

Forestry in the Highland Region

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SUMMARY

The Highland Region is the largest and probably most variable Region in Scotland in terms of geology, landform, climate and soils. This together with its general remoteness has had a considerable effect on the history and development of land use, particularly the extent and variability of forestry. Many silvicultural and management techniques have been pioneered in the past 70 years as part of the large afforestation programmes undertaken in various phases by government and private interests. Initially the impetus was to reinstate Highland woodlands devastated in the two world wars; thereafter much expansion took place to fulfil national policy objectives and eventually to provide a significant wood supply for the development of timber industries. These industries have waxed and waned in accord with national as well as local economic trends. Since 1980 however new investment and rationalization has secured local processing and sawmilling capacity which is more or less in balance with timber supplies. Many of the Region's forests provide wide environmental and sociological benefits which managers are actively seeking to conserve, enhance and interpret. As the relatively young forests mature and develop these opportunities will undoubtedly become more evident alongside an expanding valuable timber resource.

INTRODUCTION

When the Society of Foresters of Great Britain and Northern Ireland visited the Highlands and the Moray coast in 1959, J. A. Dickson and R. A. Innes then Conservator and Assistant Conservator respectively prepared a paper 'Forestry in North Scotland' (*Forestry* 32 (1)) which outlined the historical, physical and sociological developments of forestry and land use. Silviculture and forest management were described for groups of forests with similar characteristics. Much has changed in the intervening 30 years and this paper attempts to outline the more important changes.

DESCRIPTION OF THE AREA

The area to be considered, Highland Region, comprises a land surface of 2 539 122 ha which represents approximately a third of the land surface area of Scotland. There are eight District Councils — Caithness, Sutherland, Ross

*Retired 1990

and Cromarty, Inverness, Nairn, Badenoch and Strathspey, Skye and Lochalsh and Lochaber.

Geology and landform

It may be truly said of the Highlands and Islands of Scotland that the geology of the country makes the scenery (Darling, 1947).

The lithology of the Highland Region is shown in Figure 1. The rocks are mainly acid in nature except for the Old Red Sandstone in Caithness and the Moray Firth lowlands in the east, and the basalts in the west. The most prominent geological structures which are significant in the landform are the Moine thrust and the Great Glen (wrench) fault.

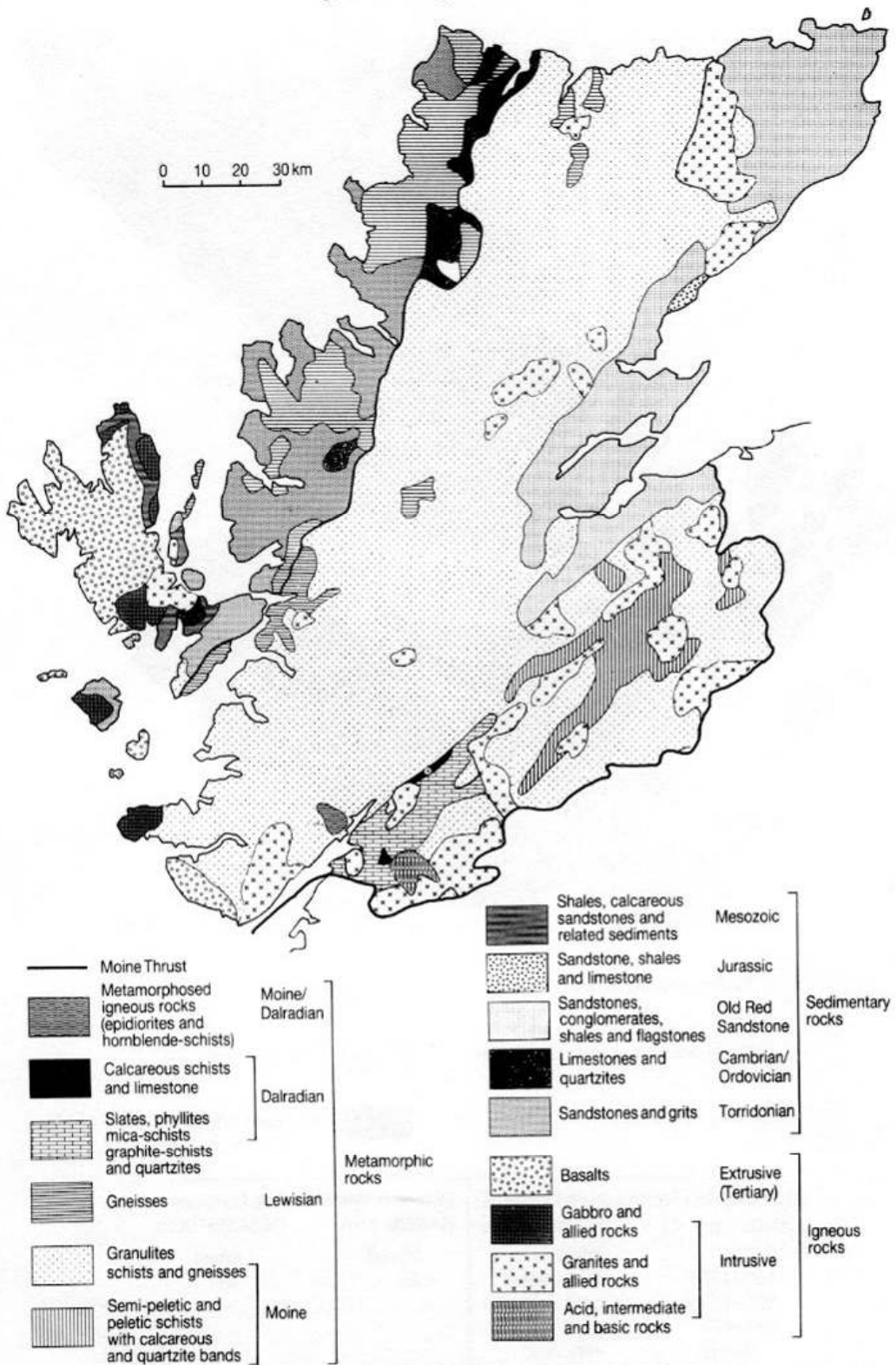
Any consideration of geology in the region must take note of the effects of glaciation. The ice-field in the Western Highlands was estimated (Pearsall, 1950) to be 1200 m thick. The massive ice-sheets in their movement scoured away existing soils, deepened existing valleys and polished rock surfaces. Vast quantities of boulders and detritus were deposited and drift, usually consisting of boulder clay, covered large tracts of land. Soil quality is largely determined by the depth and base-richness of the drift. Drift *per se* may be a poor subject but one only has to consider the areas of Lewisian gneiss and Torridonian sandstone with no glacial drift, to realize its importance and value in successful forestry.

Climate

The climate varies considerably particularly from west to east and with increasing altitude.

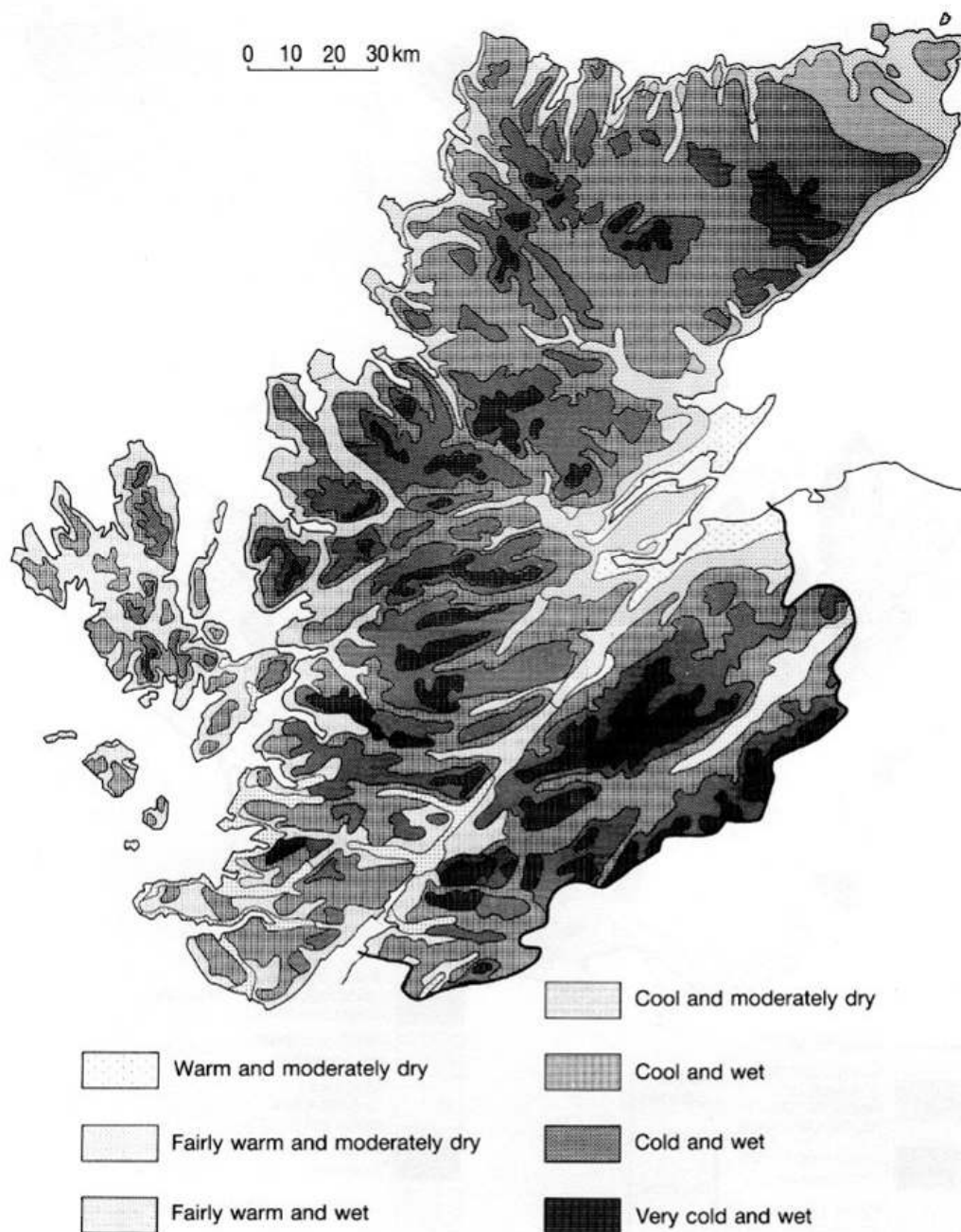
Accumulated temperatures above 5–6°C (the generally accepted threshold for plant growth) as calculated by Birse and Dry (1970) are shown in Figure 2. With the ameliorating maritime influence of the Atlantic Ocean in the west and the North Sea in the east the coastal lowlands are not subject to prolonged frost but frost risk extends over a long period. Inland sites can experience frost in almost any month. The frost hollow effect can lead to very low temperatures as experienced in upper Speyside and Cannich (–20°C). The Moray Firth lowlands are warm due to the Fohn effect created by the mountain mass to the west. The effect also increases the incidence of annual sunlight hours by burning off cloud cover (1347 h at Forres compared with 1130 h at Glenmore 341 m a.s.l.).

Rainfall is largely derived from eastern moving cyclones which carry moist air over the lower lying western islands and peninsulas with rainfall increasing in intensity and duration with altitude in the mountains before decreasing in the rain shadow areas of the eastern basins. Typical annual averages are 700–800 mm in the Moray Firth lowlands, 800–1000 on the Caithness plain and over much of the area east of the Great Glen, 1000–1200 mm in east Sutherland and between 2400 mm and 3200 mm on the western mountains.



Modified from Bibby and Hudson (1982), Futton and Towers (1982) and Walker *et al* (1982).

Figure 1. The solid geology of the Highland Region.



Accumulated Temperature Divisions RANGE (day °C)	DESCRIPTION
>1375	warm
1100–1375	fairly warm
825–1100	cool
550–825	cold
0–550	very cold

Potential Water Deficit Divisions RANGE (mm)	DESCRIPTION
25–50	moist
<25	wet

Modified from Birse and Dry (1970)

Figure 2. The climate of the Highland Region.

Potential water deficit as defined by Birse and Dry (1970) is shown in Figure 2. April to June is generally the driest period of the year.

Western coasts and islands sustain the full force of the frequent North Atlantic gales with mean windspeeds being some of the highest in the world. Shelter is offered by the mountains to the glens and the east coast. The wind zonation map produced by the Forestry Commission (Miller, 1985) provides a useful indication of this (Figure 3).

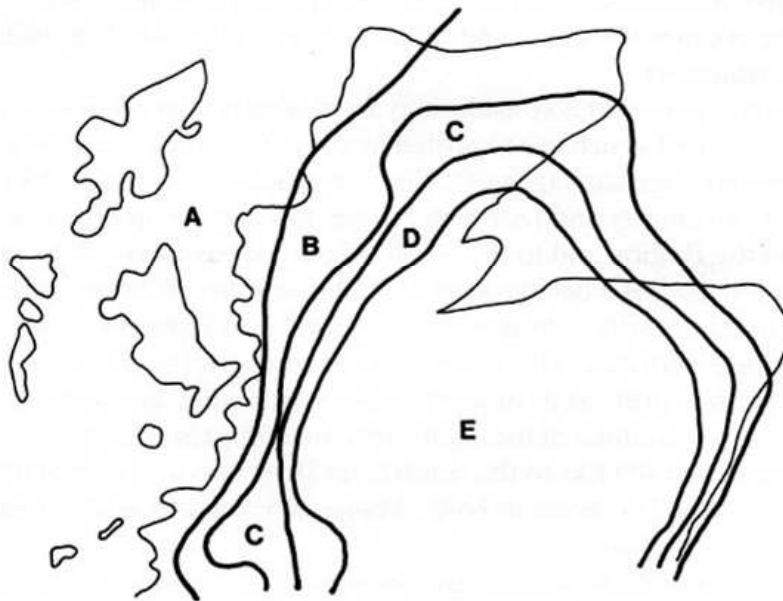


Figure 3. Wind zonation of Highland Region, based on a combination of wind speed data and exposure flag surveys (Equal gradations of wind exposure from high — A to low — G).

Soils

West of the Moine thrust, glaciation and erosion have removed most of the drift leaving extensive areas of bare rock. Soils present are invariably of a peaty nature. The main exception to this are soils derived from basalt which include areas of brown earths.

The large area underlain by Moinian rocks and granites largely comprise peat, peaty gleys and peaty iron pan soils. Peat predominates where drainage is inadequate. Depth and type of peat varies with slope, rainfall and underlying lithology. Up to 0.5 million hectares in the Highland Region — about 15–20% of the land surface — is covered with peat more than 0.5 m deep. Depths of 6.0 m are far from uncommon (W. Towers personal communication). The main exceptions to these peaty soils are steep sided glens where mineral soils such as brown earths and surface water gleys occur and also soils modified by agricultural practice, mainly crofting. Soils in the far south-west tend to be shallower with much rock outcrop.

Soils derived from Old Red Sandstone are mainly surface water gleys in Caithness and cultivated podzols at lower elevations in the inner Moray Firth. At higher elevations peaty ironpan soils predominate. A common feature of soils in all these localities is an indurated sub-soil which restricts drainage and rooting depth.

Communications

The vast size, peripheral location, sparse scattered population, long distances between settlements and the topography all have a significant bearing on transport.

The road network varies considerably from poorly aligned, weak, single track roads some of which are regarded as strategic routes classified as 'A' roads to modern dual carriageways. The construction of the new A9 including the Kessock, Cromarty and Dornoch bridges has and will greatly improve links within the Region and to the south. Much improvement work remains to be undertaken against a background of restrictions in capital investment. Increased forestry traffic, along with other rural developments has resulted in funding being prioritised. This is being undertaken for the forest industry by the designation of preferred (timber) routes which will when necessary feature in the programme of local authority road improvements.

There are main rail links to the south from Inverness and Fort William and 'branch' lines from Inverness to Kyle, Thurso/Wick and Aberdeen and from Fort William to Mallaig.

Dalcross Airport (Inverness) provides airlinks to London, Glasgow, Aberdeen and Manchester as well as the Northern and Western Isles.

LAND USE AND THE RURAL ECONOMY

The main land use activities in the Region are as follows:

Agriculture and Crofting

Agriculture is an important economic activity employing around 6000 people with similar numbers in support industries. Total agricultural output in 1985 was estimated at £96 million with over 60 per cent derived from livestock production. (Anon, 1989). Scope for furthering the Government's policies of switching support from commodities in surplus by diverting into other activities, less intensive practice and creation of farm woodlands is rather limited given that most agricultural production in the Region is not contributing much to the surpluses and also because the local climate, topography, land tenure and peripheral location are limiting factors. Only 1 per cent of the Region (26 000 ha) is prime agricultural land centred in Easter Ross (Plate 1 and Figure 4). The main arable crops grown are cereals and potatoes. The population of crofters has fallen significantly together with a



Plate 1. Prime agricultural land under cereals on the Black Isle overlooking the Cromarty Firth.



Figure 4. Prime agricultural land in the Highland Region.



Figure 5. Crofting land in the Highland Region.

corresponding fall in the number of crofts: 33 209 crofts in 1947 (Dickson and Innes, 1959) to 2000 in 1989 (Anon, 1989). Nevertheless crofting is still an important part of agriculture and social development in the rural scene (Figure 5). Income from crofting supplemented by other employment has sustained families and communities including local services in the remoter areas. Much discussion has taken place of late regarding changes to legislation which will allow crofters to own and manage crofts presently owned by the

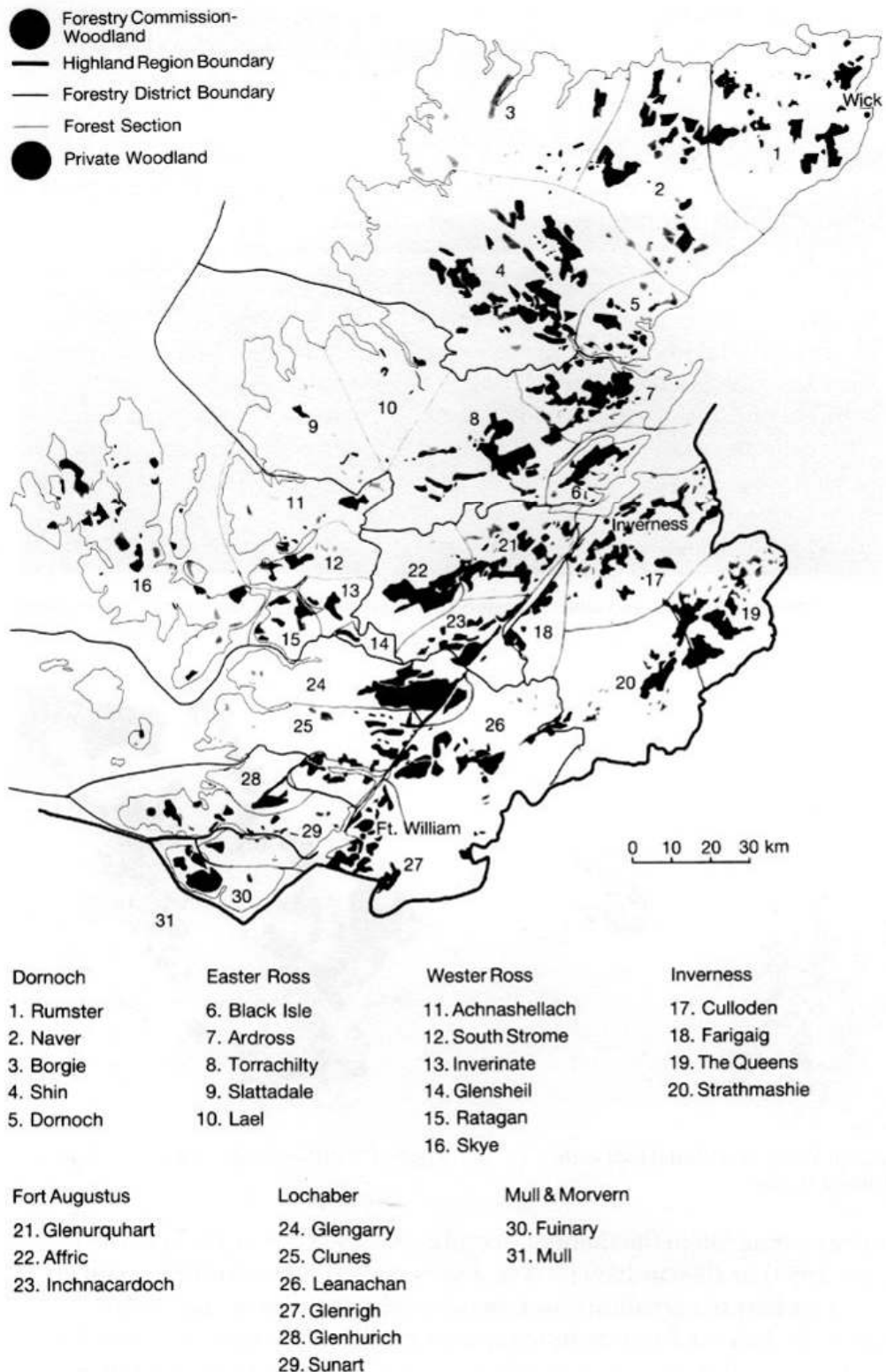


Figure 6. Forestry Commission forests and private woodlands in Highland Region.

state, restore rights to create new crofts, enable tenants and crofters to undertake farm forestry and gain control of sporting and mineral rights.

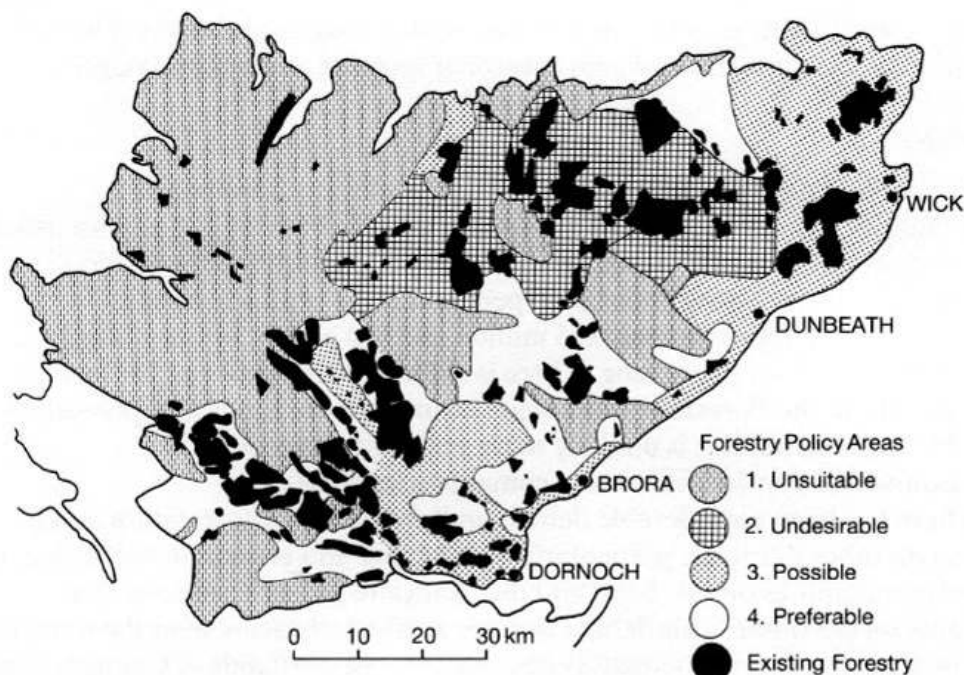
Forestry

Commercial forestry is a major land use amounting to 300 00 ha of woodland, 12 per cent of the Region's area (Figure 6) as well as an important economic activity contributing approximately £25 million to the Region's economy and employing about 1200 people directly with a further contribution of approximately £25 million and 600 people in sawmilling and downstream timber processing. There is still considerable scope for further afforestation; the Forestry Commission estimate there is physical potential to double the area but this is unlikely to be achieved on account of environmental considerations and competing land uses.

There has been considerable debate on the merits of afforestation and its effect on other interests, particularly the viability and economic well being of rural communities on one hand and the change to the environment and wildlife on the other. This debate became particularly acute over the so called 'Flow Country', more adequately described as the peatlands of Caithness and Sutherland. The Nature Conservancy Council (NCC) called for a moratorium on further afforestation of the peatlands. Highland Regional Council (HRC) with the agreement of the Scottish Office convened a Working Party in mid 1987 with representatives of Highlands and Islands Development Board (HIDB), Countryside Commission for Scotland (CCS) and the NCC, with the Forestry Commission (FC) and Scottish Development Department (SDD) as advisers to prepare a land-use strategy for Caithness and Sutherland. The HRC's report was finalized in January 1989 and endorsed by the Secretary to State for Scotland. The report accepted that a further 40 000 ha of new forest should be created in the interests of sustained timber production and that the very substantial areas which the NCC intended to notify as Sites of Special Scientific Interest (SSSI) should be protected from forestry development. This involved the formulation of the four policy areas shown in Figure 7. This approach to land-use planning with reference to forestry development has now been widened to form the Indicative Forestry Strategies being prepared by Regional Councils in Scotland.

Sporting

Sporting interests continue to be an important constituent part of the activity of traditional Highland estates with benefits to local communities. The Region carries a stock of 160 000 red deer yielding an annual cull of 16 500 animals valued at £1.4 million, with revenue from employment, sporting rates and tourism yielding £2 million; rod fishing for salmon contributes £9 million annually mainly through local spending and support of local jobs (Anon, 1989).



FORESTRY POLICY AREAS

UNSUITABLE (339,900 ha.)
Land which is too high, too exposed, too wet or operationally unsuitable for commercial forestry. There is local scope for small-scale proposals.

UNDESIRABLE (150,600 ha.)
Land which is unsuitable for large-scale commercial forestry because of a combination of factors including substandard public roads, open landscape character, sporting interests, and nature conservation value.

POSSIBLE (155,700 ha.)
Land which may be suitable for forestry subject to detailed assessment of crofting, agriculture, sporting landscape, nature conservation and other interests.

PREFERABLE (123,800 ha.)
Land which is considered most likely to be suitable for forestry taking account of technical, environmental and other factors. This area excludes any existing SSSI's of significant size, and Stage 1 SSSI proposals, and Crofting Common Grazing and any agricultural land of Macaulay Land Use Class 3 or better.

FORESTRY POLICY

Presumption in favour of **SMALL-SCALE** forestry i.e.,
Proposals within the Farm Woodland (i.e., up to 40 ha.) or appropriate small scale proposals within the Woodland Grant Scheme.
Re-stocking of and/or amelioration of existing plantations.

Presumption in favour of **SMALL-SCALE** forestry i.e.,
Proposals within the Farm Woodland Scheme (i.e., up to 40 ha.) or equivalent within Woodland Grant Scheme.
Restocking of and/or amelioration of existing plantations.

Presumption in favour of a **RANGE** of forestry i.e.,
Proposals within the Farm Woodland Scheme (i.e., up to 40 ha.).
Proposals within the Woodland Grant Scheme.
Restocking and/or amelioration of existing plantations.

Presumption in favour of a **RANGE** of forestry i.e.,
Proposals within the Farm Woodland Scheme (i.e., up to 40 ha.).
Proposals within the Woodland Grant Scheme.
Restocking and/or amelioration of existing plantations.

Figure 7. Forestry policy areas in Caithness and Sutherland.

Tourism

Tourism contributes £340 million per annum to the Region's economy supporting 10 600 jobs both directly and indirectly; the bulk of visitors come from within the UK (90 per cent) with England contributing 55 per cent. (Anon, 1989). The remaining 10 per cent arrive from overseas to enjoy the scenery, heritage, wildlife and the peace and quiet. The provision of facilities is a subject of much debate among the various development and funding agencies. An example of this is downhill skiing which is a major recreational activity with main centres at Cairngorm, Glencoe and recently Aonach Mor. The main conflict arises as a result of the objection of conservationists to the expansion of skiing into areas regarded as high quality 'wilderness'.

Environmental heritage

At present the NCC have designated 381 450 ha comprising 304 SSSIs (of which 27 are National Nature Reserves (NNRs)) covering 15 per cent of the Region (Figure 8). Approximately 546 400 ha, 22 per cent of the Region, has been designated by the CCS as National Scenic Areas (NSAs) (Plate 2 and Figure 9). The designation of large areas of SSSIs has caused concern among farming and forestry interests. HRC have also expressed doubts.

The CCS are currently undertaking a review of the popular mountain areas in Scotland most of which lie in the Region, to re-examine the case for National Parks.



Plate 2. The Kyle of Sutherland National Scenic Area.



Figure 8. Sites of Special Scientific Interest in the Highland Region.

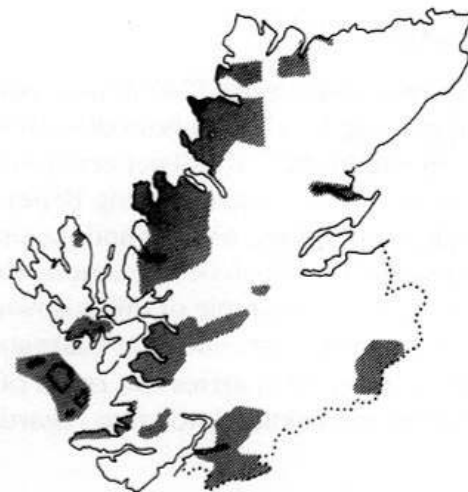


Figure 9. National scenic areas in the Highland Region.

A number of non-statutory bodies are also active in environmental conservation and management in the Region including the RSPB, National Trust for Scotland, Scottish Wildlife Trust and the Woodland Trust.

HISTORICAL

From the evidence available, it would appear that the Highlands were colonized by birch (*Betula* spp.) following a period of tundra vegetation, after the retreat of the ice some 12 000 years ago. This was followed, in the Boreal Period, by the spread of Scots pine (*Pinus sylvestris* L.) which became the dominant tree species over large areas, with birch usually of secondary importance. Later (towards the end of the Boreal Period when the climate was distinctly warmer and drier than at present) elm (*Ulmus* spp.) and oak (*Quercus* sp.) extended northwards. Climatic changes in subsequent periods, however, resulted in wetter and cooler conditions which were to erase considerable areas of Highland forest and to replace it with blanket and basin bogs which persist to this day over much of North Scotland.

Clearance of forest by human activity led to the deterioration of soils and encouraged the spread of peat, heath and bog.

By the Middle Ages, however, there were still large areas under trees, though almost certainly these were scattered and degenerate. It was not until the sixteenth century that we find, with the growth of rich estates, the first deliberate attempt to establish and conserve woodlands in the form of policy woods. The earliest plantings were almost certainly for amenity. Perhaps not until near the end of the seventeenth century do we find shelter-block planting, to provide shelter for stock and firewood for the home.

However, while these plantations were being formed, considerable inroads were being made into the natural woods in the straths and glens by iron-smelters, shipbuilders, and housebuilders.

In 1607 a 'bloomery' was set up at Loch Maree. To provide fuel for it and other furnaces, large tracts of Highland natural forest were bought and exploited until the middle of the nineteenth century. Among the areas of natural pine forest which were worked during this period were Abernethy Forest, Rothiemurchus Forest and Glenmore Forest on Speyside and the forests on Loch Maree side, in Glengarry and in Glenmoriston. The exploitation of the natural hardwoods for charcoal lasted from about 1609 until 1788.

This record of destruction is incomplete without mention of the sheep farmers who first appeared in the 1780s and who burned large areas of pinewood — to improve sheep pasture!

By the end of the eighteenth century it is clear that noteworthy efforts had been made to restore the damage. The First Statistical Account of Scotland (1792–6) devotes considerable space to the subject of woodland, as does the Second Statistical Account published in 1845. The prosperous estates in the middle of the last century laid down large areas in trees, until the agricultural depression of the 1880s restricted their plans. Dickson and Innes (1959) record that, at the time of writing, examples of check were still clearly evident in the Black Isle and at Torridon where the inadequate drainage of plantations laid down about 1900 compared very sadly with the intensive drainage of 50 years earlier.

The two great wars of this century saw the virtual extinction of the older age trees in the Highlands. In the 1939–45 war it is estimated that 21 500 ha of Highland woodlands, yielding 4.04 million m³, were clear felled — nearly all of which was grown on private estates.

Both the Forestry Commission and private estates set to work after the war to replant felled areas and to extend the area of forest by new planting in line with post-war forest policy. Improvements in the technology of afforestation, especially in ploughing and draining equipment and in the use of fertilizer, greatly extended the limits of what could successfully be planted. Afforestation of the poorest heaths and the peatlands became possible provided adequate cultivation and drainage could be carried out. As a result, forests were restored on areas from which forest cover had been lost thousands of years earlier.

The area of woodland in the Region had fallen to little more than 165 000 ha by 1947 (Anon, 1952), barely 6.5 per cent of the total land area. The corresponding area in 1980, as a result of the planting achievements since then, was 240 000 ha, 9.5 per cent of the total land area (Census of Woodlands, 1980). The distribution of ownership of high forest is shown in Table 1.

During the 1980s a further 62 300 ha were planted, as described later, with the emphasis switching from the Forestry Commission (21 500 ha) to the Private Sector (40 800 ha) as a result of a Government forest policy review.

An historical note would be incomplete without reference to the remnants of natural forest which still exist in the Region, especially those of the Caledonian pine forest.

TABLE 1: *Highland Region — area of high forest in Local Authority Districts in 1980 (Forestry Commission Woodlands Census, 1982)*

Local Authority District (LAD)	Forestry Commission (ha)	Private forests (ha)	Total forest (ha)	Forest as percentage of LAD land area
Caithness	3 579	567	4 146	2.5
Sutherland	23 413	7 587	31 000	5.0
Ross & Cromarty	23 778	12 376	36 154	7.0
Skye & Lochalsh	12 319	1 273	13 592	5.0
Lochaber	33 551	15 312	48 863	10.5
Inverness	25 648	16 574	42 222	14.5
Nairn	1 890	6 275	8 165	20.0
Badenoch	6 416	14 994	21 410	9.0
Total	130 594	74 958	205 552	8.0

Broadleaved forest remnants are usually composed of birch, rowan (*Sorbus aucuparia* L.), and in a few places, oak and ash (*Fraxinus excelsior* L.). These woods survive mainly on rocky or inaccessible sites. With few exceptions, size and timber quality are poor, their main attributes being their high conservation and landscape value.

The remnants of the pine forests were described by Steven and Carlisle (1959). They are to be found at a number of widely distributed localities such as Strathoykel (Amat), Achnashellach, Loch Maree, Shildaig, Rhidorroch, Glen Affric, Glengarry, Glenmoriston, Glen Loy and Strathspey (Abernethy, Rothiemurchus).

Glen Affric contains one of the larger remnants and is in Forestry Commission ownership. Since acquisition, measures have been taken to extend the stocked area by planting Scots pine of local origin. Fencing programmes have been undertaken to more effectively exclude red deer from the pinewood areas and hence encourage natural regeneration. Management plans envisage the extension of the woods beyond their present limits and some further planting on bare ground has been carried out.

Encouragement to private owners to protect and extend native pinewoods is described later.

FORESTS OF THE FORESTRY COMMISSION

Forest Administration

From 1 April 1990, the forests within the Highland Region were managed as seven Forest Districts. These are displayed on the map at Figure 6, together with the main forest areas contained within them. Wester Ross Forest District has responsibility for forest areas in the Western Isles Region and likewise Mull and Morvern FD has responsibility for the Island of Mull in Strathclyde Region which fall outwith the remit of this article.

TABLE 2: *Highland Region — Forest Districts at 1 April 1990, areas and forest Age Class distribution*

Forestry Commission Forest District	Areas of high forest by Age Class (ha)				Total	Forest sections
	0–20 years	21–40 years	41–60 years	60+ years		
Dornoch	22 877	12 073	576	146	35 672	Borgie, Naver, Rumster, Shin, Dornoch
Easter Ross	6 968	10 369	4 079	662	22 078	Black Isle, Ardross, Torrachilty, Slattadale, Lael
Wester Ross	8 811	4 820	1 063	611	15 305	Ratagan, Glenshiel, Inverinate, South Strome, Achnashellach, Skye
Inverness	3 211	9 622	1 666	500	14 999	Culloden, Farigaig, Queens, Strathmashie
Fort Augustus	4 941	9 124	1 214	859	16 138	Glenurquhart, Affric, Inchnacardoch
Lochaber	11 124	8 751	2 809	464	23 148	Clunes, Leanachan, Glenrigh, Glenhurich, Sunart
Mull & Morvern (Part)	2 235	2 215	871	14	5 335	Fiunary
TOTALS	60 167	56 974	12 278	3 256	132 675	

Forest District area statement

Table 2 shows the total area of each Forest District, the forests managed by each and the age class composition of the forest areas. The statement for Wester Ross includes the areas in the Western Isles, but these are a relatively insignificant part of the total. The Table indicates the very unbalanced age class distribution and the preponderance of young plantations within the Region.

Forest Land

Early acquisitions were in the main concentrated on land of better quality, much of it steep in the west, the Great Glen (Plate 3) and its tributary valleys.



Plate 3. The steep slopes of the Great Glen at South Laggan, Glengarry Forest which were originally afforested in the 1920s and 30s have been progressively clearfelled and restocked over the past 12 years.

Mechanized ploughing in the late 1930s allowed extensions on to heathlands primarily around the inner Moray Firth and with further advances on to the blanket and basin peats which cover much of the Region.

Acquisitions in more recent times have tended to move increasingly to the peripheral parts of the Region — Sutherland, Caithness and the Island of Skye.

Afforestation

The history of afforestation in the Region has been a record of developments, both mechanical and silvicultural, which enabled a steady extension of the limits of plantable land to the most infertile heaths and peatlands. Inevitably some mistakes were made in the course of progress (and mistakes in afforestation are not always soon apparent) and modifications to practice have been made from time to time.

The early plantings in the 1920s on the good quality land which made up much of the acquisitions were generally very successful. Areas of acquired broadleaved cover were treated in a variety of ways but its value as a nurse was usually recognized, especially on wet or frosty sites where it was often initially retained until girdling after successful establishment of the young conifer stand. On drier sites, clearance ranged from clearfelling to partial retention. Scattered oak at Inchnacardoch was sold standing when the conifer crop was over 30 years old. On the slopes of Craig nan Eun, clearings in oak

scrub were planted. Some of the better oak was retained, but scrub oak was often felled for the preparation of split oak posts.

However, where planting was extended to sites of shallow peat over drift, ground preparation was often inadequate, notwithstanding the evidence available from older woodlands of the need for intensive draining and turf planting on such sites. As a result, there were significant failures, especially on the infertile peaty slopes of Glenshiel, Achnashellach and Slattadale.

Failures, too, were often associated with the over-optimistic use of the spruces, both Norway (*Picea abies* (L.) Karst.) and Sitka (*Picea sitchensis* (Bong.) Carr). It was understandable that one of the main considerations, given the Commission's objectives, was to select high yielding species. In consequence, though Scots pine was the main species in the drier east coast, the spruces and Douglas fir (*Pseudotsuga menziesii* Mirb. Franco) were the primary choices elsewhere. The extension of spruce planting to infertile sites populated or colonized by heather led to check. The early belief that Norway spruce was better able to stand exposure than Sitka resulted in its use on higher slopes in the west with poor results.

Other than in the east coast, pines were little planted in this period. Larches, mostly European (*Larix decidua* Mill.) and Japanese (*Larix leptolepis* Gord.), were extensively planted on good sites, often on grass/bracken slopes where spruce would be preferred now. Canker tended to be prevalent on European larch in the west and poor form was often the result of the use of Japanese larch on fertile moist sites. On the whole, however, results were very good and many excellent stands of larch were grown.

Lessons were learnt from the failures on the more infertile heaths and shallow peats and the 1930s became a period of rehabilitation of the failed areas — at the same time as afforestation of new land continued. Turfing and intensive draining became normal practice on peaty areas, the use of lodgepole pine (*Pinus contorta* Dougl.) increased on such sites and basic slag was applied to young trees. The use of pines, both Scots and lodgepole, and larches increased generally and spruces were planted more cautiously.

By 1939 excellent stands of Douglas fir had been established in the more eastern forests in the Great Glen and locally elsewhere, Sitka and Norway spruce were growing very satisfactorily on the better soils of both west and east coast forests and there was a pleasing mix of pines and larches. However, the more infertile shallow peats of some forests were still posing problems which it was apparent could only be properly overcome by intensive drainage and aeration which could only be satisfactorily achieved by mechanical methods.

Ploughing development provided the means of draining and cultivating the heathlands to a shallow depth at least. In 1937, the first large scale mechanical ploughing was carried out, opening up the possibility of successfully planting the large areas of poor upland heaths which had proved difficult subjects to plant successfully. From then onwards afforestation of heathlands

accelerated and much of the immediate post-war planting took place on the eastern uplands of the region.

The early ploughs had neither the power nor the strength to cut deeply or to penetrate the more difficult compacted soils but ploughing development progressed. By the 1950s the Cuthbertson plough could plough and drain deep peats to a satisfactory depth, while the Ross tine could cultivate the more compacted mineral soils. With the advances in ploughing equipment, and the adoption of phosphate application at time of planting, the limits of what could be successfully planted extended still further.

Ploughing and fertilizer application had produced startling improvements in growth on the basalt soils of the west coast and resulted in the expansion of afforestation in Fiunary and on the island of Skye. Expansion, on a cautious scale initially, also began in Caithness and Sutherland.

On the heathlands of the eastern areas Scots pine remained the primary species, sometimes with a minor admixture of European larch following old private estate practice. The use of Japanese larch increased, particularly in recognition of its value in fire protection and it was normal to plant it in fire belts on the perimeters of plantations and within them. Norway and Sitka spruces were used with caution — even on relatively moist fertile mineral soils. Scots pine or larch were usually preferred in these areas of low rainfall. The use of lodgepole pine on the poorer sites was increasing and intimate mixtures of pine and spruce were planted. Suitable sites for Douglas fir were fewer than in the pre-war acquisitions but unfortunately the seed sources used in post-war plantings in Farigaig and Glenurquhart produced crops of poor form. Plantings were however generally successful though perhaps sub-optimal in terms of volume production given the use of pines and larches on sites capable of growing spruce.

Sitka spruce remained the main species in the west. Efforts continued to find species suitable for the drier and more infertile sites there. Japanese larch was widely tried but, in conditions of exposure on the coasts and on shallow peats, form tended to be poor. Corsican pine (*Pinus nigra* var. *maritima* Ait-Melville) was tried briefly and selectively on the islands — early growth was often satisfactory but subsequent attacks of the fungus *Brunchorstia* in the early pole stage discouraged further use. Lodgepole pine became the main species for sites regarded as too dry or too poor for spruce.

The expansion into Sutherland and Caithness was based largely upon the success of lodgepole pine on deep peats after intensive single furrow ploughing and draining and the application of phosphate fertilizer. By the 1960s the 'humpy' plough could drain to a depth of 80 cm. Research guidance favoured the use of lodgepole pine of south coastal origin because of its fast growth. Notwithstanding the prevalence of basal sweep and incipient instability it was hoped that by reducing or delaying fertilizer application and by the use of smaller plants (tube seedlings were in vogue for a time) this disadvantage could be overcome. Thus south coastal lodgepole pine became the predominant species used in peatland planting and the use of this origin

was not discontinued until the late 1970s. Mixtures of south coastal lodgepole pine with Sitka spruce were also tried and discontinued in the 1960s due to the former component suppressing the latter. During the 1970s slower growing straighter north coastal or intermediate origins were used extensively as low-input forestry was adopted as the preferred policy for the infertile peatlands.

Much of the afforestation programme was now based on the peatlands of the north and west and the use of lodgepole pine extended even to the better peats in the west. In 1960 lodgepole pine comprised 15 per cent of the plants used. By 1975 this proportion had increased to 69 per cent. Given the lower quality of land which could be acquired and the degree of exposure affecting much of it, it was inevitable that the use of lodgepole pine would increase but the end of mixture planting and its extension to a wide range of peatland types accelerated the trend.

Re-appraisal of the use of lodgepole pine origins largely restricted its use to Alaskan or north coastal ones in the more exposed situations and to Skeena ones elsewhere. However, the preferred origins were not always available in the numbers required and seed imports affected choice. A significant use of inland origins in the late 1970s in exposed areas proved unfortunate. Although initial growth was satisfactory, they later proved incapable of coping with exposure. As a result significant replacement programmes became necessary through the late 1980s to the present in west Sutherland, Fiunary, Sunart and Skye. Fortunately, these plantings were on peats of reasonable quality and Sitka spruce replantings are growing satisfactorily.

Rates of afforestation in the region grew steadily after the war, reaching a peak of about 5000 ha in 1970 and averaging about 3700 ha per year from 1960 to 1980 (Figure 10).

Government review of forest policy in the early 1980s, however, decided that private forestry should be encouraged to carry out the major part of the national programme of new planting while the Forestry Commission's share should decline. In consequence, afforestation by the Commission has declined through the past decade to a level of 1574 ha in 1990.

The attack of pine beauty moth (*Pannolis flammea*) on pure lodgepole pine plantings on peatlands (Plate 4) in 1975 and past evidence that spruce could be grown successfully there in intimate mixtures with pines or larches, subject to a suitable fertilizer regime until canopy closure, led to a return to mixture plantings in the 1980s. Ploughing practice also changed. Evidence of instability in stands grown on single-furrow planting on heathlands and peats led to the use of the double-furrow plough, with deep cross-drains at intervals, as necessary.

The use of fertilizers developed considerably over the years. The requirement for phosphate to achieve successful establishments on infertile peats had been recognized since pre-war days, though applications were primarily directed at the more demanding spruces. However, the desirability of applying phosphate to all species on peats and the poorer heathlands at time of planting came to be accepted. One or two subsequent applications of

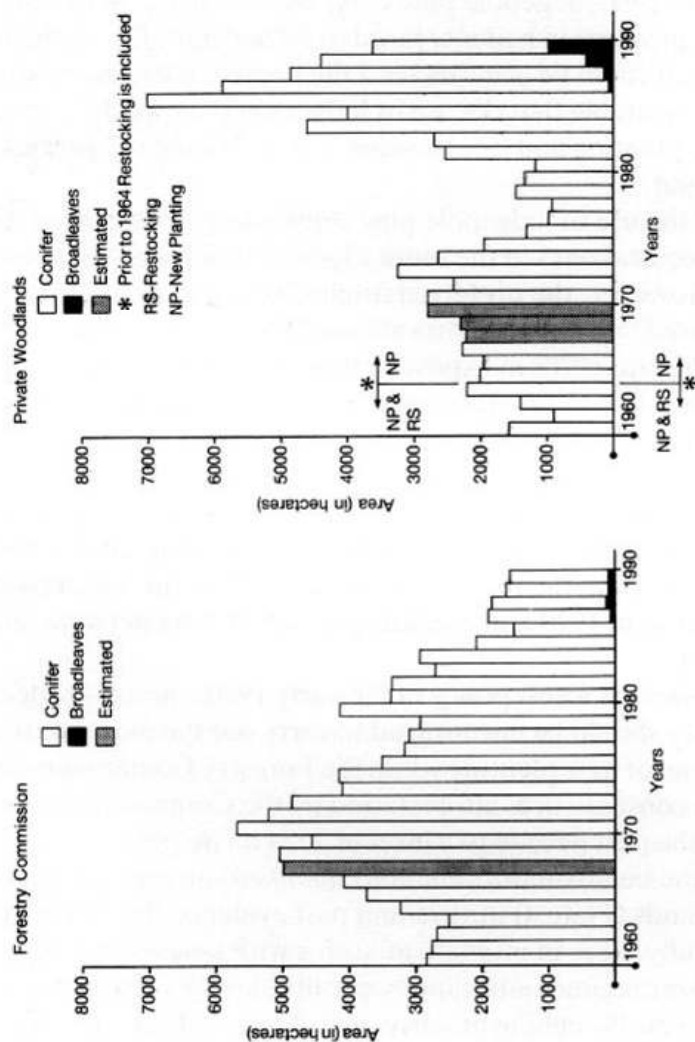


Figure 10. Forestry Commission and private afforestation annual programmes achieved 1960–1990 in the Highland Region.



Plate 4. Pine beauty moth defoliation of lodgepole pine at Naver forest.

phosphate, and potash too on deep peats, were also found necessary on certain sites to maintain good growth until canopy closure when further applications became unnecessary. The development of aerial application made possible large scale treatment of plantations both at time of planting and subsequently. Fertilizer regimes appropriate to site type and species planted were adopted and treatment by helicopter became standard practice. However, aerial application, using ungranulated P or PK fertilizers, could not achieve the uniformity of distribution to ensure satisfactory early growth of the more demanding spruce in particular on peatlands of low fertility. In the light of the more satisfactory results obtained by hand treatment the decision was taken to revert to hand application at time of planting on such sites, at any rate, until uniform aerial application can be achieved.

The application of nitrogen fertilizer in the form of urea had also been found to be effective in preventing spruce from suffering heather check on peatlands and heathlands. However, nitrogen deficiency in spruce can be avoided by the use of intimate mixtures with pine or larch nurses and this is current practice. Aerial application of urea is, however, carried out as necessary, to earlier pure plantings of spruce. Heather kill using herbicides applied on the ground is also practised to achieve the same result, but weather conditions limit the area that can be treated during the appropriate period for treatment.

The plantable reserve in the region at 31 March 1990 was just over 5000 ha, the lowest level for a very long time. This reserve is confined mainly to the peripheral areas of the region, Caithness, Sutherland, Sunart and Skye.

Smaller areas remain to be planted in Fort Augustus and Easter Ross Forest Districts.

In recent years, the main species planted have been Sitka spruce and lodgepole pine in intimate mixture with the object of producing a final crop of spruce (Plate 5). This reflects the predominance of peats and peaty gleys of low fertility in annual programmes. Results have been satisfactory and a final spruce stand of YC 12 on average is expected. Larch is now only planted on mineral soils for reasons of visual amenity, hybrid larch (*Larix eurolepis* Henry) being preferred. Scots pine is planted wherever suitable heathland sites are found and its use has been extended to Wester Ross using plants of west coast origins. It is also being planted in upper Glen Affric using plants of native origin to extend the existing native pinewoods. Broadleaved trees are planted as a constituent of most plantations for amenity and wildlife conservation reasons, usually wherever better soil conditions exist such as along water courses.



Plate 5. A 3-year-old triplicate mixture of Sitka spruce and Alaskan lodgepole pine in Glengarry forest. The mixture comprises of groups of three spruce plants alternating with groups of three pine plants in each row. The species groups are in turn staggered across the rows with each pine group adjacent to a spruce group to maximize the nursing effect of the former on the latter.

Mention has been made of periodic trends in the popularity of different species. To a large extent this reflected changes in the quality of land acquired over the past 70 years. However, much of the afforestation carried out has been of a pioneering nature as programmes continued to extend into land which had previously been regarded as unplantable. Under these circumstances it was not at all surprising that the use of species was subject to review in the light of successes and failures.

To indicate these trends, Table 3 indicates the main species used from 1960 onwards and Table 4 summarizes the composition of the present growing stock as at 31 March 1990 by main species, area and Yield Class.

TABLE 3: *Highland Region — main species used by the Forestry Commission for planting and beating-up*

Year	Scots pine	Lodgepole pine	Larches	Sitka spruces	Norway spruce	Broadleaves
1960	52	15	7	19	3	—
1965	18	38	4	33	2	—
1970	4	56	4	35	—	—
1975	3	60	5	30	—	—
1980	6	62	9	23	—	—
1985	17	37	3	43	—	—
1990	6	37	2	51	—	4

Values are percentage of all plants in each year

Restocking

This account relates to the restocking of stands acquired or established by the Commission. The scale of restocking up to the mid 1970s was rarely large, comprising the replacement of pine and larch at economic maturity, stands of poor growth on sites of high potential and Norway spruce felled prematurely due to severe red deer damage.

Significant rotational felling of Douglas fir and spruce stands planted by the Commission began in 1974. Early restocking results were poor, particularly with Douglas fir, but these have been improved using site preparation*; better plants and planting methods, the development and increased use of herbicides and protection against pine weevil (*Hylobius abietis*) attacks using permethrin. Results are now much more satisfactory.

Sitka spruce has been the major species used, with Douglas fir replanted generally where it grew well in the first rotation with some extension to suitable sites elsewhere. Most restocking to date has been on the high quality

*D7 ploughing on indurated sites, TTS Delta scarifying on free draining mineral soils, mounding and draining using back actors on wet and peaty sites.

TABLE 4: Highland Region — areas and growth rates of the main conifer species in Forestry Commission forests 1 April 1990

Species	Area (ha)	Average Yield Class ($\text{m}^3\text{ha}^{-1}\text{yr}^{-1}$)	Range of Yield Class ($\text{m}^3\text{ha}^{-1}\text{yr}^{-1}$)	Check (%)
Scots pine	26 562	7.6	2–14	3
Corsican pine	121	7.5	2–12	7
Lodgepole pine	48 395	7.5	2–14	3
European larch	1 284	7.0	2–14	3
Japanese larch	4 566	7.3	2–14	4
Hybrid larch	1 499	7.2	2–14	4
Sitka spruce	42 567	11.9	2–22+	10
Norway spruce	4 069	10.9	2–22	6
Douglas fir	2 537	12.8	2–22+	1
Grand fir*	98	13.9	6–22+	12
Noble fir†	155	11.8	2–22	13
Western hemlock‡	152	12.5	2–20	4
Other conifers	159	—	—	—
Total conifers	132 164	9.1	2–22+	4

* *Abies grandis* Lindl.† *Abies procera* Rehder‡ *Tsuga heterophylla* (Ref.) Sarg.

Plate 6. A former Scots pine site at Dornoch forest restocked 4 years ago with pure Sitka spruce on D60, T90 ploughing.

sites of pre-1939 plantings but is now extending to the better heathland sites where Sitka spruce either pure or in mixture is largely replacing primarily pine (Plate 6). Broadleaf trees, native if possible, have been more widely used as a constituent of restocking either by acceptance of often prolific natural regeneration or where necessary by planting.

From a level of 124 ha in 1970 restocking programmes have increased to 850 ha per annum and will rise to about 900 ha by the turn of the century.

Deer protection

Any account of forestry in the region would be incomplete without reference to the importance of deer control. Grazing, both by sheep and deer, did much to reduce the extent of tree cover in the past. Without exclusion of deer from young plantations or strict control of numbers in older plantations, further severe damage can be expected. The numbers of red deer (*Cervus elephas* L.) on adjoining deer forests in parts of the west highlands in particular has never been higher.

The need to design forest areas, both externally and internally, with the requirements of deer control and prevention of damage in mind was appreciated as awareness of damage was realized. For many years now, consultation with the Red Deer Commission has been frequent with regard to the siting of fence lines and the provision of deer down-falls. Internally, open spaces are left unplanted to provide deer-lawns to assist future deer control. Foresters and rangers are now trained in deer management methods which involve population assessment and deer cull targets designed to keep deer numbers at an acceptable level. Experience at Fiunary and elsewhere has shown that it is not sufficient to concentrate protection solely on areas being established — serious damage can be caused in older stands if deer numbers are not kept under control.

Red deer pose the greatest problem in the Region, but Sika deer (*Cervus nippon*), which are particularly difficult to control and are extending their territories, and roe deer (*Capreolus capreolus*) are also increasing in numbers.

Harvesting and marketing

Timber production

By 1990, production from Forestry Commission forests in Highland Region had grown to 325 000 m³ per annum. Table 5 indicates growth in the volumes harvested at 3-year intervals since 1960.

During the 1939–45 War (as in the First World War) British private woodlands were dramatically overcut in place of imported timber. The Forestry Commission woodlands were still predominantly young and unproductive. While some early thinning was carried out, the main yield came from older acquired woodlands. Total production was, however, small.

By the end of the war, thinning potential was beginning to increase,

TABLE 5: *Highland Region — production in Forestry Commission forests, volumes thinned and felled*

Year	Thinned	Felled	Total
1960	54	23	77
1963	44	15	59
1966	80	19	99
1969	58	62	120
1972	88	62	150
1975	52	88	140
1978	n.a.	n.a.	191
1981	76	126	201
1984	56	190	246
1987	83	215	298
1990	47	278	325

Values are '000 m³

n.a., not available

particularly in the fast growing stands on sites of good quality in the Great Glen and in west coast forests. On the steep slopes of the west and central Highlands thinning possibilities were constrained initially by a lack of access and a programme of road construction was instituted. The easier terrain of the east posed fewer problems and thinning of acquired woods and, in due course, Commission plantings progressed.

The level of production was limited not only by problems of access and terrain but also by distance from the only significant market for small roundwood at the time, the mining industry. Sales of standing timber were limited by the fact that timber merchants were less willing to undertake harvesting in the more remote forests. Direct harvesting by Forestry Commission staff developed, to various points of sale from sales at stump to sales of finished products — round and sawn pitwood and sawn timber — at one or two forests. In the post-war period Commission sawmills operated at Culloden, Lael and Ratagan.

In spite of the constraints production from felling, in particular, increased steadily, though continuing to lag behind potential in the forests of the west. Thinning production has fluctuated in response to demand for small roundwood which generally increased during the 1980s. A switch of approximately 40 000 m³ in 1990 from thinning to felling was necessitated by windthrow sustained in an exceptional 1989 gale.

The increasing availability of small roundwood from the rising production of British forests was beginning to attract the interest of wood processors. In 1961 a small particle-board mill was opened in Inverness. Although it only survived until 1967 it did provide a local market for the forests around Inverness at a time when the demand for mining timber in the north declined.

However, the opening by Wiggins Teape in 1965 of a pulp and paper mill at

Corpach near Fort William had a very big impact on production. The Forestry Commission had entered into a long-term contract to supply nearly 200 000 t annually to this mill, and the forests in the Highland Region were expected to provide about 90 000 tonnes annually. The pulp-mill used a chemical process and could utilize all conifers, a major attraction to forests in the region given their mix of species. Planning for the increased harvesting necessary to achieve the supply had been in progress for several years before 1965.

Direct harvesting by the Forestry Commission expanded substantially. Initially, the increase was met by additional thinning. Production, however, had to be cut back in 1969 and 1970 as a result of the 1968 windthrow in mid Scotland and harvesting resources were transferred to that area to assist with clearance. Production resumed its upward trend thereafter.

The start of major rotational clear fellings in the older stands of Douglas fir and spruce made available a significant additional volume of sawlogs — clear fellings of the early larch stands had already started but without the same impact on total log supply. In anticipation of this, the Forestry Commission, in 1970, advertised the availability of a log supply of 54 000 m³ per year on a long-term contract and invited prospective purchasers to submit proposals for the utilization of this material. Subsequent negotiations led to the acceptance of the proposal by one company for the establishment of a new sawmill at Corpach, near the Wiggins Teape's pulpmill, and as a result the Kilmallie Sawmill opened in 1974. Clear fellings began on a major scale, mainly in the forests of the Great Glen and the west.

Though clearfelling was now to increase steadily, thinning was being reduced in the difficult terrain of the west and concentrated more on the easier heathlands of the east. It was difficult to justify thinning on economic grounds in areas remote from markets where costs of harvesting and roading, as in cable-crane country, were high and wood values low. In such situations it was decided to stop thinning, subject always to review in the light of any significant changes in costs or prices. In due course, it was also decided to abandon thinning in forests where the risk of windthrow was high as is the case in many of the west coast forests — and those on peat.

The closure of the Wiggins Teape pulpmill in 1980, at the start of a period when the domestic pulp and paper industry suffered severely from world recession and the strength of sterling, eliminated the only major market for small roundwood in the region. However, it opened the door to the start of export of pulpwood on a major scale to Scandinavia from a number of ports in the north of Scotland. Wiggins Teape, in fact, pioneered the trade by shipping the balance of their pulpwood stocks from Invergordon.

Exports were a temporary measure introduced in the north, as in other parts of Britain, to sustain harvesting resources until new processing industries could be attracted by the available wood supplies to replace those which closed in the recession. Exporting in fact continued right through the decade continuously from Inverness and Montrose and intermittently from many other ports — almost all on the east coast.

The decade saw a dramatic rebuilding of the wood processing industry throughout Britain, the introduction of new plants and the expansion of existing ones. In 1985 a new factory was opened by Highland Forest Products at Dalcross near Inverness to manufacture oriented strand board (OSB), with a projected wood requirement of 160 000 t annually and a contract with the Forestry Commission to supply about 50 per cent of this total. Scots pine was the preferred species.

Forests in the Region were also required to supply small roundwood, especially spruce, to meet contractual supply to other mills outwith the region. Demand for sawlogs also rose steadily as a result of considerable investment by the sawmilling industry in expansion and modernization.

All these developments inspired high levels of demand and production. Thinning activity was particularly high, mainly in the forests around the Moray Firth but also extending into central and more northerly forests on stable sites encouraged by improved returns from early thinning. Late in the decade, however, contractor shortages were becoming evident and demand for some wood products declined with the restraint on construction activity generally.

Throughout the development of production, the relative extent of harvesting carried out directly, by staff or contractors employed by the Forestry Commission, and by sales standing to timber merchants has fluctuated considerably as indicated in Table 6.

TABLE 6: *Highland Region — production in Forestry Commission forests, sales standing and direct harvesting volumes*

Year	Harvested by direct working		Harvested by sales standing	
	Volume ('000 m ³)	Percentage of total production	Volume ('000 m ³)	Percentage of total production
1960	34	44	43	56
1963	21	35	38	65
1966	52	51	47	49
1969	91	75	29	25
1972	122	82	28	18
1975	119	85	21	15
1978	168	88	23	12
1981	188	87	29	13
1984	194	79	52	21
1987	217	74	76	26
1990	216	67	109	33

Standing sale merchants always had problems in carrying out contracts in the more distant parts of the region. They had difficulty in obtaining and retaining the necessary labour force in areas of low population. Harvesting

workers generally had to be imported from the east coast and tended to become discouraged by the problems of weather (and midges in the summer!), terrain and distance. The merchants, being usually based on the east coast or further away, had to supervise at long range. Performance has generally improved in recent years with better public roads, the introduction of higher output machines and more sales now being of clearfellings. Direct harvesting by the Forestry Commission faced many of the same problems but had the advantage of more local supervision and resident harvesting staff, in the days of the pulp mill at least.

The level of commitments even now makes it necessary to carry out a high proportion of direct harvesting, though to a lesser extent than in the days of the Corpach pulpmill. However, in an area distant from the main centres of population and sensitive to fluctuations in national demand, the Commission's long-term contracts, from the pulpmill onwards, have provided a degree of stability to harvesting programmes. Without these and a significant proportion of direct working, it is unlikely total production would have grown as it has. Without the Forestry Commission's long-term supply contracts it is also unlikely the major small roundwood processing industries would have been established.

Markets

The sawmilling industry which absorbs the major share of production from the forests in the region is a traditional industry in the east, founded on the log supplies mainly of Scots pine provided by estates with a history of forest management situated within the area. The development of the Forestry Commission forests has created an additional supply of sawlogs from forests throughout the region, a supply which has increased considerably since rotational clear felling of the early plantings began. The sawmilling industry has responded with considerable investment in new plant and equipment, particularly in the last 20 years.

There are now three sawmills of large capacity in the region, four of medium size and several smaller with a total capacity to process about 300 000 m³ of sawlogs. There are also sawmills in the adjoining Grampian Region which regularly purchase logs in Highland Region, and purchasers also come from much further afield.

In recent years, there has been little difficulty in selling logs. Demand for spruce and Douglas fir logs has been very high indeed. In some of the more remote forests disposal of larch, in particular, has sometimes posed problems. Demand for small palletwood logs has tended to fluctuate with levels of industrial activity in the country and import prices, as could be expected in an area far from the main markets.

Unlike sawmilling, present markets for small roundwood have been created in recent times. The OSB mill at Dalcross takes 80 000 t, 50 per cent of its required wood supply, annually from the Forestry Commission under the terms of its supply contract. At present this is mainly pine and the supply

area takes in the east of the Region. The factory has recently announced expansion plans which will require supply from a wider area.

Spruce pulpwood from forests in the region is presently supplied to the modern pulp and paper mills at Shotton and Irvine and to the Workington cartonboard mill — the latter supplied by sea from Lochaline (Fiunary Forest). Mixed species chipwood is also supplied to the Caberboard plant near Stirling which manufactures particleboard and medium density fibreboard. Until recently regular exports of pulpwood continued from Inverness.

Eastern pine forests supplied poles for the transmission pole market until a short time ago. Unfortunately, the specification introduced by British

Telecom is now so demanding that it has discouraged local supply.

Harvesting methods

Skilled labour for harvesting operations has always been at a premium in the Highlands. Shortages have been particularly acute at times when harvesting programmes were expanding to meet a market requirement, for example the start up of the Fort William pulpmill, or with the advent of other labour markets willing and able to afford higher levels of remuneration. Oil platform construction yards, of which two are still operational in the Region at Ardersier and Nigg, periodically absorb large workforces, attracting personnel from the forest industry among others. Economic considerations have encouraged a movement from direct employment over to contract labour for harvesting, except in the case of key extraction machine operators. Notwithstanding this shortage the harvesting costs have not moved upwards in real terms until recently and indeed are still among the most competitive in the country. This in turn has until recently frustrated the introduction of mechanized harvesting systems which, particularly in the case of thinnings, cannot offer the cost savings experienced elsewhere with such systems.

The start of thinnings on the steep slopes of the west and central highlands posed extraction problems — and still do! In the early days, horse extraction was the normal method but chutes and primitive cable-ways were tried too — often with exciting results! The possibilities of using cable systems practised in mountain areas of Europe were explored and, sometimes, tested in Highland conditions. One such cableway was tried out in the Great Glen as early as 1956, a continuous moving cable called the Lasso. The cable-crane as used in Norway was found to be the answer, however, and tractors with Isaachsen double-drum winches and tower were introduced for extraction in the period leading up to the opening of the Corpach pulpmill. After very intensive training, cable-crane teams were available to boost outputs to meet the pulpmill requirements. Since then, cable-crane machinery has developed through the use of skylines winches with extended ranges and trailer winches which could handle heavier loads. Improvements in output have been achieved, leading to the investigation of roadside systems that could cope economically with the problems of congestion caused by the higher outputs. Forwarders, skidders and lorries with rear-mounted loaders have been

introduced into the system to carry out secondary extraction. In Lochaber, a clam-bunk skidder is employed to serve the outputs of several cable-cranes. The introduction of a mechanized processor in the system is under trial and several contractors have already moved to this capital intensive system. Balancing the elements in a system primarily constrained by cable-crane outputs and in many instance insufficient roadside space still causes difficulties.

The requirement to use cable-cranes has, however, now been greatly reduced by the development of forwarders with much greater terrain capability. Forwarding, initially using nursery tractors and hand-loaded trailers on spaced racks, had always been practised on the Black Isle. The advent of tractor/trailer combinations with a grab led to an extension of forwarding and a reduction in skidding. The introduction of purpose-built frame-steered forwarders from Scandinavia extended the use of forwarders from the eastern forests to the rest of the region and on to slopes which had previously been regarded as suitable for only cable-cranes. A limited amount of skidding in certain situations has also displaced the use of cable-cranes.

At present, primary extraction methods used in direct working are as follows: forwarding 70 per cent, skidding 10 per cent, cable crane 20 per cent.

PRIVATE FORESTS

Ownership

During the 1960s private sector forestry amounted to 40 000 ha of woodland rising to in excess of 50 000 ha by the end of the decade. This was distributed among a dozen large traditional Highland estates with 800–2000 ha each and twice that number of smaller estates with smaller areas, together with a few existing landowners who had gone in for large investment planting schemes.

The Scottish Woodland Owners Association were actively advising and assisting these estates at a time when interest in forestry was considerable. The FC North Scotland Conservancy annual report encapsulated this in 1965 with 'The increased interest in forestry on the part of the private owners probably stems from the general feeling that more forestry must be high on the list of priorities in dealing with the Highland "problem" and partly because of the changed political scene.'

However, in the early 1970s interest in forestry on the estates had waned considerably with many of them being broken up into several smaller ownerships for fiscal and financial reasons. Many owners sold out and provided an opportunity for the newer forestry development companies with their multi-ownership investment planting schemes. This trend continued into the 1980s with institutions, high earning individuals and overseas interests all active. The Forestry Commission disposal programme which commenced in the early part of the decade contributed to an increase in private ownership.

The first development by a forestry company in Caithness and Sutherland was in 1979/80 inspired by low land prices and development costs and growth rates comparable with the Scottish average. The land involved was thought to have little or no conservation value. A surge of activity ensued with large tracts of land changing hands and being planted. However, so much open peatland being planted resulted in conflict on a grand scale with initially the RSPB and then the NCC.

In recent years, land including forest has been purchased by nature conservation bodies. The RSPB, for example, have purchased large areas of native pinewoods adjacent to their Loch Garten Reserve in Strathspey.

In the late 1980s there has been a further surge of sales by traditional estates encouraged and financed by the southern property boom and overseas buyers. Sporting interests have been particularly to the fore.

Fiscal changes

The Highlands contained some of the largest Dedication and Approved Woodlands Schemes in Britain during the 1960s which together with Schedule D Tax incentives were successful in restoring the vast areas of Scots pine woodland devastated in the two wars. The Dedication Scheme and taxation system also resulted in estates breaking up their land holding into smaller ownerships to take advantage of short term financial benefits.

By the late 1960s and early 1970s this, together with Capital Transfer Tax, had exerted considerable pressure on owners whose interest in forestry on their properties declined. Interest switched to private investors to coincide with the introduction of the Basis III Dedication Scheme of the mid 1970s. This scheme increased the amount of consultation between the Forestry Commission and other agencies, such as the Department of Agriculture and Fisheries for Scotland who were cautious regarding the release of land for afforestation.

The first native pinewood scheme introduced in 1977/78 met with limited success.

With the introduction of the Forestry Grant Scheme in 1981/82, the high level of new planting being proposed throughout the 1980s coupled with an increasing interest in conservation resulted in much more consultation.

The introduction of the Broadleaved Woodland Grant Scheme as part of the new Broadleaf Policy in 1985 led to a marked increase in the area of broadleaves planted. The statistics (Figure 10) look promising although the real success of the policy will be judged on the future environmental benefits gained.

Since the 1988 budget changes, investment planting has declined steeply while the increased grants available through the Woodland Grant Scheme have encouraged more estate owners to consider afforestation. The Farm Woodland Scheme is of little consequence given the nature of this Region. The new Native Pinewood Scheme has attracted considerable interest.

Silviculture

More intensive silvicultural practices were adopted in the 1960s. These tended to follow Forestry Commission practices such as deeper ploughing, choice of species (Japanese larch decreasing, spruces increasing except in the east where Scots pine predominated) and fertilizer application. Much of the planting in this period was restoration of woodland devastated in the two wars some of which had been cleared or underplanted as planting moved on to sites where woodland had been absent for considerably longer. Ploughing became standard practice especially on poorer sites and also where heavy weed growth was anticipated. Protection problems came more to the fore in the mid 1960s with shoots being organized to control roe deer and owners being encouraged to treat stumps with creosote to prevent the spread of 'fomes' butt rot (*Heterobasidion annosum*).

Silvicultural practice in the 1970s and 1980s continued to mirror Forestry Commission techniques. Levels of afforestation are depicted in Figure 10.

Production and marketing

The production of timber from private woodlands in the Highlands has been and still is very difficult to assess. At present the potential annual production probably amounts to approximately 200 000 m³. The volumes notified by dedicated estates and the volume licensed by the forest authority provide only some indication of the activity in any year, and in general follow similar trends to those of the Forestry Commission. In the 1960s harvesting was in the hands of contractors working to about half a dozen large sawmilling companies which were sustained on the maturing stands which had been too young or too remote to contribute to the war effort. The main harvesting effort in the private sector was progressed by the emerging forestry companies who provided a harvesting and marketing service for first and second thinnings to the pulpmill at Fort William. This service has continued in conjunction with that offered by five harvesting organizations associated with sawmills. The markets have fluctuated considerably in a similar manner to that experienced by the Forestry Commission. Today private woodlands contribute a significant volume of conifer timber from thinnings and an increasing volume from clearfelling of post-war plantings. The hardwood resource is inadequate to support a steady market though from time to time framing timbers for the fishing boat building industry on the north-east coast of Scotland has proved a lucrative market for those estates with moderate oak grown in small woodlands among the limited areas of intensive agriculture on the coastal plain and in the lower river valleys around the Moray Firth.

MULTI-BENEFIT FORESTS

The concept of multi-benefit forestry is becoming increasingly recognized and practised, not least in Highland Region. The Forestry Commission has a



Plate 7. The Strath Rory glacial meltwater channels SSSI at Ardross forest. The Forest was established during the 1980s with particular regard to forest design and in particular the provision of open space.

number of striking examples the best of which is probably Strath Rory, part of Ardross Forest in Easter Ross (Plate 7). Although still relatively young, the earliest planting being 1977, the rewards are already presenting themselves. Features of interest include:

1. Significant input in general and public roadside landscaping with particular emphasis on forest margins and open space. The design of open space aims to accommodate movement of wildlife, maintain habitat diversity and facilitate deer control.
2. The conservation and interpretation of the important geomorphological features, in particular the best example of glacial meltwater channels in the Highlands (designated as a SSSI).
3. The practical conservation of an unusually diverse range of habitats and research into management of a herb rich meadow.
4. Public access to and the interpretation of a hen harrier nesting site which has attracted increasing numbers of visitors:
1988 — 4500 visitors
1989 — 6000 visitors.
5. The protection and study of archaeological sites.
6. Practical conservation of important bird species by provision of nesting opportunities.
7. Public access.

All this exists together with timber production which is still some years away, in one forest. This, however, is not a solitary example as the Region's forests are endowed with a range of diverse wider benefits.

There are a number of notable forest landscapes throughout the area. Glenurquhart Forest managed by the Forestry Commission was recognized in the Scottish Woods and Forests Award in 1986. Unfortunately, uncharacteristic gale damage in 1989 resulted in much alteration to the professionally produced design plan which envisaged the transformation of an evenaged plantation to an irregular forest by progressive felling of landscaped coupes followed by the redesign of the second and subsequent generation forest. Other examples where such work is being undertaken are at Glen Nevis, Affric, Longart and Glenmore.

Nature conservation projects are an important aspect of forest management. Those of notable success in Forestry Commission woodlands comprise: capercaillie (*Tetrao urogallus*) reserves, artificial osprey (*Pandion haliaetus*) eyries, bat boxes (Plate 8), otter (*Lutra lutra*) haven, nesting boxes, artificial merlin (*Falco columbarius*) nesting platforms, and artificial floating islands for black and red throated divers (*Gavia artica* and *G. stellata*) (Plate 9).



Plate 8. A Forestry Commission conservation forester assisted by school children erecting bat boxes in Ardross forest.

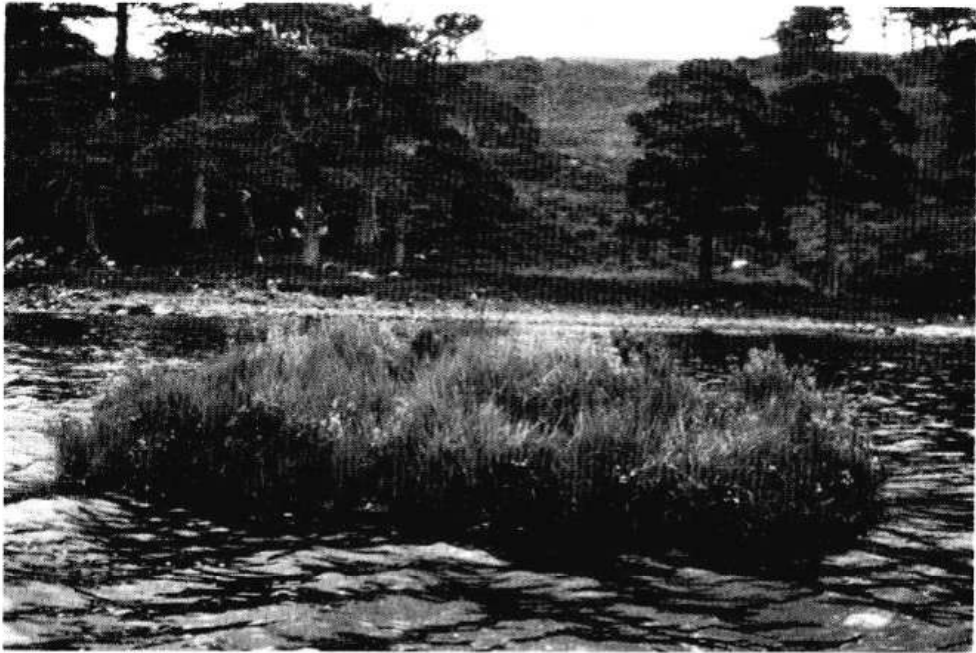


Plate 9. An artificial island constructed by the Forestry Commission from polystyrene and chicken wire topped with natural vegetation to assist the breeding of black and red throated divers. This example is located in Glen Affric on a loch with an adjacent native pinewood.

The forests of Highland Region contain many fine sites of significant archaeological interest which have been increasingly recognized and protected by forest managers. Striking examples include: clearance villages, hill forts, duns and hut circles, standing stones and stone circles, burial mounds and cairns. Many of these are now being interpreted for the benefit of the public.

Forest recreation facilities for the public are mainly provided by the Forestry Commission although some private estates and forestry companies do provide a limited service albeit largely of a commercial nature, e.g. Rothiemurchus Estate and the Landmark Centre. There is only one Forest Park — Glenmore, the Queen's Forest near Aviemore. It boasts a range of facilities including a visitor centre, camp site, forest walks and trails, ski tows and cross country ski trails. Most Forest Districts provide a number of facilities. The present provision amounts to walks (160 km), trails (25 km), car parks (53), picnic sites (58) and many interesting view points.

A long distance footpath, the Great Glen way, proposed by the Countryside Commission for Scotland will extend the West Highland Way from Fort William and will pass through a number of forests in the Great Glen before arriving at Inverness. Numerous important mountain access routes also pass through forests. These are becoming more heavily used with each passing year and make the requirement for increased maintenance more demanding on the landowners to ensure that erosion is kept in check.

In total it is estimated that the FC forests of Highland Region experience 1 250 000 day visitors per annum.

Other important activities which benefit from the forest environment comprise orienteering, husky trials, day permit stalking and fishing, car rallies, including the Snowman in February and the Six-day motor bike trials in May.

THE FUTURE

The preparation and implementation of the Highland Regional Council's Indicative Forestry Strategy in 1990/1991 and beyond will have a considerable bearing on future afforestation in terms of its location, extent and format. Hopefully, it will provide a framework for continued enlightened development with due regard to environmental considerations.

Further radical development of silvicultural practice at present seems unlikely, despite the 'greenhouse effect', although the wider use of improved Sitka spruce is likely. The modification of silvicultural systems and forest design will, however, respond to increasing public awareness of the available benefits to be gained, particularly in second and third rotation forests.

Production will continue to increase mainly as felling of post war stands gains momentum with thinning remaining fairly static from now on (Figure 11).

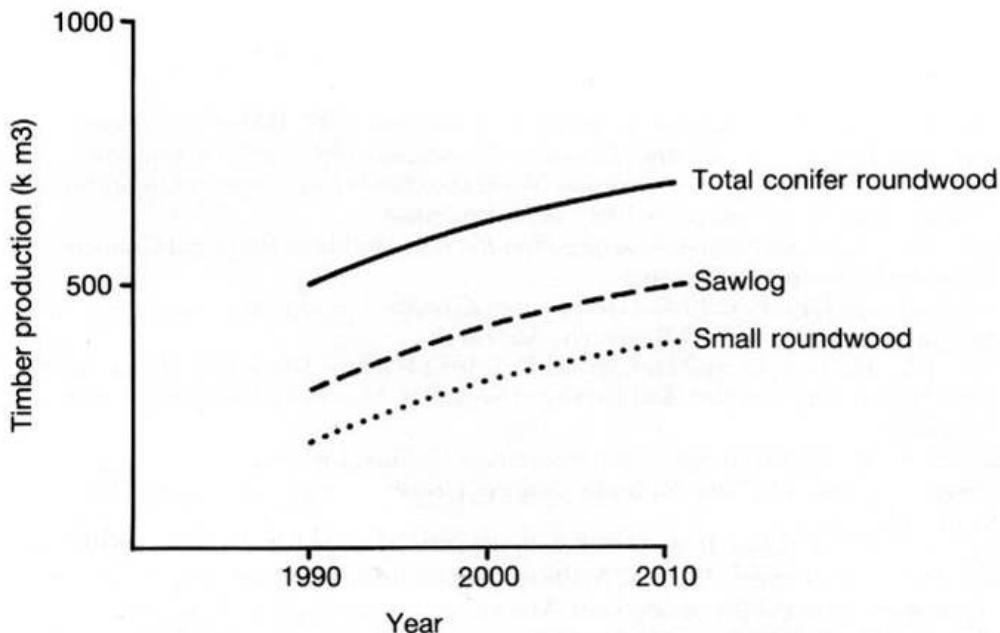


Figure 11. Projection of potential timber production from Forestry Commission and private woodlands in the Highland Region (Production is expected to rise significantly beyond 2010).

Forestry will be an increasingly important land use and economic activity in the Highland Region. The ups and downs which have plagued the industry locally in the past will reduce as production increases and markets stabilize

but no doubt they will continue to contribute to the interest of those engaged in the business of forestry management in the Highlands for some time to come.

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