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COED-Y-BRENIN

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Coed-y-Brenin

FORESTRY COMMISSION

HISTORY

OF

COED - Y - BRENNIN

FOREST

1921 - 1951

NORTH (WALES) CONSERVANCY

HISTORY OF COED-Y-BRENIN FOREST

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HISTORY of COED-Y-BRENIN FOREST

GENERAL DESCRIPTION of the FOREST

Situation

The present forest of Coed-y-Brenin was originally called Vaughan after the family from whom much of the land was acquired. Included in the forest both under its old and its present name is the detached block in the Wnion valley known as Hengwrt.

In 1935, to mark King George V's Silver Jubilee, one forest each in England, Scotland and Wales was renamed the equivalent of the King's (or Queen's) Forest, and the then Vaughan Forest was chosen to become "Coed-y-Brenin", the "King's Forest" in Wales.

The forest lies within a radius of nine miles west, north and east of Dolgelley the county town of Merionethshire. The main block of forest starts some three miles north of Dolgelley in the Mawddach valley, through which the main road to Ffestiniog and Snowdonia runs, and spreads out on either side of this valley and its two tributary valleys of the Eden (from the north west) and Afon Wen (from the north east) which join the Mawddach near the village of Ganllwyd.

Two miles to the north west of the main block on the lower eastern slopes of the Rhinogs lies a block of some 1,100 acres known as Cwrt after one of the holdings situated on it.

Hengwrt, which has already been mentioned, is the other large detached block totalling to date 1595 acres of plantation and it lies on the western slope of the Aran mountains on the south and east side of the Wnion valley through which the main road from Dolgelley to Bala and Corwen runs.

Along the north of the estuary formed by the junction of the Mawddach and Wnion, about a mile and a half north west of Dolgelley, are several small blocks of plantation. One of them, Waterloo Wood, is the oldest in the forest. In addition two small blocks occur to the north of the Wnion valley east of Dolgelley.

Though it is idle to forecast future extensions of the forest, large areas of derelict woodland and birch and oak scrub lie on the north side of the Wnion valley from opposite Hengwrt to Dolgelley and all along the south side of the Wnion valley and the Mawddach estuary, the latter area being on the northern slopes of Cader Idris.

Area and Utilisation

Coed-y-Brenin has been acquired over a period of years through some 33 leases purchases and exchanges. Since 1949, 13 of the large farms or sheep mountains have been transferred to the Ministry of Agriculture and there is still one more farm to be so transferred.

Sheep farming is the main form of land utilisation in this part of North Wales, and its special features have to a considerable extent determined the availability of land for planting. The hill sheep farm consists of three inter-related parts, the small area of meadow and arable land usually in the immediate vicinity of the farmstead, the ffridd which is the more sheltered and lower lying winter grazing and which often includes some form of scrub or woodland, and the mountain or summer grazing.

It is only the ffridd and the mountain that as a rule can be considered as available for planting. Obviously the amount of mountain a farmer grazes must be related to the amount of wintering he has got. When a part or whole of a farm is acquired for planting, therefore, it has to be done with regard to this relationship, not only in respect of the balance between the ffridd and the mountain, but also the access from one to the other.

Another consideration is that the sheep go with the land, so care has to be taken in the disposing of flocks or re-letting of mountain grazing. For a short period the Commission had to take over a flock of sheep on the Cwrt area.

It is on Hengwrt with its half-dozen large and fairly good sheep farms that there has been the most trouble in getting land for planting.

The Commission's practice of keeping its holdings and smaller farms on a 364-day tenancy has at times given rise to local criticism, but this has died down as it was seen that the interests of the tenant were respected.

The sporting was never very good and nowadays it is almost impossible to let it. Apart from woodcock and a few blackgame, very little game is to be seen on the forest. There is, however, good fishing on nearly all the rivers and streams in the forest area though the practice of planting up to the banks has seriously interfered with it.

Gold, copper and manganese were at one time mined extensively in the area and old workings and trial levels are common in the forest. There is, therefore, always a possibility in the case of the leased land that the lessor may decide to work the minerals again and the forest suffer as a result. In 1937 a limited amount of work was done to open up levels in the Afon Wen valley and a small group of promising Scots pine seedlings destroyed.

Table I

Acquired from	By	Date	Plantations acquired	Plantable excl. 61 4	Nurseries	Agricultural	F.W.H.	Unplant-able	Other land		Total
									Des.	area	
1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.
R. Vaughan Esq.	Lease	19. 1.21.		611							611
Mrs. M.M.Owen	"	8. 3.21.		313							313
Maj.Gen.J.Vaughan	"	21. 3.21.		113							113
" " " "	"	22. 5.28.		1504							1504
Mrs. M.E. Lewis	"	15. 7.24.		170							170
R.Vaughan Esq.	Convey 'ce	30. 3.25.		351				52			403
Mrs. M.M. Owen	Lease	21.10.26.	45	2332		583		1792			4752
T.H. Roberts Esq.	Convey 'ce	6. 7.27		703		126		719			1548
Rev.Gordon Lloyd	"	31. 3.28		395		26	30	142			593
Messrs.Hughes & Lobb	"	31. 3.31		481			31	218			730
Maj.Gen.J. Vaughan	Lease	27. 5.31		116							116
J.N.West Esq.	Convey 'ce	23. 6.31.		466		15	20	37			538
Miss & E. Eaton Esq	"	21. 8.31.		423							423
R. Evans Esq	"	15.10.31.		240		44		90			374
E. Jones Esq.	"	20.11.31.		416		52		208			676
C.Ansell Esq.& Others	"	29. 1.32.		941			85	697			1723
W. Evans Esq.	"	19. 2.32.		248				315			563
M.Tudor Esq.& Others	"	22. 8.32.		126		12	20	114			272
Mrs. E. Jones	"	31. 8.32		23			8				31

/ Mrs.M.E.Lewis

Acquired from	By	Date	Plantations acquired	Plantable excl. Col. 4.	Nurseries	Agricultural	F.W.H.	Unplantable	Other land		Total
									Des.	Area Ac.	
1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.
Mrs. M.E. Lewis	Lease	28. 7.34.		284		60					344
Henry Pugh Esq.	Convey'ce	16. 3.37		29		18		96			143
J.A. Roberts, Esq.	"	10.11.37.		68			19	24			111
Mrs. G.T. Pugh	"	30. 5.38.		125			22	68			215
Mrs. S.W. Thomas	"	30. 5.38		84			12	97			193
R. Richards, Esq.	"	28. 9.38.		146			28				174
J.H. Wood, Esq.	Lease	25. 3.41.		255			24	20			299
E. Thomas, Esq.	Convey'ce	16.10.41.		26			6	5			37
" " "	Exchange	14. 7.48.		25							25
D. Tudor Esq. & Another	Convey'ce	18. 9.48.		22							22
Maj. Gen. J. Vaughan	Lease	8. 9.49.	7	75			2				84
Messrs. J. & W. Jones	Exchange	9.11.49.		233		23					256
Min. of Agriculture	Transfer	25. 3.50.		65				19			84
H. Lee, Esq.	Lease	12. 4.50.		84							84
E.J. Gittins, Esq.	Convey'ce	11.12.50	44	140				41			225
TOTAL ACQUIRED			96	11633		959	307	4754			17749
Disposed of, to:											
Mrs. M.M. Owen	Surrender	31. 1.28				92		144			236
E. Thomas, Esq.	Exchange	14. 7.48.						22			22
Mrs. M.M. Owen	Surrender	9.11.49.		430		96		208			734
TOTAL DISPOSALS				430		188		374			992
<u>NET TOTAL</u>			96	11203		771	307	4380			16757

TABLE II

	Acres
(a) Woods and plantations:	
Acquired	96
Formed by Forestry Commission	7958
(b) Awaiting planting:	
Felled	257
Bare	1481
(c) Nursery	6
(d) Agriculture:	
Farmed by Forestry Commission	-
Tenanted	679
Transferred permanently to Ministry of Agriculture:	
Agricultural	1092
Bare land	465
Forest Workers' Holdings	41
Unplantable	3717
(e) Forest Workers' Holdings	575
(f) Unplantable	361
(g) Other	29
Transferred temporarily to Ministry of Agriculture (included in (b) above)	nil
	<u>16757</u>

Physiography

The dominant physiographic feature of mid-Merionethshire where Coed-y-Brenin lies is the great valley running south-west from the upland basin of Bala Lake to the narrow mouth of the Mawddach estuary which empties into Barmouth Bay.

North of this valley is a mass of more or less domed mountains divided in two by the valley of the Mawddach which runs south into the main valley about a mile west of Dolgelly. The western half is composed of a mountain mass, of which the major features average 2,200 ft. in height, known geologically as the Harlech Dome. The eastern half is made up of a complex of features of volcanic origin dominated by Rhobell Fawr, 2408 ft. in height.

The main block of plantations lies in this area and extends from about 100 ft. above sea level in the Mawddach valley to an average of 1100 ft, but reaches 1300 ft. in a few places. On the Brynllin Bach area which is being planted in F.Y.52, the planting line is just below 1500 ft.

In the lower reaches of the three main rivers, the Mawddach, Eden and Afon Wen which flow south through this area, the valleys are narrow and steep-sided. The slopes of the Eden valley are rather less steep, but are thickly strewn with boulders. These sites were formerly for the most part oak woodland of varying quality and were some of the first to be planted by the Commission, mainly with Douglas fir and European larch. The tops of the intervening spurs, minor plateaux in effect, were originally occupied by small farms amongst scattered blocks of woodland. The tendency has been to plant up these areas and gradually reduce the farms to small holdings of about 20 acres.

In the upper reaches the valleys open out into basins or fairly wide U-shaped valleys the sides of which slope gradually up to dome-shaped features which dominate them. The catchment areas are comparatively large and the rivers rise considerably after rain. The valley bottoms and lower slopes are occupied by farmland and the plantations start at about the 700-foot mark and extend

up the slopes and on to the shoulders of the mountains.

Spruces, pines and some Japanese larch form the crop.

Easterly and westerly aspects predominate and the steep-sidedness of the lower valley reaches results in the exclusion of the early morning sun from much of the plantations. Due to the north/south orientation of the topography exposure to the prevailing south-west wind is not severe except on the highest ground.

The Cwrt block lies on the western edge of the largest and shallowest of the upland basins, that of the Eden.

The plantations, dating from 1932 to 1938 in the southern half and 1947 to 1951 in the northern half, lie between 700 ft. and 1200 ft. on gently easterly slopes intersected by shallow valleys. Peat occurs throughout the greater part of the area in places reaching great depths. It is predominantly a spruce area.

Though apparently under the lee of the Rhinogs, a large part of the southern half of the plantations suffer severely from the sea winds coming up the passes through the mountains.

Going back to the main valley, it is bounded on the south by an almost unbroken mountain range close on 3,000 ft. in height in several places formed by the south-facing escarpment of the Arans and the north cliffs of Cader Idris. The former dominate the Wnion valley and the latter the estuary.

The western slopes of the Arans are composed of a series of hanging valleys and it is in four of these and their intervening spurs that the greater part of Hengwrt lies. These valleys tend to be steep-sided on the south and gentle peat-covered slopes on the north side. The shoulders of the two most easterly spurs are steep, but those further west slope gradually on to terraces above the main valley on which there are peat bogs.

The plantations go from about 500 ft. above sea level to over 1500 ft. in places; a high proportion of them are above the 1,000-foot contour.

Some woodland formerly occurred on the lower slopes but the majority of the area was heather-grassland. The bogs in the

hanging valleys tend to be better for planting than those in the terraces because the former are more easily drained.

Aspects range from north-west round through the west to south. The Aran range with its westerly spurs have the effect of excluding the morning sun from a considerable portion of the plantations and frost and snow persist in the upper valleys until late into the year.

Exposure to the westerly winds is mitigated by Cader Idris.

Across the main valley from Hengwrt is a group of plantations known as Caer-defaid. It lies in a fertile and sheltered valley under the lee of Rhobell Fawr. Though the greater part of it lies above 1200 ft., it is one of the most promising blocks in the whole forest.

Spruces and pines are the dominant species on Hengwrt though some fine stands of Japanese larch occur on the old woodland sites.

Finally, the few scattered blocks on the south-facing slopes of the main valley lie between 20 ft. and 700 ft. on old woodland and bracken sites. Though they are mostly on rather dry and steep slopes they are capable of growing most conifers and some hardwoods.

Geology and Soils

Coed-y-Brenin lies on the junction of the Cambrian and Ordovician systems, but the geology of the area is somewhat complicated by the fact that this junction is marked and disrupted by the "ring fence of volcanoes" which surrounds this south-east corner of the Harlech Dome.

The greater part of the main block lies on the Cambrian rocks with their numerous igneous intrusions. The various beds strike in a roughly north-east/south-west arc and dip generally to the south-east. Hengwrt, the Wnion valley and the eastern side of the upper Afon Wen valley on the other hand lie on Ordovician rocks of volcanic and sedimentary origin.

This general division can be further broken down to six geological zones which can be distinguished in the forest area and its surroundings.

From north-west to south-east these are: -

(1) Lower Cambrian Grits and Slates

(Dalwen Grits, Llanbedr Slates, Rhinog Grits)

The greater part of the Cwrt block lies on the two former which are covered by a shallow boulder clay which gives rise to a sour moorland vegetation with very deep peat in places. The steep and broken slopes at the northern end of the block are formed by Rhinog Grits.

(2) Lower and Middle Cambrian Grits and Flags

(Rhinog Grits, Manganese Shales and ore beds, Barmouth Grits, Gamlan Flags and Cefn-Coch Grits).

These, with the Rhinog Grits predominating, underly almost the whole of the forest area in the Eden valley from Craig-y-Cae in the south, taking in the whole of the Craig-y-Gamllwyd feature and across the river to Craig-y-Penmaen in the north. The whole area is characterized by broken and boulder-strewn slopes with a fairly deep boulder clay and rocky dip slopes and terraces carrying a shallow loam. Rather damp oak-ash woodland occurred formerly on the lower slopes and wet moorland on the upper. The terraces on the east side of the valley often have a grass bracken vegetation.

(3) Menevian and Upper Cambrian (Lingula) Shales and Flags with numerous Igneous Intrusions

(Clogan Shales, Vigna Flags, Penrhos Shales, Ffestiniog Flags).

The first three form a band averaging a mile in width curving round from the Farchynys block 3 miles east of Barmouth, along the north side of the estuary, up the Mawddach valley forming either slope and taking in the Cefn-deuddwr spur between the Eden and Mawddach, and as far as the boundary of the forest beyond Cwmheisian. The remainder of this zone, which extends eastwards to a line running approximately due north from Llanfachreth is occupied by the Ffestiniog beds and their many and extensive igneous outcrops.

The topography is characterised by steep sided valleys with occasional craggy igneous outcrops. The soils derived are brashy

shallow loams.

The steeper slopes were formerly the site of oak-birch woodlands but where the land levels out on the tops of the spurs a moderately good dry grassland exists.

(4) Ordovician Volcanic Tuffs of the Arenig Series

(Rhobell Group)

The lower western slopes of Rhobell Fawr which form the eastern side of the upper Afon Wen valley are composed of these rocks. These slopes are of moderate gradient and very rocky and broken and pass from former grassland and dense hazel scrub on shallow rocky loam to badly drained heather moorland on the peat-covered rock on the middle slopes.

(5) Upper Cambrian Dolgelley and Tremadoc Slates, Shales and Mudstones

These uppermost beds of the Cambrian System form on the eastern edge of the Harlech Dome a tongue about four miles long and three-quarters of a mile wide. It lies in a pass along the eastern foot of Rhobell Fawr. The slopes of the valley were formerly good grassland and the valley bottom is covered by a two- to four-foot layer of amorphous peat. The plantations in the valley have so far been very successful considering their altitude.

(6) Ordovician Sedimentary Rocks of the Arenig Series and Extrusive rocks of the Llanvirn series

The greater part of Hengwrt lies on the sedimentary rocks which consist of coarse-grained hard sandy grits on the lower slopes and pass through flagstones into fine shales higher up in the hanging valleys. The main central spur of Foel Ddu, which runs north-west from the main Aran range is formed of igneous rock of the Llanvirn series and its lower slopes are almost devoid of soil and tree growth is very poor as a result.

Professor G. Robinson of Bangor University made a brief general reconnaissance of the soils of the central part of the main block of Coed-y-Brenin in 1948 in connection with the problems of European larch dieback.

His investigations were confined to the soils of Zone 3 and were made without reference to geological maps, so cannot well be referred to other areas. He stated in his report, however, that "from the standpoint of soil formation the differences between the rocks of the area are not very profound". He found the rocks to be hard crystalline or sub-crystalline and probably of low basicity. Among the Ordovician rocks on Hengwrt sub-basic andesites occur and on Bryn Benglog in this area a natural ash woodland with associated calcicole flora occurs.

Professor Robinson found little evidence of complication from external glacial drifts, but it seems likely that, lying so close to several foci of glacial action such as the Arenig, Rhinogs and Cader Idris, the forest must have derived much of its soil from this source and even in the valleys of Zone 3 there are many deep pockets of what would appear to be boulder clay.

Regarding the development of the soils and their influence on tree growth he says "In spite of the relatively low degree of weathering of the parent rocks profile development is unmistakable and I would describe the dominant profile as a truncated or eroded podsol. Whether the truncation was catastrophic, consequent on first deforestation, or the result of normal erosion, cannot be decided. There is very little development of bleached A horizon but an impressive development of sesquioxides (feruginous) B horizon so the general impression is of orange brown or rust brown soils. Depth and stoniness vary considerably but, except in occasional flushes where grey soils occur, the main character may be summed up as follows:

- (1) Stoniness, often so marked that the soil is sometimes merely a filling between a general mass of brash.
- (2) Feruginous character of the profile nearly to the surface.
- (3) Low base status.

The soils form generally a rather stony phase of a series recognised in the Soil Survey of Wales as the Cymmer Series.

There seems no obvious reason for the poor performance of certain species, for over most of the area the depth did not strike me as being a likely limiting factor."

Peat over the forest as a whole tends to be shallow and fibrous,

but there are many localized sites where deep amorphous basin peat has formed.

Land in the Dolgelley district likely to be afforested or re-afforested in the future lies mainly on the predominantly volcanic Ordovician rocks east of Dolgelley, and to the west on the fairly fertile Upper Cambrian and Menevian shales north of the estuary and the rather less fertile Dolgelley and Tremadoc Slates and intrusive rocks south of the estuary. Much of this land is very broken and carries inferior crops of scrub oak.

Vegetation

As the planting operations have taken in both former woodland and open mountain and moorland, a fairly wide range of plant associations is met with. They are naturally from the moist to wet end of the scale but apart from the fact that very few calcicole associations are present, vegetation associated with all degrees of fertility is represented.

Moist sessile oakwood is the dominant climax woodland from sea level to about 500 ft. On the wetter soils such as the boulder clays an ash-oakwood community occurs. From about 500 ft. upwards a birch-rowan community tends to dominate the oak woodlands. On the very wet flushes and on the river sides the common alder occurs and grows fairly vigorously.

About the 1,000-foot contour dense hazel scrub is common, particularly on the Ordovician rocks.

The most striking tree occurring as an individual rather than in stands, is the sycamore; very fine specimens occurring round farmsteads up to 600 ft.

Wild cherry is locally common and on sheltered sites grows to large proportions. Few specimens of really good beech are to be found in this district, but at the same time a number of species of trees and shrubs normally associated with south-east England occur. There are sweet chestnut which coppices strongly, hornbeam which regenerates comparatively freely, whitebeam, spindle, dogwood and alder buckthorn.

Mature conifers are a fairly common feature of the landscape and fine specimens of Scots pine of a hundred years and upwards occur in

many places. European larch of good form but only medium volume are equally frequent and some very fine Douglas fir occur in one or two places. Silver fir has grown to a greater height than any other of the conifers but they are usually of indifferent form, flat topped and of greater age.

Rhododendron has been introduced into much of the old woodland and thrives to the exclusion of all else.

The non-woodland communities on the better sites range from the grass-fern type (actually dominated by bracken with bramble) to the Molinia-Juncus community in the better drained peat basins.

The shallower shaley soils which occur on the high ground over the Upper Cambrian Slates and shales carry a vegetation of Nardus and fine grasses which on steep slopes passes into gorse (Ulex gallii) and Calluna or gorse and grass depending on the closeness of the rock to the surface and the intensity of grazing. On the gentle and moister slopes Molinia with Polytrichum and Vaccinium occur giving good conditions for spruces, particularly if the ground can be ploughed.

The Calluna-Vaccinium and Calluna-bracken associations are rather limited, the former occurring on some of the steeper slopes that were formerly old woodland sites, and the latter as a somewhat transitional community on the more broken ground on the Cambrian grits and at the bottom of scree slopes.

Calluna, Erica tetralix and Scirpus occur mostly on the pockets of shallow peat on the dip slopes of the grits and round the margins of igneous outcrops. On Cwrt it occurs on the large raised bog over very deep peat.

Dense tussocky Molinia which is difficult to afforest unless it can be deeply ploughed occurs over the boulder clays.

There are limited areas of the Myrica community which have proved most intractable. Often associated with them is the alder buckthorn.

Meteorology

No detailed figures are available but rainfall varies from about 50 in. to 70 in. on the lower ground to much more on the higher ground. The driest season of the year is April, May and June.

The prevailing wind is south west, which is also the direction in

which the main valley of the Wnion and Mawddach estuary lies. It has a limiting effect on tree growth on the high ground and influences growth severely near the coast. Generally, however, the mountains give good protection to the forest against this wind. September has a reputation for being a month of gales.

Snow is sometimes serious on high ground and late spring frosts have caused damage from time to time. Air drainage is comparatively free throughout the forest, however, so air frosts are more frequent than ground frosts. There are few real frost hollows.

As a whole the climate may be said to be mild.

Risks

Sheep are by far the worst source of trouble and constant patrolling and fencing upkeep is necessary to keep them in check. In laying out plantations this aspect has to be perpetually kept in mind.

Rabbits are confined to the lower ground and are not a serious factor. Hares, which occur in the mountains, do a certain amount of damage, as do blackgame.

The most serious insect pest so far is Neomyzaphis abietina which attacks Sitka spruce. Its attacks seem to occur in a three-year cycle but the trees make a good recovery.

Of the fungal diseases, Armillaria mellea is the most prevalent but considering the large area of old woodland that has been replanted its attacks so far have been very slight. In the nursery Meria laricis did quite a lot of harm at one time.

European larch dieback and canker has been widespread and many acres of plantation almost killed out. A certain degree of recovery by the larch is apparent however in some cases. A case of severe canker on P.29 Japanese larch occurred on Hengwrt and isolated instances of it have been noted elsewhere. It seems fairly certain that brashing was the primary cause but the exact conditions giving rise to its development are not yet known.

As far as fire danger is concerned, the extensive occurrence of heather and Molinia and the highly inflammable nature of the spruces which are commonly planted on such vegetation introduce a very severe risk. The compactness of the main block and Cwrt block makes the

danger of fire spreading fairly considerable.

The broken nature of the ground and the number of roads and fairly large streams give a measure of protection at the present stage against the spread of fire. It is unlikely, however, that they will constitute of themselves effective firebreaks capable of stopping crown fires when the plantations get older. In view of the unevenness of the crops in many plantations there will always be a considerable danger of ground fires spreading into the crowns.

Unless heavy pumping equipment is used it is difficult to get adequate water supplies to the greater part of the forest.

The total area destroyed by fire has been 123 acres.

Roads.

For general access the forest is well served by public roads at present, but as the produce from the plantations increases in volume and size there is little doubt that extensive improvements will have to be made to these roads.

Once off the public roads access to the plantations was poor, but since 1947, 19 miles of stoned road and tractor track have been built and the position is becoming more satisfactory. At the present rate of progress another two years should see the forest adequately served with arterial roads, but the provision of feeders or tushing tracks for horses and light tractors will have to go on for some years.

The problem at present is what type of road is in the long run the most economical to construct. Because of heavy rainfall and the unstable type of ground met with in many parts of the forest a bulldozer formation alone is not adequate for lorries or tractors and often too rough for horses. Maintenance of the new roads is becoming a big item.

A bed of loose shale has been found on the steep slope below Cwm Heisian. This is spread thickly on the dozed formation of the roads, filling up the interstices between rocks and boulders and giving a fairly smooth running surface. This has proved an economical method of construction and has worn well over the past year. The use

of this shale will also help with maintenance costs. Local mine tips are also being acquired to provide further sources of material.

The extraction of long timber will soon be a problem as the public side roads have sharp turns and are very narrow, while the bridges are limited to 10-ton loads. There is a Bailey Bridge across the Mawddach which is the sole link for the plantations on the eastern side.

Labour

The size of the labour force has kept pace fairly well with the growth of the forest both in size and the variety of operations.

During the war there was very little planting and a comparatively small labour force was maintained. After the war the labour force nearly doubled and by 1948 when planting was resumed on a large scale it had reached 120, at about which figure it has since remained. A further 20 to 30 men have been employed on road construction during this latter period.

Thinning started in 1942 and has become one of the major forest operations. To meet the extra work involved much of it is now carried out by contract to timber merchants.

Of particular value as a source of supply of workers has been the establishment of more than 40 Forest Workers' Holdings scattered throughout the forest. It is significant that many of the Grade I workmen are men living on forest holdings and that at least three men who started their forest career in holdings at Coed-y-Brenin are today Foresters.

SILVICULTURE.

F.Y. 22-F.Y. 30

Coed-y-Brenin being one of the oldest Commission forests and one comprising a variety of types of ground, the changes and developments in silvicultural practice may well be considered with the history of the forest.

The first plantation to be formed was Waterloo Wood, P.22. It can be considered typical of most of the plantations of the 1920's, being on the site of woodland felled during or just after the 1914-18 war. Like the others it is on a steep slope and at low elevation, but differs from them in being rather more exposed and on a drier site.

It was planted with Douglas fir with some European larch on the upper slopes and tongues of spruce on the flushes and pines on the rockier parts. Coppice weeding and cleaning comprised the main items of maintenance for several years.

The early acquisitions from the Vaughan estate consisted of derelict woodland and scattered scrub on the steep sides of the valleys of the Mawddoch and Afon Wen in the Vaughan block and the steeper heather-covered sheep mountains on Hengwrt. From the start, therefore, contrasting planting conditions were encountered, with mineral soils which were planted with Douglas fir and European larch, and peat soils on exposed ground and at high elevations up to about 1500 ft. which were planted with spruces. The pines, Scots pine, Corsican pine and mountain pine were planted on sites similar to those on which these species are planted at the present time. Japanese larch was not planted on any large scale till 1928 when it was used extensively on old woodland and hazel scrub sites on Hengwrt as well as on the better type of mountain grassland at Caer-defaid in P.29.

At first it was the practice to plant Sitka spruce on the deepest peat which was usually found on the more sheltered sites, whilst Norway spruce was planted on all other types of spruce ground. About 1929, however, it was realized that the Sitka spruce could stand more exposure than Norway spruce and could compete better with the heather and gorse vegetation of the shallower soils, so a reversal in their sites is evident from then on.

It is of interest that by 1926 pine/spruce mixtures were being used on exposed heather banks, both Scots pine and mountain

pine being used with Norway spruce which, as has just been mentioned, was being planted on such sites at that time. The behaviour of these mixtures has shown considerable variation within very small areas; in the worst cases the Scots pine is leaving the spruce behind completely, and at the other extreme the spruce is forming a close and uniform crop that tends to suppress the pine which are removed in the early thinnings. Mountain pine gives less trouble than Scots pine due to its restricted height growth.

It would appear that on the most difficult sites the spruce has benefited from the shelter of the pines, but on the better sites there is no clear proof that the mixture has been of any benefit.

It was not until 1929 that turf planting of the spruces was adopted, notch planting being the usual practice. At Caer-defaid (829) a proportion of the spruce ground was turfed but it was not till F.Y.31 that the practice became general.

In 1932 some of the notched spruces on Lletty Wyn were lifted with the surrounding turf and apparently responded to the treatment, but the cost was, of course, prohibitive.

Coppice weeding and staking Douglas fir would appear from tour notes and instructions to have been major commitments during this period.

F.Y. 31.

In F.Y.31 a large acreage round the south and western slopes of Moel Hafod Owen was planted. These plantations extend from about 300 ft. above sea level on the left bank of the Mawddach to 1200 ft. or more on Moel Hafod Owen.

The soil over much of the area is a shallow shaley loam much compacted with years of grazing and gorse dominated much of the area. It was burnt off before planting but soon became a problem again. European larch, which has since failed almost completely, was planted on the lower slopes, and Japanese larch

on what must have been fine grass land and on some of the gorse banks. Apparently it was intended to use Japanese larch on this type of ground right up to the council road, but supplies did not permit. This species has done well on the whole though on the gorse banks growth has been slow.

Virtually the whole of the spruce crop was originally planted as a row by row mixture of Norway and Sitka spruce, there being a shortage of Sitka spruce which would have been the more suitable species. On the better ground the Norway spruce has been dominated when the canopy closed, while on the poorer shoulders it looks far from healthy. The Sitka spruce is making steady, if slow, growth, and there seems little doubt that the crop at a fairly early age will be composed almost entirely of this species.

F.Y.32 - F.Y.38

F.Y.32 saw the start of a new phase in the development of Coed-y-Brenin in the acquisition of two large blocks each containing somewhat over a thousand acres of plantable land in the Eden Valley. They were the Cwrt/Graigddu block and the Abereden/Maesgwm block. They both lie on the hard grits and slates of the lower Cambrian beds overlain in many parts by considerable deposits of boulder clay. They are characterized by a water-logged, rocky and rather infertile soil with peat of varying depth. The southern end of the Abereden block is rather more favourable being more sheltered and having carried an oak woodland crop. The ground, however, is very rough and broken.

The afforestation of these two areas occupied the years F.Y.32 to F.Y.38. During the same period the afforestation of the Afon Wen valley was almost completed and several isolated blocks of old woodland such as Wenallt on Hengwrt, and Coed ffridd-goch and Pen cefn near Dolgelley were planted; it was in these areas that much of the European larch, which has suffered so severely from die back, was used. The afforestation

of the central valley on Hengwrt, Afon Harneg, was started in the latter half of this same period.

West of River Eden.

Both the two main areas were, as has already been indicated, decidedly intractable. Abereden was not only very rocky and boulder strewn but on much of the lower slopes were the remains of moist oak woodland and higher up birch rowan woodland. Ash and sallow, both strongly coppicing species, were common throughout. Much of the woodland had been felled during the 1914-18 war but much of the poorer timber remained. In those days there was no market for the timber, though much of it could be used for stake-making, and furthermore it was a time of strict national economy and expenditure on preparation of ground and maintenance was kept to a bare minimum.

As was the practice at that time, Douglas fir was planted on the old woodland sites throughout, the oak that was not utilizable being ringed. Norway spruce was planted on the wettest slacks. Above the woodland Norway spruce was planted direct (i.e. unturfed) on the bracken ground with Sitka spruce on turves higher up and on the Scirpus and Molinia ground. Pinus contorta with Scots pine on the less exposed sites was planted on the rock outcrops.

Cwrt Block.

On Cwrt Norway spruce was used much more extensively in the early years than would be the case to-day and in F.Y.34 Sitka spruce seedlings had to be used because of the shortage of plants. Pinus contorta which was mixed with the Sitka spruce on the worst heather ground suffered severely from blast from the sea-winds coming through Drws Ardudwy. A lot of intensive draining was required on the Cwrt area as a whole.

East of River Eden.

Also in this period of the 1930-1940 decade the slopes east of the Eden were acquired. Here the ground was rather better

particularly on the Afon-deuddwr area and here Douglas fir was planted and is now growing satisfactorily.

There were also some stands of quite good quality oak which were visible from the main road. Amenity considerations made it undesirable to do much ringing here, so the oak was underplanted with beech, Thuja, Tsuga, Douglas fir and Norway spruce with the intention of removing the overcrop in a series of thinnings. During 1939-45 much of the best oak was felled and rather upset the original plan which was to retain the best to put on further increment. Recently the canopy has been opened up considerably to free the undercrop, but a fair proportion of oak remains.

On the plateau top and towards Penmaen much of the bracken ground was direct planted with Norway spruce with Scots pine on the more rocky ground, though in P.34 Japanese larch was used extensively on the grass-bracken terraces. The usual relation of Sitka spruce with pines was adopted on the sour and more exposed sites.

Hengwrt.

On Hengwrt in the Harnog valley conditions were again difficult with very shallow soil and thin peat over igneous rock on the north bank and ill-drained boulder clay on the south. Heather, gorse and Molinia vegetation prevailed and Sitka spruce and Pinus contorta were the main species employed. The area planted in F.Y.40 was treated with basic slag at the rate of 2 oz. per plant with beneficial results.

Beating up etc.

Beating up during this period was for the most part fairly orthodox and successful. Two exceptions were at Coed ffridd goch where the Pinus contorta used for beating up the European larch have grown too fast and are now very coarse and liable to wind-throw, and in P.30 and P.31 Japanese larch, where

Douglas fir beat ups in small gaps have completely failed to keep pace with the larch, though only planted one or two years later.

At Wenallt P.32 Douglas fir seedlings were used on an old woodland site and were beaten up the following year with Japanese larch which now forms rather under half the crop and at present tends to outgrow, but hardly suppress, the Douglas fir.

Results on Productivity of the period - F.Y.32 to F.Y.38.

During the period F.Y.32 to F.Y.38 an area almost equal to half the present total area of the forest was planted. Much of that area, as has been shown, was poor or exposed land and unfortunately on the better ground the fast growing species such as Douglas fir and European larch have not done well. The European larch has almost without exception suffered severely from die back whilst much of the Douglas fir was planted on moist sites where it was also subject to intense coppice competition. The resulting crop has been very uneven and of slow growth and thinning has had to be delayed.

From the point of view of productivity this period has been disappointing and will remain so for some years. P.33 however was the last year in which European larch was planted in Coed-y-Brenin (except for provenance plots in F.Y.51) though it was not till F.Y.37 that it was laid down that no more European larch was to be planted "as all were doing very poorly" (W.L.T. 1.7.37). During the last few years a certain measure of recovery has been evident.

During this period the seven-wire fence was replaced by sheep netting and draining and turfing technique was developed. Hinge turfing was used for the first time on Esgair-gawr P.35 at Hengwrt.

Towards the end of the period the older Douglas fir plantations were getting well into the thicket stage and were being opened up by rocks and the thinning of them began to be considered.

It was in 1935 that the forest was renamed Coed-y-Brenin.

F.Y.39.

By 1939 the lack of land available for planting was causing concern. Cae-cyrach and Goetre in the Eden valley had come to hand in 1938 and their planting about rounded off the work in this area. On Hengwrt the Coed rhos llwyd plantation added a useful area and the P.40 Werngawr plantation more or less completed the afforestation of the Harnog valley.

F.Y.40 - F.Y.46.

From F.Y.39 till after the war it was a matter of raising the planting line here and there and planting Sitka spruce or replanting small blocks of woodland felled during the war; beech, Norway spruce and Tsuga were used mainly for this purpose.

P.42.

The one exception was the very useful Penrhos block which was planted in 1942 and more or less completed the planting of the spur between the Mawddach and Afon Wen that forms the southern part of the main block.

This area was interesting in that Corsican pine was planted more extensively than hitherto; wisely it was confined to low altitudes and fairly good heather-bracken ground. Various mixtures of Scots pine with Douglas fir and Sitka spruce were also planted on heather and bracken ground. The Scots pine/Douglas fir mixture was an innovation and probably a good one, but the same cannot be said of the Scots pine/Sitka spruce mixture. Firstly, the ground was for the most part not a spruce type and, secondly, it was overlooked that Sitka spruce is not a shade-bearing species in the way Norway spruce is.

By 1942 the pre-war stocks of plants were used up and planting was greatly reduced so there was an opportunity to concentrate on the beating up and drainage upkeep of the large areas of plantations of the '30s.

First thinnings.

In April 1939 the Chairman visited Coed-y-Brenin with the

object of "inspecting plantations entering the thinning stage" (R.L.R. 11.4.39). From then on the better parts of the older plantations were under constant watch and subject to comment in inspection notes.

Thinning started in F.Y.42, 120 acres mostly of Douglas fir and Japanese larch being treated. About the same area received its first thinning in each of the subsequent two years and in F.Y.45 70 acres came in for their second thinning. Since then about 200 acres in all have been thinned each year.

In one or two instances in these early thinnings the average volume per stem was over 1.5 cubic feet, but naturally the produce on the whole was small and rails and the smaller sizes of pitwood was all that was produced. Simple wire rope extraction was used in some of these early thinning operations.

F.Y.47 - F.Y.52.

F.Y.47 saw the start of the return to planting programmes of pre-war dimensions. The afforestation of the northern half of the Cwrt block and the poorer ground at the head of the Afon Wen valley was started and on Hengwrt sixty acres of P.35 ground burnt the previous spring were replanted.

In F.Y.49, 336 acres were planted and in F.Y.50 over 550 acres - figures comparable with those of the 1930's. All types of ground were involved throughout the forest from small blocks of marginal land that was formerly Forest Workers' Holdings byetake or part of farms within the forest to large areas of felled woodland and poor mountain grazing.

On Hengwrt the more sheltered and less steep northern sides of the Ty cerig and Cwm-ochr valleys which were partly planted in the 1920's were afforested. The ground was mostly boulder clay with fairly deep Juncus peat in parts and much of it was ploughed.

Ploughing.

Ploughing started in F.Y.48, Ransome Solotrac and Duotrac ploughs being used on marginal grassland at Pen-rhos

at Hafotty Hendre in the Afon Wen valley to supplement the old nursery at Pandy Glasdir which had been in use from the start and which despite regular green cropping was falling off in fertility. The Hafotty nursery was on marginal land and thus had neither the advantages of an established nursery nor of a heathland nursery. Furthermore it was remote and very broken up but its outturn was quite good. In F.Y.49 it was decided that Pandy Nursery was conifer sick and it has since only been used for hardwoods, mainly beech and red oak. In F.Y.51 it was decided to stand down the Hafotty nursery by stages as beds became empty.

During the last three years 50-70 tons of bracken compost have been made each season. Maesgwm Camp has been used for seed storage.

Maintenance.

Of the maintenance operations the racking and drainage upkeep of the plantations of the 1930's that have tended to stay put in the thicket stage has been the main item, with brashing following closely in importance. The high cost of this latter operation has been a perpetual source of concern and partial brashing has been generally adopted to reduce expenses.

Thinning.

The thinning programme did not show the large increase that was expected in this period. The more rapid-growing species, Douglas fir and Japanese larch, which were thinned heavily in 1947, 1948 and 1949 did not come in for thinning again as soon as was expected and the Douglas fir in the Eden valley were disappointingly slow in reaching the first thinning stage.

In F.Y.49, 50 and early 51, 165 acres were thinned by timber merchants, but early in 51 it was found that due to lack of adequate access and sufficiently large parcels of thinnings, the merchants fought shy and this practice had to be suspended

(Cwrt), Hafotty Hendre and Tycerig, and again in F.Y.49 at Ysgawydd-y-glyn. At Caer-defaid on deep Juncus peat the Begg plough was used for the first time in 1949 and proved its worth for preparing peat ground.

For P.50 the Begg was used again on Hengwrt and the Cwrt block. The R.L.R. was used on very stony dry soil carrying a vegetation of heather and dense gorse near the fire lookout on the main block. The Fisher Humphreys was tried out on Hengwrt but without much success.

In 1950 and 1951 both the Begg and the Cuthbertson double and single-furrow ploughs were used and proved satisfactory. Techniques had improved and the practice of working outfits in pairs proved an economy.

On the whole, however, Coed-y-Brenin cannot be considered as being a ploughing forest though had ploughs been available in the 1930-1940 era it seems likely that the difficulties of establishment would have been considerably reduced, particularly on the Cwrt block.

Plant supply and choice of species.

Plant supply during this period was liberal except in the case of Pinus contorta. Sitka spruce was by far the most extensively planted species with Japanese larch a poor second. Picea omorika was planted on the more frosty parts of Ty-cerig in F.Y.48, but with poor results. Corsican pine was once more used on a fairly large scale, this time on poorer ground than in 1942 and up to 800 ft. on Dolfrwynog. In planting Douglas fir the wetter ground was avoided, spruces being used instead.

On the old woodlands beech and red oak were planted fairly extensively, use being made of existing coppice and regeneration which was filled up where necessary with beech, Japanese larch or Scots pine. Other woodland areas were cleared and replanted in the normal manner.

Nursery.

In F.Y.48 a further 4 acres of nursery were laid down

for the time being.

From 1947 onwards a system of roads and extraction rides had been built up and it should be possible to resume large-scale thinning by merchants on a permanent basis, market conditions permitting, in F.Y.52.

Research - Note by Research Branch.

Experimental work undertaken at Coed-y-Brenin by the Research Branch has been concerned with provenance trials with Douglas fir (Experiment 2, P.33) and European larch (Experiments 3, P.51 and 4, P.52), and also with the effect of method and season of brashing on the development of stem cankers on Japanese larch (Experiment 1, P.48).

Douglas fir provenance (Experiment 2, P.33).

This experiment consists of a trial of five seed lots supplied by Messrs. Johannes Rafn of Copenhagen and was initiated by the Conservator N.(W.) in collaboration with Professor Thomson of Bangor University. The trial was taken over as a registered experiment by the Research Branch in 1949.

The seed origins represented are as follows:

- A. British Columbia - coast strain from Howe Sound, altitude 325 ft.
- B. British Columbia - Shuswap strain from Shuswap Lake area, altitude 1150-1820 ft.
- C. Washington, U.S.A. - Olympic Reserve, altitude 1150 ft.
- D. Washington, U.S.A. - Rainier National Forest, altitude 500 ft.
- E. Washington, U.S.A. - Western Cascade Mountains, altitude up to 2950 ft.

The plots are laid out at Cwm-heisian in the upper valley of the River Mawddach on fairly steep ground on its lower slopes. The elevation is approximately 500 ft. and the aspect is north-west. The site is sheltered by the sides of the narrow, steep-sided valley, but is subject to severe frost.

The ground at the time of planting carried a dense growth consisting predominantly of bracken, with other species, and there was, also, a considerable amount of coppice and seedling oak from the previous crop. The plants were put in as 2 + 1 transplants in single large blocks.

The plants experienced a certain difficulty in the early years on account of the dense weed growth, and many gaps were filled with Thuja.

At the end of six years the Rainier National Forest and Cascade Mountains races had put on the most growth, the Olympic Reserve race being rather less vigorous. The Shuswap strain was much the smallest, whereas the coast strain from Howe Sound was noted as being more varied in type than the rest.

As no replication is provided in the layout and on account of the irregular nature of the ground growth rate comparisons as between the different race lots cannot be relied upon. The collection will, however, be of value in the study of race characters such as coarseness of branching, form of stem and crown, pest and disease resistance and any other characters which may appear. No assessment has been carried out yet.

Larch provenance (Experiment 3, P.51).

In 1951 a larch provenance experiment was laid down at Coed-y-Brenin with the aim of testing a wide range of larch origins on a lethal site where the species was already known to have failed. The site selected is on the lower slopes of the narrow, steep-sided valley of the Afon Wen, in Compartment 92, which had, until 1932, carried a crop of mixed hardwoods of low quality. European larch planted on the area in 1932 had failed through die-back, and at the time of laying out the experiment the ground was occupied by coppice oak, birch, hazel and rowan, with an occasional surviving larch.

The experiment lies at an elevation of 500 ft. - 600 ft., about 100 ft. above the bottom of the valley, with the high ground

of Pen-y-Bryn rising to 1352 ft. on the south-east. The aspect is north-west and the exposure slight except in the upper parts. The slope is very steep and uniform, being 35-40 degrees.

The ground vegetation is mostly herbaceous, consisting chiefly of bilberry, hemp-nettle, bracken, wood sorrel, honey-suckle, foxglove, and bedstraw.

The soil is mainly a reddish brown clay loam, very strong, and two feet or more in depth. It has been described by the late Professor G.W. Robinson as a truncated or eroded podsol of the Cymmer Series, a characteristic feature being the dominance of the 'B' horizon. It is considered to be a soil suitable for the normal growth of larch.

The following five origins were represented in this experiment:

<u>Seed origin.</u>	<u>Identification number</u>
A. Scotland, Farigaig, Inverness-shire - a good Scottish strain of larch.	49/259
B. Scotland, Strathconon, Ross-shire - a fairly good Scottish strain of larch, but possibly of Alpine origin.	49/261
C. Poland, Skarzysko, Kielce.	49/230
D. Japan - Japanese larch.	49/56
E. Scotland - Hybrid larch; selected 1st generation progeny from Japanese larch avenue at Dunkeld.	49/260

Plots of these origin were also laid down in a similar larch provenance experiment at Drumtochty in Scotland in the same year.

The experiment was laid out in a latin square with a unit plot consisting of ten rows of ten plants. Races A and C were also planted in single large blocks of 900 plants. The plants were spaced at 5 ft. x 5 ft. throughout and were one year-one year transplants in all cases.

Losses among the Strathconon lot in the first year were heavy, totalling 71 per cent., and in the following year this was replaced by Identification number 50/66, Altyre, Morayshire. Losses among the Farigaig lot totalled 36 per cent, but among the

rest losses were negligible. It is considered that the poor condition of the plants on arrival was the chief cause of the initial losses.

In February, 1952, an assessment of height and shoot growth was carried out which showed that the Skarzysko lot, with a mean height of 18.2 in. and a mean shoot of 6.2 in., had maintained its early supremacy over the rest both as regards height and current year's growth. This race was about five inches taller in mean height than the hybrid lot, seven inches taller than the Japanese larch, and nine inches taller than the Farigaig, Scottish lot.

Experiment 4, P.52.

In 1952 a further range of larch provenances was laid down in the Pen-y-Bryn experimental area on adjacent ground to the north-east of Experiment 3, P.51, under identical site conditions.

The following lots were planted as one-year-old transplants in a latin square layout:

<u>Seed origin</u>	<u>Identification Number</u>
F. Scotland, Altyre Estate, Morayshire	50/66
G. Scotland, Millburies Estate, Morayshire	50/81
H. Moravia, Hruby Jesenik, (Sudeten Mountains)	50/265
J. Germany. Schlitz, Hesse	50/141
K. Switzerland, Munsterthal, Canton of Graubunden	50/252
L. Scotland, Craigvinean Forest, Dunkeld - second generation hybrid larch	50/67

A repetition of this experiment, with the addition of Identification number 50/139, Poland, Skarzysko, was also planted on a similar, but less steeply sloping site at Dolgoed in the Mawddach Valley. Extensive blocks of races K and L were planted at Pen-y-bryn, and of race J. at Dolgoed. No assessment of losses or growth has yet been made.

Brashing experiment with Japanese larch.

In January, 1948, an experiment was laid down in collaboration with Mr. W.R. Day of the Imperial Forestry Institute, Oxford, to test the effect of different methods and seasons of brashing on the development of stem cankers. This investigation arose as a result of the occurrence of severe cankers on the stems of Japanese larch in the Doldeuli area, believed to have originated at the time of brashing and associated particularly with the exit points of branches. The aim was to attempt to discover how far the physical injury caused by the brashing operation and subsequent injury by frost could be related to the damage sustained.

The plantation chosen for the experiment was one of Japanese larch planted in the same year (i.e. 1929) as the one in which severe damage had occurred. It is situated in the Caer Defaid area at 1350 ft. altitude and occupies a basin-shaped depression between masses of high ground. The ground has a gentle, uniform slope with a south aspect and is moderately exposed. It is subject to severe frosts. The soil is a thin peat overlying a very stony clay loam. The larch crop was vigorous and growing well, with top heights of 20 ft. - 25 ft.

The area was laid out in plots, and the different methods of brashing applied were by means of stick, saw and hook, each of which was carried out at the four periods of the year, January, April, July and October, compared with a control.

The experiment has been inspected annually for signs of bark die-back or cankering around the brashing wounds. The wounds caused by all the methods of brashing have, however, healed in the normal manner. It does not appear that the conditions necessary for the development of the cankers were produced in the year the experiment was carried out, probably on account of the mildness of the weather.

Sample Plots in Coed-y-Brenin Forest

The Sample Plots established in Coed-y-Brenin Forest are both interesting and varied.

They number five, two Norway spruce one Sitka spruce one Japanese larch and one European larch; one of the Norway spruce and the European larch are the fastest growing plots of these species in Wales. The other Norway spruce plot provides an interesting experiment of Norway spruce planted with mountain pine.

All the sample plots were established in August 1948 and are fairly widely distributed throughout Coed-y-Brenin Forest.

The geology of the whole area is Cambrian and in general gives rise to at least 2 ft. of medium to a heavy loam.

The rainfall varies slightly over such a large undulating area but the mean average is approximately 70 in.

Sample plot W.46 Map ref. 23/734258 Norway spruce.

This plot is situated at Cefn Deuddwen, elevation 450 ft. near the river Mawddach six miles from Dolgelley on the Festiniog Road. It has an easterly aspect and is sheltered to the west by the crest of the hill. The soil profile shows a black humus layer merging to a medium orange-brown loam to a depth of 26 in., with numerous angular stones scattered throughout. The crop was notch-planted at a spacing of 5 ft. x 5 ft. on Molinia ground in 1926 and quickly overcame any

check, growing to a height of $7\frac{1}{2}$ ft. in five years. It increased its rate of growth during the next 15 years reaching an average height of 49 ft. giving an average annual growth for these years of 2 ft. 9 in.

It received a brashing in 1943, and prior to 1948 it had been thinned lightly twice, producing a volume of 335 cu.ft. per acre.

On establishment of a sample plot a normal silvicultural grade of thinning was introduced (C/D) but at that time there were signs of previous under thinning, many trees having narrow and flattened crowns.

Stem form however is exceptionally good and there is now more than 50% of the entire crop with class one stems. Stocking is described as full with a slight tendency to groups, there being one or two gaps caused by the removal of dominant trees.

This Quality Class I plus Norway spruce was not high pruned owing to the fact that at the time of establishment it was too large.

The undermentioned figures are from measurements taken in 1948 and 1951.

Figs. per acre

Year of Measurement	Main Crop						Thinnings			Total crop	
	Age (yrs.)	No. of trees p.a. after thinning	AV. Ht. of 100 largest trees ft.	True Girth in.	B.A. sq. ft.	Vol. U.B. Hoppus ft.	No. of trees per acre	Average True Girth in.	Vol. U.B. Hoppus ft.	Basal area sq. ft.	Volume under bark Hoppus ft.
9/1948	23	587	53	22½	128	2507	352	13½	335	188	3362
8/1951	26	462	58	25½	131	*2830	125	20	435	212	4120

Thinnings prior to 1948

* derived from previous measurement's form factor

Sample Plot W.47, Map Ref. 23/754251 Sitka spruce.

This plot is situated in Compartment 90 at Pen-y-Bryn at a height of 850 ft. slightly exposed to the north west with a northerly aspect. The topography is a gentle slope or shelf with steeper ground above and below the plot. This factor is mainly responsible for the waterlogged conditions that frequently appear after rainy weather. A deeper drainage system would improve matters. The soil depth is 30 in. composed of a silty loam merging with a mottled grey-brown loam. Shale chips and stones are found throughout these layers.

The plot received its first thinning on establishment when a normal grade thinning was carried out. Quite a few stems were curved due to wind damage and exposure but these will gradually be removed in subsequent thinnings. The stocking is complete and distribution tends slightly to groups.

Evidence was found in 1948 amongst thinnings of wind damage to leading shoots and some leaf cast.

In 1951 the best trees were pruned to a height of 25 ft. at the rate of 281 per acre, the cost being a 1/- per tree.

Detailed measurements per acre are as follows:

Year of Measure- ment	Main Crop							Thinnings			Total Crop	
	Age (yrs.)	No. of trees after thin- ning	Av. Ht. of 100 largest trees per acre ft.	Av. True Girth ins.	B.A. sq. ft.	Vol. U.B. Hoppus ft.	No.	Average True Girth	Volume U.B. Hoppus ft.	Basal area	Volume under bark Hoppus ft.	
9/48	23	834	37½	19	128	1798	352	15	383	162	2181	
8/51	26	606	43½	21½	119	*1970	228	18½	567	188	2920	

* Fig derived from previous measurements from factor.

Sample Plot W.48, Map Ref. 23/755250 Norway spruce and mountain pine.

This plot occurs in Compartment 85 also at Pen-y-Bryn, 900 ft. above sea level with the same aspect as the previous plot W.47. It is on a steeper slope with free drainage. The soil depth is 2 ft. of light medium brown loam running into a rock-shale. The object of the plot apart from Yield Table purposes is to investigate the value of mountain pine used as a nurse for Norway spruce on exposed mountain sites.

On a heather-bracken site in 1927, Norway spruce with mountain pine was planted at a spacing of 5 ft. x 5 ft. One row of mountain pine to two rows of Norway spruce.

By 1948 the mixture was tall enough for a thinning, when 92 of the Norway spruce were removed per acre, most of which were under timber size. The mountain pine had fallen completely below the canopy, the majority dead or dying. The plot was now treated as a pure Norway spruce with the dead mountain pine removed.

The Norway is of very good form with deep and well developed crowns and excellent stems.

In 1951 the plot was thinned again and selected trees pruned to a height of 20 ft., the cost of pruning being 9d. per tree.

It is difficult to assess whether the mountain pine had the desired nursing effect as no other pure Norway spruce exists on a similar exposed site nearby. However, allowing for the high elevation and exposure, it is thought that initially the mountain pine had some sheltering effect on the Norway spruce.

Measurements to date per acre are as follows:

NORWAY SPRUCE - Quality Class II.

Year of Measure-ment	Main Crop						Thinnings			Total Crop	
	Age (yrs.)	No. of stems remain- ing per acre	Av. height of 100 largest trees per acre ft.	Average true Girth in.	B.A. sq. ft.	Vol. U.B. Hoppus ft.	No. of trees	Average true Girth in.	Vol. U.B, Hoppus ft.	B.A. sq. ft.	Volume under bark Hoppus ft.
9/1948	22	1374	31½	14	107	-	92	82	10	110	-
8/1951	25	902	36	15½	96	1099	472	12½	351	132	1460

Sample Plot W.49, Map ref. 23/695195. European larch

Occurring in Waterloo Wood on a steep convex slope at an elevation of 350 ft., facing south though exposed to valley winds from the south-west.

There is a soil depth of 32 ins., comprised of reddish loam with numerous shaley stones giving rise to a varied vegetation. Species include, Vaccinium, Pteris, Galium saxatile, Rubus fruticosus, Lonicera, Oxalis, Digitalis, Calluna, Hedera helix, Agrostis, Aira flexuosa with several mosses.

The larch was planted in 1922 at a spacing of 5½ ft. x 6 ft. Owing to the steepness of slope and exposure to the prevailing winds many of the stems had some curvature.

The first thinning for which the Research Branch has accurate records took place in 1947 when 230 stems per acre were removed. In 1951 it received another thinning, though this time a heavier grade was introduced (D grade) and a further 72 trees taken out. 25% of the thinnings showed butt rot, but it is hoped that the larger and better shaped trees remaining in the plot have escaped this fungal attack.

Some oak and rowan were left standing in the plot.

Detailed measurements per acre are as follows:

Quality Class II.

Year of Measure-ment	Main Crop						Thinnings			Total Crop	
	Age (Yrs.)	No. of stems remain- ing per acre	Av. height of 100 largest trees per acre ft.	Average true Girth in.	B.A. sq. ft.	Vol. U.B. Hoppus ft.	No.	Average Girth in.	Vol. U,B. Hoppus ft.	B.A. sq. ft.	Volume Hoppus ft.
9/1948	27	340	47	21½	67	-	230	14½	213	90	-
8/1951	30	268	50	23½	65	1164	72	19½	191	100	1572

Sample Plot W.50, Map Ref. 23/696196. Japanese larch.

This plot occurs in Waterloo Wood at 400 ft. a little higher elevation than the European larch. Situated on a rocky uneven slope it is exposed to the same elements as plot W.49. The soil profile shows a black humus layer merging with a medium reddish loam 34 in. in depth. Numerous stones are found in these layers.

The crop was planted in 1930 and like the previous plot also suffered some stem curvature during its early years of growth.

It received one thinning prior to its establishment as a sample plot when 256 stems were removed. Only one tree was taken out of the plot area in 1948, but in 1951 a heavier grade was introduced bringing its stocking down to a D grade, which is considered best silviculturally for larch. The canopy is quite open due to the grade of thinning plus the fact that badly curved and wolf trees were also removed.

At the last measurement in 1951 selected trees were pruned to 10 ft.

Four small beech were left in the plot, remnants of attempted under-planting prior to 1948.

Vegetation covers nine-tenths of the area and the types compare favourably with plot W.49.

Measurements per acre are as follows:

Quality Class III.

Year of measurement	Main Crop						Thinnings			Total Crop	
	Age	No. of trees per acre	Av. height of 100 largest trees per acre ft.	Average true Girth	B.A. sq. ft.	Vol. U.B. Hoppus ft.	No. of trees per acre	Average true Girth	Vol. U.B. Hoppus ft.	B.A. sq. ft.	Volume U.B. Hoppus ft.
9/1948	19	418	33½	17	54	-	256	13½	284	74	-
8/1951	22	368	37½	19	58	722	50	19	105	87	119
			Thinnings prior to 1948								

(Sgd.) D.H. HOUSE

Mensuration Section,
April, 1952.

Conclusions.

This forest was one of the first in North Wales and in many ways conditions are similar to those at Gwydyr. Much Douglas fir was planted in the early years and, although there has been criticism about the poor type of ground planted with this species, we have none the less got many good Douglas plantations although the rate of growth is sometimes slow. This mixture with pine on poorer sites is a more recent practice that shows promise.

Some of the plantations on heather Molinia peat on igneous rock have given difficulty and the presence of boulders and rock makes ploughing difficult if not impossible. This type of ground described by the Chairman as "Hard Rock" country is usually characterised by bog myrtle and frequently occurs in small patches, but the total extent is considerable. Sitka spruce is the most promising species with Pinus contorta on rocky outcrops but it has not been possible to achieve success in all cases. Both Norway spruce and Sitka spruce have got going in some places and an admixture with Scots pine or mountain pine shews promise. The difficulty and expense of draining and the impossibility of ploughing render afforestation of this type of country uneconomic. At lower elevations on the Mawddach estuary where the ground is drier Corsican pine shews promise.

Japanese larch will probably find a larger place in the derelict woodland areas now being acquired as many of these are on poor rocky ground carrying dense scrub growth where other species would be expensive to establish.

The increment at Coed-y-Brenin has not so far been nearly as high as at the nearby forest of Dovey which is on sedimentary rock and where growth conditions are particularly favourable.

HISTORY OF COED-Y-BRENIN FOREST

APPENDIX I

Notes from Inspection Reports

The following inspections by Technical Commissioner, Assistant Commissioners, Commissioners and Chairman have been carried out at Coed-y-Brenin:

- 21.4.27 Technical Commissioner
- 18.10.27 Assistant Commissioner
- 28/29.4.30 Technical Commissioner and Assistant Commissioner
- 17.4.31 Commissioners' Tour
- 17.10.32 Assistant Commissioner
- 4/5.8.33 Commissioners' Tour
- 6/11.3.35 Assistant Commissioner and Sir A. Rodger
- 27.4.35 Chairman and Assistant Commissioner
- 1.7.37 Assistant Commissioner
- 10.7.38 Chairman and Advisory Committee
- 13.1.39 Assistant Commissioner
- 11.4.39 Chairman
- 11/14.4.41 Chairman
- 21.6.41 Assistant Commissioner
- 25.6.41 Chairman
- 6.11.41 Divisional Officers' Visit
- 8.5.42 Chairman
- 29.9.43 A/Assistant Commissioner
- 7.11.43 Assistant Commissioner and M.P. Price, M.P.
- 9.4.44 Chairman
- 16.4.48 Chairman and Chief Engineer
- 28.8.48 Mr. W.L. Taylor
- 18.4.50 Chairman, Forestry Commissioners, Technical Committee.

One point of interest is the question of the pine/spruce mixtures. There are no instructions or details indicating how it came about that these mixtures were planted.

The first mention of the mixture is in April 1935. Commenting on an observation that the "mixture of Sitka spruce/Scots pine is better than Norway spruce/Scots pine in heather on high wet ground" the Chairman says "With regard to the use of Scots pine, it will not produce an economic crop at high elevations where, moreover, it will not even stand up on soft ground. The area which evoked the note should have been planted with Sitka spruce." He also observed that blowing pines are never worth staking.

The next reference is on the Chairman's tour of April 1939. Once more referring to the Lletty Wyn F.26 mixtures the notes say: "The pine mixtures were/^{discussed}as their treatment is a difficulty at other areas (Cynwyd). On the whole the Norway spruce/mountain pine mixture on the worst ground has developed satisfactorily as the pine has sheltered the Norway spruce without suppressing them. The Norway spruce/mountain pine mixture is excellent on some of the better ground where the spruce are now pushing through the pine but elsewhere the Scots pine are overtopping some of the spruce. As this mixture consists of two rows of spruce to one of pine a satisfactory crop could be raised so long as one row of spruce pushes through. In this case it is doubtful if cleaning is really necessary now but it will need watching. If and when cleaning is needed some spruce can be adequately freed by thinning back the pine branches but, if much cutting is required, it is better to cut back the pine a few feet from the ground. Cutting any pine right out is to be avoided owing to risk of beetle damage.

It is clear that on certain types of ground two rows of spruce to one of pine makes a satisfactory mixture and a Sitka spruce/Scots pine mixture may well be used on heather

ground to save Sitka. Pinus contorta may sometimes be better than Scots pine."

At the Divisional Officers' meeting on 6th November, 1941, the plots were again visited and the following report made: The mixture is "mainly confined to the Norway spruce areas on the higher ground. The results are most marked, and, except in the most exposed areas or where vegetation shows the poorest types of soil, the spruce is getting away remarkably well. The pine in most cases will go ahead and beat the spruce necessitating some hard cutting back of the pine branches on the sheltered side where the spruce has a reasonable chance of survival.

The general opinion expressed was that the value is more than a shelter value and that some biological influence is at work. No beneficial effect, however, except in deep fibrous peat, is found from the use of Pinus contorta.

Present silvicultural policy is therefore swinging over towards a mixture of Scots pine in spruce and Douglas fir areas, certainly as a nurse in early years, and possibly as part of the crop throughout its life. There is little doubt that advance crops such as Scots pine in mixture and Japanese larch provide conditions suitable for the introduction of some more valuable succession crop."

The next visit to the area was by the Technical Committee on 18.4.51. Then it was noted:

"Results have varied with the ground and with exposure. Where the growth of both species has been fairly even the pines have been partly removed in thinning or cleaning operations. In many cases Scots pine is tending to overtop the spruce and a certain amount of pruning of the former species has been carried out. As this is a recurring operation it is not desirable.

The future treatment was discussed and the Director-General was stated that though the Norway spruce/often well below the Scots

pine, it had for the most part got over the period of initial check and therefore the pine had carried out its function of establishing the spruce. Future treatment should be the removal of the pine in the next thinning except where it was filling a gap in the crop. The final crop would probably be mainly Norway spruce with a small proportion of scattered Scots pine.

In the case of the mountain pine the form of growth is permitting the spruce to continue growing more or less unchecked by it and it seemed likely that the Norway spruce would eventually form canopy and suppress the mountain pine."

There the matter stands at present but there remains a good deal of doubt whether the mixtures are beneficial and, if so, what is the best form of mixture both as regards species and spacing, and, finally, how they should be treated in the course of their development.

The other point of interest which is referred to in the tour notes is the one of European larch die-back.

One of the worst die-back areas is Pen-y-Bryn, P.32. This was inspected on 5th August, 1933. "The European larch which had been planted under ringed trees of oak and birch have always looked well and the general opinion was that they would flourish."

"Discussions arose as to why European larch had been planted in preference to Douglas fir and opinions differed as to which would have been the best species. It was generally agreed that this valley was one of the best valleys which had been seen in Wales and high hopes were raised for the ultimate success of the plantations in it."

In January 1937, at the hand-over of Divisional Officers, it was noted of this same area: "This is an example of ¹/₅ scrub oakwood which was ringed at a time when there was considerable fear of planting Douglas fir at Coed-y-Brenin, so European larch was used and has not suffered from any shading effect of the ringed trees which have now all died off."

The Assistant Commissioner on his visit of July 1st 1937, however, said that "no more European larch should be planted as it was doing very poorly", and in April 1941, on the Chairman's visit, it was noted that "in C.98 European larch (P.25) many of the larch showed signs of canker."

HISTORY OF COED-Y-BRENIN FOREST

APPENDIX II

Supervision

Divisional Officers

D. W. Young	...	...	1922/25
O. J. Sangar	...	...	1926/30
A. P. Long	...	...	1931/37
A. H. Popert	...	...	1937/39
C. Fairchild	...	...	1939/41
R. H. Smith	...	...	1941/46

Conservators

R. H. Smith	1946/47
F. C. Best	1947/

State Forest Officer

W. A. Cadman	1946/51
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District Officers

I. L. Simpson	1922/25
R. G. Broadwood	1926/27
G. Lowe	1927/28
J. McEwan	1928
R. H. Smith	...	...	1928/36
F. C. Best	...	...	1936/39
J. L. Shaw	...	...	1939/46
J. R. Hampson	...	...	1946/47
R. Butter	...	...	1947/48
M. G. Harker	...	...	1948/

• Foresters

A. Price	II.	...	1922/23
T. Evans	II.	...	1924
J. Williams	I.	...	1925/30
R. Butter	I.	...	1931/34
	Head	...	1934/40
J. Lomas	I.	...	1940/46
	Head	...	1946/

RATES OF GROWTH

Opt.	Sp.	P. Year	Age	Geology and Soil	a. Altitude	b. Aspect	Mean Height of Dominants (ft.)	Mean Annual Increment (in.)	Current Annual Increment during last 5 years (in.)
322	S.F.	42	10	Cambrian. Penrhos shales. Deep light brashy orange-brown loam overlying shale scree. No leached horizon.	a. 200' c. Steep	b. W. d. Sheltered	18	22½	25
5	S.F.	25	27	Cambrian. Vigra flags. Very fine dry brashy loam with many gritstone fragments overlying scree. Shallow Pine/heather litter	a. 400' c. Steep	b. S.E. d. Sheltered	38½	17	23½
327	C.P.	42	10	Cambrian. Igneous "Greenstone" outcrop. Slightly gritty orange-brown loam with frequent stones. 4" horizon of slight humus penetration.	a. 350' c. Steep	b. E.S.E. d. Sheltered	14	16½	17
7	C.P.	27	25	Cambrian. Igneous "greenstone" outcrop. Very fine freely drained orange-brown brashy loam with many rock fragments. Shallow pine/heather litter.	a. 550' c. Steep	b. E. d. Sheltered	37½	18	19½
288	F.C.	32	20	Cambrian. Penrhos shales. Deep medium orange-brown loam with many rock fragments. No leached horizon.	a. 250' c. Medium	b. E.S.E. d. Sheltered	42	25	18½
124	F.C.	30	22	Cambrian. Rhobell volcanic. Medium depth of reddish-brown medium loam with many gritstone fragments. 6" horizon on humus penetration.	a. 1200' c. Medium	b. West d. Slight	19½	10½	16½
1	E.L.	22	30	Cambrian. Vigra flags. Deep very light and freely drained orange-brown loam, with some small stones.	a. 400' c. Steep	b. S.S.E. d. Fairly sheltered	44	17½	16
37	J.L.	37	15	Cambrian. Penrhos shales. Deep light orange-brown stony loam with 4" horizon of humus penetration.	a. 450' c. Medium	b. West d. Fairly sheltered	32	25½	25½
128	J.L.	30	22	Cambrian. Rhobell volcanic. Yellowish grey medium loam, slightly podsolized. Frequent stones and rock fragments	a. 900' c. Medium	b. West d. Slight	36	19½	19½
134	D.F.	36	16	Cambrian. Manganese Grits. Damp medium orange-brown loam with many stones overlying stiff grey-brown stony clay with boulders. Podsolized.	a. 600' c. Medium	b. South d. Fairly sheltered	31	23½	28
145	D.F.	32	20	Cambrian. Rhinog grits. Dark greyish-brown humic clay loam overlying stiff grey clay with high proportion of stones and boulders. Very wet.	a. 450' c. Medium	b. East d. Fairly sheltered	33	19½	25
2	D.F.	22	30	Cambrian. Penrhos shales. Medium depth of light loam with numerous small shale fragments and rock fragments.	a. 300' c. Steep	b. South d. Fairly sheltered	50	20	23½
276	N.S.	35	17	Cambrian. Gamlan Grits. Deep clayey orange-brown loam over grey clayey loam. 2" humus penetration.	a. 550' c. Gentle	b. West d. Fairly exposed	31	22	23
75	N.S.	27	25	Cambrian. Rhobell volcanic. Shallow reddy-brown fairly heavy loam over stiff yellowish-grey loam with many small stones and rock fragments.	a. 900' c. Medium	b. W.N.W. d. Slight	33	15½	18½
12A	S.S.	29	23	Cambrian. Dolgelly shales. Deep dark brown amorphous peat over deep very stiff loam with shale fragments and small stones. Podsolized.	a. 1200' c. Gentle	b. S.W. d. Fairly exposed	40	21	23½
13A	S.S.	29	23	Cambrian. Dolgelly shales. Medium depth of dark brown to black amorphous peat over very stiff yellowish grey loam with many shale fragments. Podsolized.	a. 1050' c. Gentle	b. S.W. d. Exposed	36	18½	21½
54A	S.S.	26	26	Ordovician. Shale. Leached grey clayey loam with much grit, small stones and boulders.	a. 1100' c. Steep	b. N.N.E. d. Fairly sheltered	40	15½	30
43A	S.S.	26	26	Ordovician. Shale. Leached grey clayey loam with many stones and boulders of all sizes.	a. 1000' c. Medium	b. North d. Exposed	44	20½	25

APPENDIX IV.

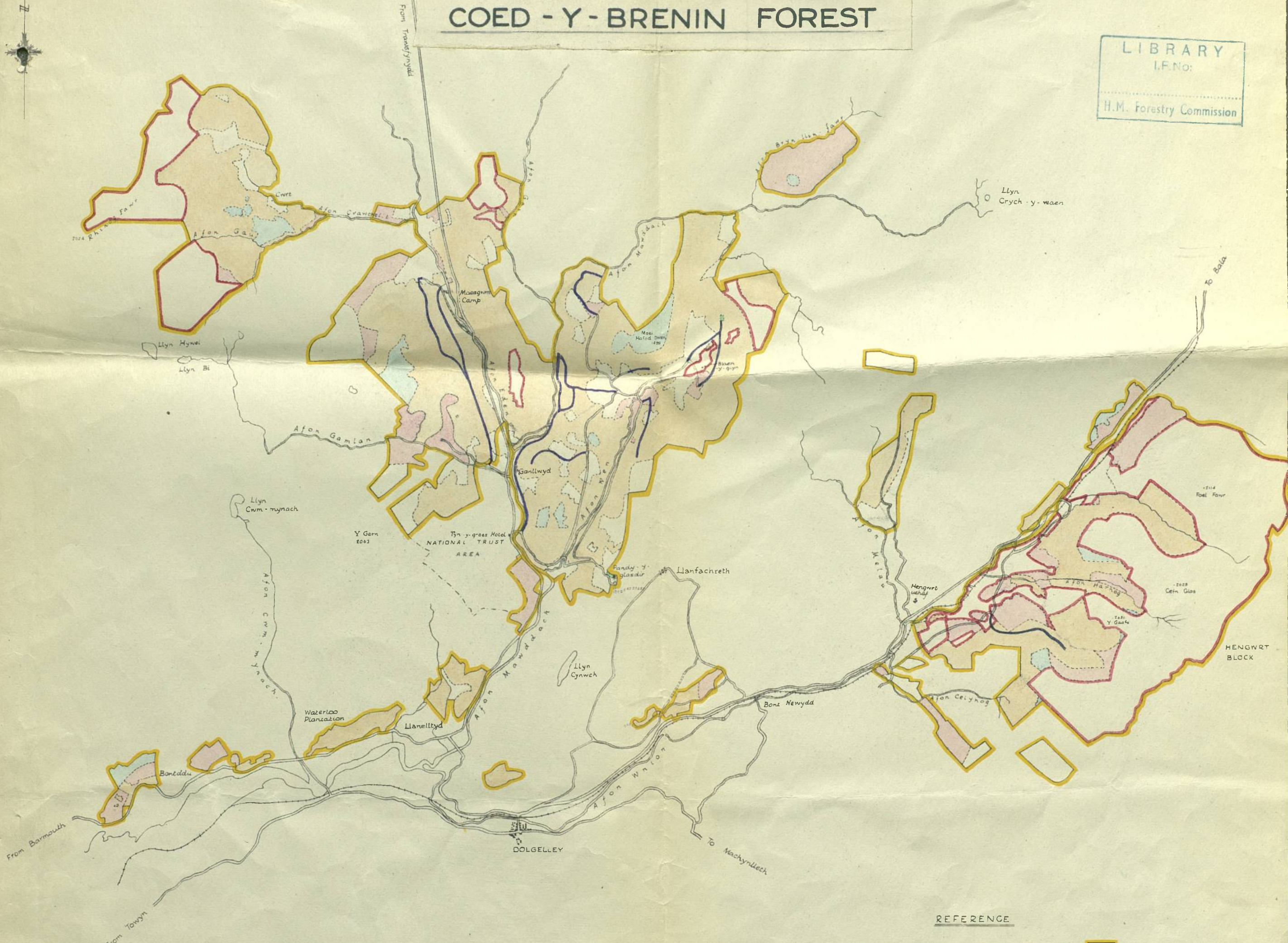
THINNING YIELDS.

Species	P. Year	Compt.	No. of Thinnings	Before Thinning		After Thinning		Thinnings		Total Volume c.ft.	Remarks
				Stems per Acre	Average Q.G.B.H. (in.)	Stems per Acre	Average Q.G.B.H. (in.)	Stems per Acre	Upper Height (ft.)		
SP	P. 25	5	3rd	630	5 3/4	470	5	160	31	395	SP dominant
SP/NS	P. 28	108	1st/2nd	1387	3 1/2	847	4	530	22	483	
JL	P. 37	37	1st	1110	3 3/4	760	4	350	24	220	
JL	P. 36	99	1st	1266	4 1/4	748	3 3/4	518	23	305	
JL	P. 31	62	1st	900	4 3/4	590	4 1/2	310	23	401	Exposed
JL	P. 31	59	1st/2nd	940	3 3/4	500	4 1/2	440	24	354	
JL	P. 30	118	1st	1020	4 1/4	700	4	320	31	380	
JL	P. 30	123	1st	1140	4 1/4	720	5	420	30	456	
JL	P. 30	128	2nd	767	4 3/4	507	5	260	28 1/2	472	
JL	P. 30	45	3rd	590	5 1/2	397	5 1/2	193	33	400	
JL	P. 31	125	2nd	570	5 1/2	460	5 1/2	110	33	240	
JL	P. 30	125	3rd	500	5 1/2	435	5 1/2	65	34	112	Inaccessible. Thinned early
JL	P. 30	125	3rd	395	5 1/2	330	5 1/2	65	37	215	
DF	P. 32	145	1st	935	3 1/2	712	4 1/2	223	28	238	(Badly stocked. Liabile to windthrow.
DF	P. 25	31	2nd	445	4 1/4	355	4 1/2	90	41	379	
DF	P. 23	32	1st	820	4 1/4	465	5 1/2	355	26 1/2	380	
DF	P. 23	105	1st	950	4 1/4	565	5 1/2	385	24 1/2	355	
DF	P. 25	32	2nd	750	4 1/4	370	5 1/2	208	34	754	Inaccessible site
DF	P. 23	32	3rd	625	5 1/4	417	5 1/4	208	31	570	
NS	P. 26	91	1st	1460	4 1/2	930	4 1/2	530	29	680	Delayed pending road construction.
NS	P. 26	8	1st/2nd	1100	4	800	4 1/2	300	25 1/2	250	Light thinning on good site.
NS/SS	P. 31	18	1st	1260	4 3/4	870	4 3/4	390	19	250	Exposed site.
NS/SS	P. 31	46	1st	1190	4 1/4	890	4 1/4	300	19	180	NS has made very poor growth
NS/SS	P. 36	123	1st	1160	4 1/4	790	4 1/4	370	23	230	
NS/SS	P. 36	123	1st	1110	4 1/4	700	4 1/4	310	23	310	
SS	P. 29	13A	1st	1405	4 1/2	885	4 1/2	520	25	555	Very light 1st thinning
SS	P. 29	12A	1st	1455	4 1/2	995	5	460	26	614	
SS	P. 29	12A	2nd	975	5 1/2	700	5 1/2	275	30	463	
SS	P. 29	12A	2nd	1205	5 1/2	776	5 1/2	429	29 1/2	606	
SS	P. 29	12A	2nd	815	5 1/2	597	5 1/2	218	34 1/2	550	
SS	P. 29	13A	2nd	790	5 1/2	580	5 1/2	210	32	471	
SS	P. 26	90	2nd	1353	4 1/2	690	5 1/2	663	31 1/2	936	(Delayed pending construction of road.
SS	P. 24	34	2nd	800	5 1/2	460	6	340	45	850	
SS	P. 24	35	2nd/3rd	555	5 1/2	375	6	180	45	695	
JH/SS	P. 30	118	2nd/3rd	816	4 1/4	536	5	280	25	320	
TS	P. 27	115	4th	400	6 1/2	300	7	100	40	449	

Coed-y-Brenin

COED - Y - BRENIN FOREST

LIBRARY
I.F.No:
H.M. Forestry Commission



REFERENCE

- FORESTRY COMMISSION BOUNDARIES..... [Yellow outline]
- PLANTED AREAS..... [Brown fill]
- AREAS TO BE PLANTED..... [Pink fill]
- LAND AT M.A.F. DISPOSAL..... [Red fill]
- UNPLANTABLE LAND..... [Light blue fill]
- AGRICULTURAL AREAS..... [White fill]
- NURSERIES..... [Green fill]
- ROADS BUILT BY F.C..... [Blue line]

Scale - 1 Inch to 1 Mile

