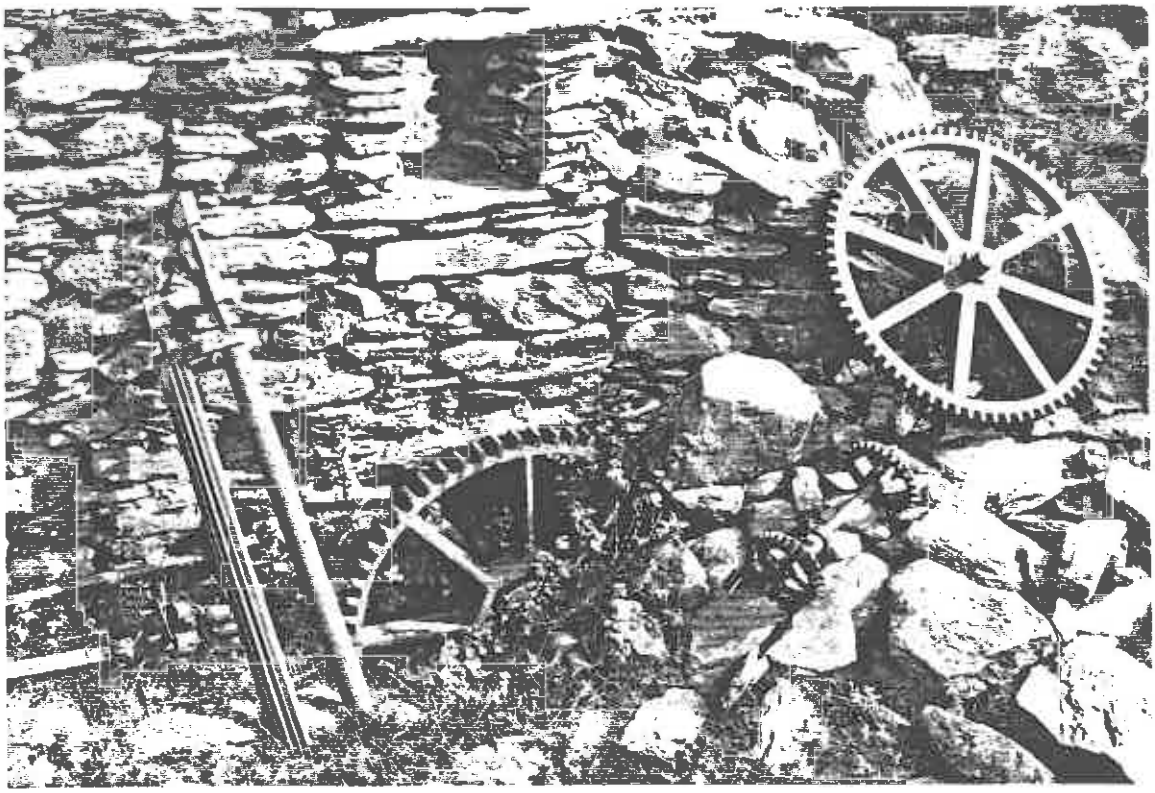
In most areas fireplace and chimney designs are thought of as being a product of the period and style, but in Manx vernacular buildings they are essentially a product of the locality. The 'standard' chiollagh has stone built sides perhaps forming a cupboard or storage area and occasionally an oven and having a substantial square stepped chimney breast above reducing to roof level. The northern slopes and valleys of the northern hills display a high number of room width chiollaghs with wattle and daub canopies showing a distinctive bell shaped slot with a relatively small stone chimney balanced on the wall head. Around South Barrule the granite is used in post and lintel form to support a substantial stone built square stepped chimney.

The farms often had associated machinery and, whilst standard watermills are rare in the upland areas, the sites of Mwyllin Beg (Little Mills) horizontal mills are not.

For a number of years past some groups of Gold Award candidates for the Duke of Edinburgh's Award carrying out explorations on the Isle of Man have been studying and recording certain groups of these upland buildings. Consequently a reasonable record exists of some few groups and in certain cases at known intervals of time allowing the rate of deterioration to be seen. The open nature of the Manx hills make them ideal for these groups of young people and for their colleagues carrying out expeditions. Whilst they record the buildings and countryside for posterity they meet a challenge which can enhance their lives and brighten the future for all.

The deserted upland farms provide a resource of information on building types and materials which is invaluable in any study of Manx buildings and the people who used them. Left to themselves the buildings erode gently and it is only when man intervenes to change the use of an area that they become endangered.

The use of granite mixed with slate on South Barrule



The remains of a thresher with the horsewalk drive and 'control window' in a random rubble slate building. Corrady, Lezayre

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