

FORESTRY  COMMISSION

LIBRARY  
I.F.  
902 (H10.42)  
H.M. Forestry Commission

HISTORY

OF

LANGDALE

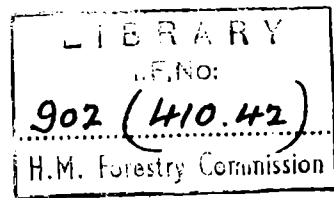
FOREST

NE(E) CONSERVANCY

FOR  
REFERENCE ONLY

Forestry Commission  
**ARCHIVE**





FORESTRY                      COMMISSION

HISTORY

of

LANGDALE                      FOREST

1934 - 1951

NORTH EAST (ENGLAND) CONSERVANCY

HISTORY OF LANGDALE FOREST

	<u>Contents</u>	<u>Page</u>
<u>CHAIRMAN'S COMMENTS</u>	... ..	1
<u>GENERAL DESCRIPTION OF THE FOREST</u>	... ..	2
Situation	... ..	2
Area and Utilization	... ..	2
Physiography	... ..	5
Geology and Soils	... ..	6
Vegetation	... ..	7
Meteorology	... ..	7
Risks	... ..	8
Roads	... ..	10
Labour	... ..	12
 <u>SILVICULTURE</u>	 ... ..	 13
Preparation of Ground	... ..	13
Choice of Species	... ..	14
Planting - Spacing, Type of plants used, Method of planting, Rate of planting, Manuring, Success of Establishment	... ..	15
Ploughing	... ..	17
Beating up	... ..	18
Weeding	... ..	18
Mixtures	... ..	18
Rate of Growth	... ..	19
Past Treatment of Established Plantations	... ..	21
Nurseries	... ..	21
Research - Introduction, Ploughing and ground prepara- tion, Species, Mixtures and nursing, Manuring, Method of planting on ploughing, Planting stock, Note on experiments at Harwood Dale, Other experimental work, Summary	... ..	22
Nutrition Committee Experiments at Broxa	... ..	29
Conclusions	... ..	32
 <u>APPENDICES</u>	 I	 33
Notes from Inspection Reports	... ..	33
Supervision	... ..	35
Notes on previous tree crops and land use on Broxa Moor and Account of prepara- tion of a Heathland nursery	... ..	36
Map of the Forest		

HISTORY OF LANGDALE FOREST

CHAIRMAN'S COMMENTS

This history, which is a good one, should obviously be read with that of Allerston. I have already commented at length on the latter, and do not propose to add to Langdale of which, excepting the experimental work at Broxa, I have seen little in recent years.

R.

July 24th, 1952.

## HISTORY OF LANGDALE FOREST

### GENERAL DESCRIPTION OF THE FOREST

#### Situation

The Forest of Langdale occupies a more or less compact block of land at the head of the River Derwent, some eight miles north-west of Scarborough in the North Riding of Yorkshire. The name of the forest is taken from the nearby village of Langdale End, and from the most prominent feature on the area, known as Langdale Rigg, which comprises one of the conspicuous tabular hills peculiar to parts of the North Yorkshire Moors.

The area was acquired in two main parts - the first block, comprising Langdale Rigg and the moorland stretching from Birch Hall up to High Woof Howe, by purchase from Sir D.A.H. Legard in 1934; the second block, comprising Broxa Moor, from the River Derwent to Silpho village, by lease from Lord Derwent in 1938. The two blocks are separated by the deep gorge of the River Derwent.

#### Area and Utilization

The total area amounts to 5544 acres, but a large area some 2000 acres in extent comprises an active part of the Fylingdales Range which extends many miles to the north, east, and west. An even larger part (3100 acres) of the forest area lies within the outer perimeter of the range, but existing plantations are preserved from firing activities, and military training has so far been restricted to the passage of troops and a few vehicles.

Former use of the greater part of the area was restricted to sheep grazing (rabbits also providing a substantial income), with a few enclosures and small fields of rough grazing on the lower ground, particularly on the eastern shoulder of Langdale Rigg, where the hill farm of High Langdale End retains over 100 acres in grass land and some fields.

The steep sides of the Derwent valley have been covered by woodland, probably for hundreds of years though much of the present crop is thought to be about 80 years old; woodlands also formerly covered many of the slopes and deep gills which cut their way south from the plateau of

Broxa Moor. Though mainly heather covered, Broxa Moor bears evidence of scattered plantations and wind breaks, whilst better parts of the moorland have been cultivated in the past. It is reported that fine larch of good quality and dimensions were taken from Barnscliffe during the 1914-18 war. A great deal of oak was cut from Langdale Side Wood some 80 years ago and from other woods on the slopes of Broxa Moor, and the quality is said to have been good; much of it was undoubtedly used for estate timber and for cleaving oak fencing posts.

For the purpose of management, the forest is divided into two Beats - Langdale (3620 acres) and Broxa (1924 acres).

TABLE I

From	By	Date	Plantations Acquired	Plantable excl. Col. 4	Nurseries	Agricultural	F. W. E.	Unplantable excl. Col. 4	Other Land				Total	
									Land Permanently transferred		Land Temporarily transferred			
									Description	Acreage	Description	Acreage		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	
Sir D. A. H. Legard	Purchase	12/11/34	16 acres	3017 (incl. 288.875 acres tenanted pending planting)	78 acres	81.282	-	12	-	-	Estate Cottages. Fylingdales Range Transferred to M. A. F.	23.756 2099.587 216.316		5543.941
Lord Derwent	Lease	11/10/38												

TABLE II

(a) Plantations -		
Acquired		16 acres
Formed by F.C.		2048 "
(b) In hand, awaiting planting -		
Blanks after felling		-
Burnt areas		-
Other land in hand		680.125
(c) Nurseries		78
(d) Agriculture. Number of tenancies	4 (permanent agricultural)	81.282 acres
" " "	2 (pending planting)	288.875 "
(e) F.W.H.		-
(f) Unplantable land in hand		12
(g) Other land (see Table I)		2339.659 acres
	Total	5543.941 acres

The tenancy of High Langdale End Farm depends upon the present food shortage, and just now much ground is being improved and re-seeded; future revision may decide upon a reclassification of this marginal hill farmland as "permanent farmland".

The management of the two Dale Farms of High Dales and Whisperdales has been transferred to the Ministry of Agriculture (Highdales 11/11/50 and Whisperdales 6/4/50).

The sporting tenancies of the Langdale and Broxa Beats are held by The Malton Investment Trust Ltd., and Lord Derwent, respectively.

### Physiography

The two Beats comprising Langdale Forest differ sharply in several respects. The Langdale Beat rises more or less evenly from a height of 300 ft. at Birch Hall up the broken moorland to some 950 ft. at High Woof Howe, near the headwaters of the River Derwent. Intersected by two moorland streams, the gradients are nowhere severe except on the abrupt feature known as Langdale Rigg which reaches a height of 800 ft. immediately to the west of the River Derwent.

The more eastern Broxa Beat is separated by the deep gorge of the River Derwent (200 ft.) which rises sharply up Barnscliffe to the plateau



which forms the greater part of the area, with a very gentle slope to the south; this varies between a height of 550 ft. at Springwood to 700 ft. along the northern escarpment. The plateau is fissured by a series of deep clefts and small dales running south, which join to form a single large valley emerging at Hackness village.

Though the aspect is generally south to south-west the area, being mainly on high ground, is exposed not only to the full force of the prevailing south-west winds, but to the cold east winds which blow in spring from the sea only six miles away. When the heather covering is disturbed to any extent, scouring of the land by accumulation of fast flowing water is a factor which becomes more serious on those parts where the water is to some extent canalised by bulldozed rides and roads.

The very extensive moor fire of 1949 laid bare a large area around the headwater of the River Derwent, and the resulting floods and quick rises after rain and thunderstorms have had some serious consequences far down stream.

#### Geology and Soils

Formed from rocks of the Middle Oolite Series of the Jurassic period, the soils provide a wide range of variety which is reflected not only in the conformation of the ground, but also in the vegetation and response in tree growth.

Apart from the hill feature of Langdale Rigg, a result of the hard Kellaway rock capped by lower Calcareous grit, the greater part of Langdale Beat consists of shales and clays of the Kellaway rock, varying to sandy and rocky patches of no great extent. This series produces hard stony ridges at one or two different levels, varying according to the contours; on these tree growth has proved most backward and plantations difficult to establish. But on the lower slopes the soils are generally sandy clays, heavy and wet, with surface leaching and pronounced podsolisation in places.

The Broxa plateau, similar to the neighbouring Langdale Rigg, presents an entirely different picture of stony dry calcareous grit with a porous and freely drained but poor soil. Leaching is more or less general and a pan at varying depth is to be found in most places. Wet patches occur

frequently, found as a result of boulder clay accumulation in what are thought to be frost cracks caused by glaciation at an early period.

The deep gills and dales on the southern part of the moor cut deeply into the underlying rock strata, and expose the massive Kellaway rock and limestone in several ravines.

### Vegetation

By far the greater part of the entire area is covered by heather (Calluna vulgaris). On the wetter parts of Langdale Beat, especially on the valley slopes, dwarf willow and bog myrtle (Myrica gale) are common, with bell heather (Erica cinerea) and occasionally Erica tetralix and Eriophorum. Small areas of moor grasses (Molinia and Nardus spp.) and rushes are found on some slopes, and bracken grows everywhere on the better and drier ground and in the deep valley of the River Derwent; with bilberry (Vaccinium myrtillus) widespread on Langdale Rigg and other stony ridges.

Prior to planting, heather covered most of Broxa Moor, with scattered areas of birch and Scots pine in some cases the result of former moor plantations or shelter belts, or regeneration from these trees. Repeated fires and heather burning controlled decisively the establishment of any pioneer crop. On wet patches of the moor, Erica cinerea and Erica tetralix are found in addition to Eriophorum spp. Juncus squarrosus is widespread as a pioneer on bare ground.

Patches of Empetrum nigrum exist but bilberry is common on many slopes facing north and especially under the partial shade of birch and rowan and scrub oak woods; some Vaccinium vitis-idaea is also present. Bracken growth is heavy on the deeper soils of the south and east aspect slopes.

Many of the slopes of the Broxa plateau were, prior to planting, covered with mixed hardwoods of a scrubby nature, consisting mainly of oak, birch, rowan, with some alder, ash, beech, willow, poplar, lime etc. on the lower slopes, valley silts and limestone soils (see also Appx. III).

### Meteorology

Exact records of the rainfall on the forest area are not available, but allowing for variation in elevation, an average of 30 in. at Birch Hall would seem to be indicated by information from nearby stations at

Irton, Scarborough and Sleights. But as much as 36 in. is probably more accurate for the higher moorland elevations. Data from the rain gauge at Broxa Meteorological station (700 ft.) suggests an annual rainfall of about 34 in. but records have only been kept since 1949, covering three years of unusually variable weather; this variation is illustrated by the rainfall recorded for 1949 - a dry year (22.67 in.) as opposed to 1950 - a wet year (40.80 in.).

The area as a whole is exposed to the prevailing south-west wind, though partial shelter is enjoyed by the smaller valleys of the Stockland and Hipperly Becks, and almost complete shelter in the deep gorge of the River Derwent and small ravines and dales near High Dales and Whisperdales. The bitterly cold east winds in spring constitute a real hazard to early flushing tree species, especially on recently planted areas.

Frost is not a serious factor over the greater part of the area, being most severe along some of the wet low lying stream sides on Langdale Beat. In summer, however, the insolation on some of the south facing banks on the dry calcareous grit of Broxa Beat is appreciable.

#### Risks

By far the greatest risk is fire, on Langdale Beat from the adjacent Fylingdales Range, and on Broxa from sightseers and trippers from the neighbouring summer resorts of Scarborough, Filey, Whitby, Bridlington, etc.

Only 8 acres out of a total of over 5500 acres have been brashed or thinned; in view of this preponderance of young plantations, and areas where heather has not yet been suppressed, an unusually elaborate organisation to cope with an outbreak of fire is called for, and this aims at providing observation posts, road and telephone communication, static water supplies, and M.D.U. crews and fire fighting equipment. The M.D.U. consists of a 4-wheel drive Fordson fire engine with 500 gallon tank and pump.

Danger from field firing of live ammunition of all kinds on Fylingdales has greatly increased with the post-war development of the summer training camp at Lownorth Bridge, and the permanent Training Depot at Pickering. Strict fire prevention drill is exercised by the Military, but constant observation is essential, and the recently erected "look out" on Langdale

Rigg is able, by means of field telephone, to give early warning of danger to the Fire Control Centre at Birch Hall, where M.D.U. and full fire fighting arrangements are organised. Likewise the "look out" at Reasty gives early warning of fires spotted over a wide arc of country ranging from Cloughton over the whole of Harwood Dale Forest, across to Fylingdales Moor; at the same time close observation of parties of trippers and picnickers on Suffield Moor is possible and reports sent back across the field telephone to the G.P.O. line at Broxa office.

The bilberry pickers in autumn present an unusual problem in their wide dispersal over the whole area, but the season is short, and the nuisance will abate as plantations grow into canopy.

Two serious moor fires in 1942 and 1949 both originating over 5 miles away were stopped less than a few hundred yards from the plantations.

Sheep have been responsible for some damage and a great deal of wasted time. To evict sheep from grazing areas to which they have long been accustomed is no easy matter, and a small defect in the fence, a snowdrift in winter, or a gate left open by hikers has resulted in sheep entering the forest, from where they have only been ejected after organised drives.

Rabbits are found locally over most of the area, being confined as usual to sheltered banks and valleys where a sandy soil provides good burrowing.

Local damage has, from time to time, been fairly severe in newly planted areas, the main damage being usually found in the Japanese larch. Steady trapping and patrolling of the fence line has reduced the problem to manageable proportions, but neighbouring coverts and derelict woodlands round Hackness provide an unlimited source of new infestation.

Hares are by no means as common as might be expected. Foxes are frequent but not plentiful and would undoubtedly become well established on such a suitable area except for the activity of the two trappers. Game is scarce and of little importance either from a protection or sporting point of view; a few hill pheasants are to be found well distributed, and scattered parties of grouse grow fewer year by year - though one pair brought off a small brood in the 2 yr. lines in Reasty Nursery in 1950.

Carrion crows, jays and magpies are also shot to assist the sporting interests both on the area, and on neighbouring estates.

The incidence of hikers and visitors to this somewhat remote area has already been mentioned; the Firing Range has rather restricted their cross country movement and damage by trespass has not been significant.

Damage by insects has not been serious, being restricted to general but mild attacks of Pine Shoot Moth (Evetria buoliana) and a more noticeable defoliation by Pine Sawfly (Diprion pini) on Langdale Rigg and Broxa Moor in 1948. Local damage in newly planted Scots pine and Japanese larch also resulted in 1950 and 1951 from weevil attack (Hylobius abietis) from adjacent older plantations. Some scattered evidence has been found on parts of Broxa of needle cast on young Norway spruce caused by the Streaked Bell Moth (Eucosma (Graphilitha) tedella) - in most cases on sickly or overshadowed trees.

No evidence of fungal attack has so far been found in the plantations, though occasional instances of damping-off, oak leaf mildew, and Meria laricis have occurred in the nurseries on Broxa Moor.

The denudation of trees from some of the steep slopes on the area, especially in the Derwent Gorge, has resulted in some landslides covering as much as one acre. Heavy snowfall, cloudbursts or sudden thaws have been instrumental, and more slides can be expected before the forest crops are able to bind the hillsides.

There are some indications that atmospheric pollution, brought from the industrial West Riding 60 miles away by the south-west wind, may have some influence on tree growth. Soot and discolouration can be found on most foliage, but nowhere is this considerable, and the effect, if any, is probably slight.

#### Roads

The initial development of the road system on the forest has aimed at establishing

- (a) a network of all weather roads giving general and through access, and
- (b) opening up the secondary roads and compartment rides for fair weather access and fire protection.

This work was largely carried out in 1948 and the succeeding 3 years. Prior to this access relied on cart tracks and moor paths. The present total of 6 miles of all weather and 14 miles of fair weather motorable roads and rides, though far from complete, gives a very fair measure of access over an area which formerly had little or none. In addition, about 23 miles of roughly bulldozed rides give access for lorries and vans. This has enormously facilitated general inspection, transport of labour, movement of plants, extraction of produce (mainly scrub and firewood), maintenance of plantations, and movement of fire fighting machines.

So far, metalling of even the all weather roads has been restricted to difficult stretches on Broxa Moor not involving more than one mile. The other "all weather" roads have relied on the stony soil under the top layer of peat, which, after rolling and compacting, has been found to bear up well to heavy traffic even in winter, except after prolonged rain or severe frost lift; this has been of particular importance for access to the large heathland nurseries.

On Langdale, however, the predominantly clay soil presents a different problem and vehicular movement over the greater part of the area is restricted to dry weather; on Maw Rigg the more sandy and stony soil permits movement by light vans, but once off the crest of the Rigg, clays and peat restrict further movement.

A certain amount of formation work and even metalling of the west side road up to High Langdale End was carried out by the unemployed from Birch Hall hostel in 1938.

Adequate for present purposes, this layout will have to be improved and expanded at a later date when extraction of produce becomes important. The improvement of the Barnscliffe road leading up the River Derwent gorge will become more pressing with the development of this part of the forest, and will link up the West Side Road and High Langdale Farm with Broxa Beat, with outlets to Broxa Moor, Lownorth Bridge, and down the valley towards Hackness.

Further road development is likely to consist mainly of improvement to existing secondary roads and compartment rides, a process not involving great expense or difficulty except on the clay and peat soils of the Langdale Moor and valleys.



## Labour

Labour for preparation of some of the ground in the initial planting on Langdale Beat was done by men from the Ministry of Labour camp at Birch Hall. This had been constructed to house unemployed from the distressed areas in 1935.

Local men from scattered farms and villages in the Langdale valley have since augmented the staff on both Beats and the bulk of planting operations was transferred to the Broxa Beat in 1941 after the acquisition of that area. All the straightforward and more accessible land was planted up early on, in the war years; weeding and general maintenance were light and a small staff was able to manage a large area.

The exhaustion of this type of ground by the end of the war necessitated further planting operations to include steep heather banks and old woodland and scrub sites. The limitations imposed on cultivation by machinery, and the heavy preparatory and weeding programmes, called for a larger staff; this was to a great extent drawn from the post war Forest Worker Training Scheme, centred at Birch Hall in 1947.

In 1948 the forest was divided into three separate accounting units, Langdale, Broxa, and Broxa Nursery. The opening of large heathland nurseries on Broxa Moor in 1945 called for a large labour staff, to some extent seasonal; this requirement was met by the daily transportation of some 75 men from Scarborough, who have in the course of the last 3 years developed a fair aptitude for the work. Alternative work on the forest during unsuitable weather has had to be found, and this has to some extent regulated the programme of plantation work.

The extensive introduction of piece work in 1949 effected a substantial reduction in labour force (at present 65) and further integration of work programmes on the forest and in the nurseries has largely compensated for the seasonal nature of the nursery work; control and management were simplified by the fusion of the two accounting units under one Forester in 1951.

## SILVICULTURE

### Preparation of the ground

The entire area (apart from moorland lying within the Military Range) has been fenced, though sheep netting was considered adequate along a great part of the perimeter on Langdale Beat, rabbits being rarely found on the higher moorland.

Early work on preparation of the ground was carried out by gangs of unemployed from the Birch Hall hostel, and aimed at draining the heavy wet slopes, by creating mounds on which planting could be carried out. This practice continued for 3 years, but was discontinued after 1939. Subsequently planting was done after burning of the heather, when possible by hand screefing and subsoiling. The greater part of the plantation on Langdale was carried out by this method, but some of the more level ground on the Rigg tops was first ploughed by the agricultural semi-digger type plough in 1938 - 40.

The more recent plantation work on Broxa, starting in 1941, has all been done on ground first ploughed by the Ransome plough and subsoiler, and after 1944 by the R.L.R. plough; excluding, of course, steep banks where this was impossible.

Practically all the steep banksides of the Broxa plateau were covered with scrub woodland with few trees of timber quality, but some sufficient to justify extraction. Treatment of these sites, begun in 1941, has varied, and initial operations aimed at girdling and planting throughout the scrub. Girdling was renewed yearly, but was not completed, and where the scrub consisted mainly of oak, the condition of the young conifer crop by 1949 was critical, and growth was severely retarded.

This method of thinning out and/or girdling the overwood was discontinued after 1947, and all such scrub in recent years has been felled, the greater part extracted for sale and the ground cleared.

More recent operations (1951) in the Derwent gorge have aimed at a

compromise whereby some scattered birch and alder overwood have been left for felling or girdling after establishment of the young crop; but all oak and other species together with coppice have been cleared, marketable material being extracted by winch and caterpillar tractor.

No considerable areas of acceptable birch exist except on parts of Broxa; areas of reasonably good stocking and form have been accepted as a crop, with the intention of a possible underplanting at a later stage.

Draining prior to planting has been a heavy item on Langdale Beat but virtually absent on Broxa; subsequent periodic upkeep of moorland drains also requires strict attention, and the vigorous growth of heather, moss, and rushes increases the cost of cleaning out and general upkeep.

#### Choice of Species

Early choice of species concentrated on the use of Scots pine and Scots pine/Sitka spruce mixtures - either 1 row/1 row, or (later) 2 row/2 row.

The pine has grown reasonably well, but only in a very few of the peaty and silt soil sites has the Sitka spruce grown satisfactorily.

The uneven growth of the alternate row Scots pine/Sitka spruce mixtures has, in particular, produced a difficult problem for present and future management. A succession of wet seasons stimulates a good growth of the Sitka spruce and on the more favourable sites some of these should maintain their place in the canopy; but over the greater part of the area covered by these mixtures, the Sitka spruce have suffered periods of check, and have become overshadowed by the vigorous Scots pine which have grown somewhat coarsely as a result of lateral room for strong branching.

Where planting on the Broxa plateau and parts of Langdale has been done on R.L.R. ploughing, growth has been more rapid; nevertheless many areas of Sitka spruce have checked, and the regrowth of heather has aggravated this condition.

Japanese larch was first planted in 1939 on Langdale, but was restricted to fire breaks running across the moors, and up the steep slopes of Langdale Rigg. Growth has been good except on wet peaty sites, and on the steep hard shoulder of the exposed Rigg top. The species has been more extensively planted since 1941 on Broxa, both on the moorland, but mainly on the bracken slopes.

Growth so far has been excellent except for a twisted form which develops generally on exposed sites, or on heavy clay and sandy soils.

Norway spruce has not been extensively planted, but small areas in the dales and gills on Broxa Beat have grown reasonably well, though checked (in places) for too long by the retention of hardwood overwood.

On the basis of the previous 10 years' experience, a more or less consistent pattern of planting has been adopted since 1948, the choice of species being selected as follows:-

Heather Moorland - heavy soils	Scots pine with Japanese larch belts
" " - calcareous grit	Scots pine or Japanese larch
Bilberry and heather banks (mainly north and west aspects).	Scots pine or Corsican pine (Scots pine on hard stony rigg tops).
Bracken banks	Douglas fir
Valley bottoms	Norway spruce
Steep slopes - heather/bracken or old woodland (mainly south and east aspects).	Japanese larch

A wide variety of other species has been planted, some detail of which is given under the description of the Research work. In addition considerable numbers of ornamental trees, mainly beech, Norway maple, red oak, cherry and birch have been planted recently (1950-52) along main roads, rides and plantation borders.

### Planting

- (a) Spacing. Initially at 5 ft. by 4 ft. the spacing was reduced in 1938 to  $4\frac{1}{2}$  ft. by 4 ft. except for Japanese larch at 3 ft. x 3 ft. During the war years, spacing was extended to 7 ft. x 3 ft. and 7 ft. x 4 ft. as a measure of economy. With the advent of the R.L.R. spacing at 5 ft. x 5 ft. returned, later reduced to  $4\frac{1}{2}$  ft. x  $4\frac{1}{2}$  ft. This has been extended in P.52 to 5 ft. x 5 ft. for the faster growing species such as Douglas fir, Japanese larch and Corsican pine on sheltered bank sides and better soils.
- (b) Initially plants were 2+1 and 2+2 averaging about 15 in. but in years when Sitka spruce were short in supply, greatly inferior stock was used. These mainly came from local nurseries at Dalby, Wykeham and Rosedale, but nursery practice in recent years has, since 1947, aimed more at the production of small 1+1 transplants. The development of the large Broxa nursery has made local supply of plants

quicker and more convenient.

- (c) Planting. This has been done almost exclusively with the spade, and by simple notching of the plant, but mattocks have been used on some of the hard stony banks and rigg tops. Limited trial in 1939 with the semi-circular spade was not successful on the sticky clay soil and discontinued.

On many sites which cannot be ploughed, a heavy turf of bracken, heather or bilberry peat is found. Prior to P.52 the practice was to cut a square out measuring 12 in. or more and lipping these over downhill; subsequent subsoiling with pick or mattock prepared the ground for the young tree. This very costly operation has been discontinued except in the most difficult sites, and a rougher and quicker "screef and plant" is now carried out.

Prior to P.52 planting on R.L.R. ploughed ground had been done on a "step" half way up the side of the furrow, but present practice aims at a quicker planting in the earth spoil at the bottom of the furrow.

Norway spruce has been planted on inverted turfs. Planting in the first 3 years was carried on late in the season - as late as June in 1940. Sitka spruce were not available for some years, and were added to the mixture one or two years after the Scots pine nurses.

- (d) Rate of Planting. This has shown some variation, reflecting the current difficulties of labour, management and plant supply. An average of just over 130 acres per annum has been maintained. A detailed statement of annual planting is shown below:-

P.37 - 46 acres	P.45 - 46 acres
38 - 129 "	46 - 83 "
39 - 177 "	47 - 122 "
40 - 134 "	48 - 9 "
41 - 187 "	49 - 125 "
42 - 101 "	50 - 298 "
43 - 235 "	51 - 188 "
44 - 168 "	

- (e) Manuring has not been carried out as a general practice, but in 1938 a dose of 1 oz. mineral phosphate per plant was given to all Sitka spruce and in 1939 to Japanese larch. In

1949 2oz. per plant of mineral phosphate was given to all Japanese larch on Broxa and to Sitka spruce on Langdale Beats. Though too early to pronounce on the 1949 manuring, the results of the operation in 1938 are not very convincing.

- (f) The success of establishment has followed closely the type of ground cultivation carried out. Early plantations on mounds or by hand screefing were slow to become established, and the return of heather further checked the growth of young trees before the closed canopy stage was reached. This is particularly noticeable in an area of some 20 acres in Compartment 37 high up on the banks of the Stockland Beck. Plantations on ground ploughed by the R.L.R. since 1941 have gained an initial impetus which they show every sign of maintaining, except where choice of species has been faulty.

#### Ploughing

Early ploughing on Langdale was carried out with the Ransome Agricultural type plough and tractor, giving a furrow 6 in. deep and 12 in. wide, and towing a subsoiler behind. Though better than hand screefing, this cultivation gave insufficient loosening of the soil, and inadequate freedom from regrowth of heather. The "Caterpillar 20" was not sufficiently powerful to pull heavier tackle, and sometimes found difficulty on stiff or stony ground.

Deeper ploughing to about 15 in. with the R.L.R. has provided these advantages, and also a measure of protection in exposed situations; but the greatest advantage has been the longer freedom from heather competition, with the consequent unchecked growth of the young plantations. The use of smaller 1+1 stock has met with success on this deep cultivated ground.

Wherever possible, heather has been burnt prior to ploughing, as this facilitates the ploughing operation, and prolongs the period of freedom from regrowth. Except for exceptionally stony ground, all ground sufficiently level for tracked tractors has been ploughed since 1944, at varying spacing as mentioned above, the current practice being  $4\frac{1}{2}$  ft. x  $4\frac{1}{2}$  ft



### Beating Up

Beating up of failures has been thorough, and in most cases prompt, except in the case of Sitka spruce failures and checked areas, where the same species were used after an initial failure. This was particularly noticeable in 1948 when an area of some 60 acres was dealt with, the rows of Sitka spruce being ploughed out by R.L.R. but unfortunately replanted with Sitka spruce. Later work of this kind on Broxa Moor in 1949 and 1950 aimed at ploughing out the worst areas of checked Sitka spruce and replanting with Japanese larch. Results so far are excellent, and Japanese larch shows signs of catching up with the Scots pine.

### Weeding

This has been heaviest on the bracken covered banks of the Stockland and Hipperly Becks, on the lower slopes of Langdale Rigg, on the banks and bracken slopes of Broxa, and where early ploughing and hand cultivation were done. Slow plant growth on some of the stony heather covered rigg tops has made heather weeding necessary long after the normal establishment period.

Weeding twice during the summer is necessary where heavy bracken growth covers the slopes; heather weeding is not normally necessary more than once every 3 years. In the earlier years when hand screefing and shallow ploughing was done, weeding was necessary for three to five years, but on the R.L.R. ploughing, weeding is not generally necessary at all; the only exception being where abandoned agricultural land has been ploughed and planted, when heavy growth of couch grass (and even bracken) may involve two or three years subsequent weeding.

### Mixtures

Reference has already been made to the extensive use of the Scots pine/Sitka spruce mixture, Scots pine being used as the nurse. Generally this mixture has not been successful and though scattered Sitka spruce will undoubtedly survive in peat and silt soil sites, and scattered throughout the Scots pine, elsewhere, it will have been at a heavy cost in planting, beating up, weeding, replanting etc.

During the last 3 years, mixtures of Scots pine and Japanese larch have been tried both in 2 row/2 row and 3 row/3 row mixtures, but results are not yet apparent. More recently, the practice of leaving a certain

amount of birch amongst all moorland plantations has been established, with the intention of producing scattered birch amongst the mature pine for soil improvement.

#### Rate of Growth

Generally speaking this has been rather slow on most parts of Langdale, but rapid in the younger age classes on the lighter porous soil of Broxa moor where deep cultivation has been carried out. Some representative crops of various ages and species are shown for illustration.

Compt.	Species	P. Year	Age	Soil	a) Altitude b) Aspect c) Slope d) Exposure	Mean Ht. of Dominants  (ft.)	Mean Annual Ht. increment  (in.)	Current Annual Ht. increment in last 5 years (in.)	Notes
27	S.P.	38	13	Kellaway. Yellow sandy soil with some clay and stones. Light and freely drained. Not podsolised.	a) 600 ft. b) South c) Gentle slope d) Exposed	19	17½	19	Good crop of Scots pine.
36	S.S/S.P.	44	8	Kellaway. Leached sand over yellow sandy clay becoming stiff. Very stony in places. Drainage slow and pan frequent.	a) 600 ft. b) South West c) Med. slope d) Exposed	(S.S. only) 5	7½	9	Typical area of Sitka spruce in check. Some Scots pine as B.U.
35	S.P.	38	13	Very similar to Compartment 27 but more leaching, and tendency to podsolisation.	a) 680 ft. b) South c) Nearly level d) Very exposed	14	13	18	Good pine crop
18	S.S.	38	13	Kellaway. Grey leached sand overlying stiff yellow clay. Drainage poor. Some rocks	a) 450 ft. b) East c) Gentle slope d) Fairly sheltered	14	13	19	Very uneven scattered crop. Many Sitka spruce still not above tall heather.
31	S.S. C.P. J.L.	47	5	Kellaway. Deep dark brown gravelly loam. Fairly free drainage.	a) 600 ft. b) South c) Nearly level d) Very exposed	5 3½ 8½	12 8 20½	12 8 20½	Typical response to deep ploughing on good soil.
34	C.P.	44	7	Kellaway. Fairly deep sandy soil but leached. Few stones; drainage free, but pan present.	a) 650 ft. b) North West c) Steep d) Exposed	6	10	12	Good, but rather uneven growth. Promising crop but not very firm.
6	S.P.	39	12	Kellaway. Grey sandy soil, deep free drainage, rather gravelly, but overlying stiffer loam.	a) 400 ft. b) West c) Steep d) Fairly exposed	20	20	17	Fair crop
1	J.L.	39	12	Kellaway. Light sandy soil over stiff yellow clay. Deep soil, few stones, but drainage free.	a) 440 ft. b) West c) Steep slope d) Fairly exposed	25	25	24	Very good Japanese larch belt but only moderate form.
1	S.P.	39	12	as C.1.	as above	21	21	19	Good Scots pine but Sitka spruce in alternate rows very irregular mainly suppressed or dead.
119	S.P./S.S.	41	11	Calc. grit, stony leached sandy soil over hard stiff yellow shale. Hard pan.	a) 700 ft. b) South c) Nearly level d) Very exposed	(S.P. only) 5½	6	10½	Typical area of checked Sitka spruce still in heather; alternate rows Sitka spruce/Scots pine.
125	C.P.	44	8	as C.119	a) 575 ft. b) South West c) Nearly level d) Fairly exposed	6½	9½	13	Irregular crop; heather still vigorous.
129	E.L.	43	9	Kellaway. Deep brown loam over stiff yellow stony subsoil.	a) 520 ft. b) South East c) Steep d) Sheltered	16	21	19	Fine young crop.
	S.S.	43	9	Leached wet sandy silt overlying very rocky subsoil	a) 540 ft. b) South East c) Steep d) Exposed.	12	16	21½	Rather uneven crop varying from place to place.
144	J.L.	45	7	as C.119	a) 630 ft. b) South c) Nearly level d) Exposed	9½	16	20	Well grown Japanese larch belt on unploughed ground.

### Past Treatment of Established Plantations

Brashing has so far been confined to a few Japanese larch belts and some of the older and more advanced Scots pine blocks. Cleaning has not been necessary over much of the area, but confined to patches of gorse in the Stockland Beck, and regrowth of birch and rowan coppice on parts of Broxa Moor.

In 1949 an attempt was made to preserve the alternate rows of Sitka spruce in the P.39 Scots pine/Sitka spruce plantations in Compartment 1 by slashing back the lower branches of the adjacent Scots pine trees.

It is very doubtful whether this operation achieved much; a few more scattered Sitka spruce were enabled to climb up into the canopy, but the heather growth on the ground was prolonged by two or three years, and proper brashing of the pine still remains to be done.

Some of the Norway spruce and Sitka spruce planted on Broxa in P.41 under partially girdled scrub overwood had, by 1949, reached a stage when growth was being seriously retarded, leaf cast was prevalent, leaders poorly formed and in some cases twisted in the lower branches of the overwood. The entire area of overwood (amounting to some 100 acres) was felled in 1950-51, some being extracted for firewood. Virtually no damage to the plantations was done, and response in the last two years has been remarkable.

### Nurseries

The first small heathland nurseries were opened at Broxa in 1945. The removal of heather and peat, initially carried out by hand, was later, in the case of Reasty, bulldozed off, and this, together with subsequent ploughing and cultivations, amounted to a cost of some £20 per acre. Subsequently similar work at Breaday cost as much as £70 per acre, and in all cases, the valuable top soil and peat humus were lost.

A new technique was evolved in 1949 for the construction of the smaller Springwood nursery, and by use of the Rotary Cultivator and subsoiler, a good tilth was produced without loss of organic material, and without the enormous heaps of spoil in windrows. The cost was reduced to little over £10 per acre, and results during the last two years have been excellent. A detailed account of this operation is given in Appendix III.

RESEARCH. Notes by the Research Branch on work carried out in the  
Allerston area which includes Broxa Moor now part of  
Langdale Forest.

1. Introduction. The first experiment was laid down by Dr. H. M. Steven at Dalby in 1924. In 1928, by which time it had become obvious that the planting of these moorlands was by no means simple and that it was going to call for a great many experiments, a reserve of 150 acres was made available at Wykeham.

By 1941 the Wykeham area having been filled up by experiments an extension area was selected at Broxa in which subsequent work was carried out. From an earlier date (1932) it became obvious that certain parts of the moorland which could not be ploughed, on account of rock or boulders, would require experiments of a different sort, so a few compartments at Harwood Dale forest were handed over for the purpose.

In all, the Wykeham area contains eighty experiments within the 150 acre reserve and the Broxa extension which runs to 160 acres, contains a further seventyfive trials. At Harwood Dale there are forty experiments in an area of 70 acres.

The account given below deals in turn with each of the main projects into which the experimental work falls.

2. Ploughing and Ground Preparation. As was mentioned in the history of the forest, the first experiment was laid down in 1924 using an agricultural plough. This was not, however, the first use of ploughs for afforestation in the district as the division had ploughed old fields in oolite areas in 1921-22 and almost a century ago the local estate used a six-horse plough before planting. This first (1924) experiment, however, was not a success, though exactly why it failed so badly is not clear, the furrows were probably not deep enough to improve the surface drainage nor wide or frequent enough to smother the heather for more than a year or so; neither did they provide enough aerated soil for early rooting. The main outcome was to emphasize the need for more intensive ploughing.

Accordingly, in 1928, a most interesting experiment (6.P.28) was laid down, incorporating direct notching, patch planting, single and triple furrow, and complete ploughing, as well as the use of explosive charges at intervals to break the pan; this last treatment was quite ineffective. The

plough employed turned out furrows of from three to six inches in depth, referred to now as shallow ploughing. After twenty-one years Scots and Corsican pines have reached twenty feet high and are fully stocked with the triple furrow and complete ploughing, but are only fifteen feet tall and the crop is irregular where directly planted. Sitka spruce and Japanese larch failed except on these more intensive ploughings, where they are now ten and twentyone feet tall respectively. In every species there is a consistent, though generally small increase of height with intensity of preparation, the height on triple furrow always being a foot or so greater than that on single furrow but a foot or so less than that with complete ploughing.

In 1931 this experiment was followed by another using the Oliver double-furrow plough (Experiment 11, P.31). This penetrated eight to nine inches now termed "moderately deep", in comparison with the present deep ploughing produced by the R.L.R. plough. The Oliver plough was used to produce double furrow and complete ploughing. In certain areas subsoiling with a special tool was carried out as a separate operation before using the Oliver plough.

Growth has been faster in Experiment 11 than in Experiment 6 with its shallower ploughing. Thus Japanese larch has reached twenty-three and contorta pine twenty-one feet high at eighteen years old. As regards method, complete ploughing has in all cases increased the height by two to five feet compared to double furrow, while in three species out of five the double furrow with sub-soiling is in turn rather better than complete ploughing. The underground channels made by the sub-soiler still persist and the long-term effect of this treatment will be watched with great interest. This double furrow plough was used for the Wykeham experiments from 1932-39.

In 1935-38 a number of root investigations were carried out on Scots pine growing on soil cultivated by various means. The main conclusion was that the roots did not travel freely through the leached zone nor the pan, but did branch freely in the ploughed soil and deposition layer. This result served to confirm the need for intensive cultivation.

When work commenced at Broxa in 1941 the divisional plough used was a single furrow type with a subsoiler drawn behind the plough. Growth in



the earlier Broxa experiments has been extremely poor. In 1943 another ploughing experiment was laid down, this time comparing different ploughs as well as intensities. The newly developed R.L.R. plough was used for both single and complete ploughing and was also combined with subsoiling, while the divisional plough was used for shallow single and double furrows with subsoiling. Results have to date been excellent throughout this experiment, after six years Japanese larch has reached six feet, Scots pine five, Corsican pine three feet, while Sitka spruce varies from three to five feet. So far, differences between ploughing methods are not great, but are generally in favour of more complete ploughing. This excellent start has delayed the appearance of differences due to preparation method much longer than was to be expected, probably due to two things (i) the excellent nursery stock, much of it from heathland nurseries, which was used at planting and (ii) to the application of phosphate throughout the experiment. For the moment, however, there is no adequate evidence as to the relative value of these ploughing methods. Further trials at Broxa compare single furrow, double furrow and complete ploughing using the R.L.R. plough.

The most unfortunate gap in these experiments is the lack of direct comparison between the moderate deep double furrow plough with subsoiling used in Experiment 11 at Wykeham and the deep R.L.R. ploughing as used at Broxa. Growth on both types has been good, and a direct comparison of growth rate, cost and their ultimate effect on the site would have been most valuable.

The fact remains that the relative importance of actual ploughing depth, breaking the pan and smothering the heather cannot yet be ascertained and until this is tested experimentally, the ideal type of ground preparation and hence type of plough must remain uncertain; experiments considered below suggest that, for spruce, mere smothering of the heather and the discouragement of heather germination may be far the most important.

3. Species, mixtures and nursing. The most important line of research at Allerston apart from ploughing has been concerned with the interaction of one species upon another alongside or in mixture. There have been practically no trials of species planted in pure plots since 1928-33 during which period it was found that only pines grew where directly planted, and that

Japanese larch was the fastest growing species on ploughed ground. Spruces never grew at all where directly planted and checked after a few years on ploughing. Many other species were tried and failed almost completely.

From 1932 onwards trials of broom as a nurse to Sitka spruce were laid down and have given most striking results. The broom provides early shelter, helps to suppress the heather and possibly supplies nitrogen to the spruce, but once again the fundamental cause of the effect is not known.

Then in 1939 as mentioned by the Chairman, the nursing effect of pines and larch on spruce became apparent in the ploughing experiments of 1928 and 31, where the species, originally planted pure in small plots, were now starting to interact where they met. The most striking effect was that produced on Sitka spruce by adjacent Japanese larch. Root investigations showed that where the growth of the spruce had improved, it was rooting among the adjacent larch, under which the ground vegetation had been killed. These and other observations led in the period 1938 to 1943 to a whole series of experiments on the different lines of work which they suggested, the most important of which are:-

(a) Planting of mixtures and methods of mixing; Sitka spruce has been used as the main crop to be nursed and Japanese larch, Scots and Corsican pines as the nurses, different proportions and different arrangements have been tried. These are long term experiments from which little has yet emerged. In mixtures of an earlier date European larch is among the promising species.

(b) Use of broom alone and in combination with Scots pine to provide short and long-term nursing. Excellent early growth has been obtained with a number of species including Douglas fir, Tsuga, beech and Lawson cypress as well as Sitka spruce.

(c) Introduction of more tender species into existing and quite vigorous pine crops. Several attempts were made with Sitka spruce but are not as successful as had been hoped. Much better results have been obtained with introduction of other species including Douglas fir, Tsuga and Abies sp. Recently this method has been extended to a wider range of species, and the introduction made on ploughed strips.

(d) Trials of heather killed by mulching, screefing and auto hoeing. These treatments inspired by the observation that spruce rooted freely where

the heather was killed under Japanese larch, have resulted in spruces, and in one instance Lawson's cypress, coming out of check and making good growth. They serve to emphasize the great importance of heather eradication, first by ploughing at the time of planting and later by nurse species which can shade out the regenerating heather.

These experiments give the greatest hope that a far greater variety of species will soon be available for what at the present time are predominantly pine forests, though it must be realised that the ultimate success of even the Scots pine/Sitka spruce mixture, the only one used on any scale, is by no means yet certain.

4. Manuring. A number of experiments from 1928 onwards have included manuring trials. The only positive result in the early years was obtained with phosphate which was usually applied as basic slag. Phosphate is an aid to good early growth of all species but benefits pines to a rather smaller extent than other species. One to two ounces of slag or ground mineral phosphate has in recent years always been applied to species other than pine in the experiments.

Recently Dr. Crowther of Rothamsted has reopened the question of field manuring and since 1947 an extensive series of experiments has been laid down at Broxa.

5. Method of Planting on ploughing. Several early experiments on the older types of ploughing were inconclusive. With the introduction of R.L.R. ploughing with its deep furrow and huge ridge, the actual position and method became important. While tests of various positions were laid down from 1945 onward the 'step' position was adopted in experiments until results were forthcoming. The step was cut into the ridge side thus avoiding the dry ridge top and the furrows which are liable to flooding, while at the same time giving shelter in the early years and allowing the roots easy access to the decaying vegetation.

6. Planting Stock. Trials of different ages of planting stock of the common species have been made from time to time. In the early years transplants were generally found to be more successful, though seedlings of pines and Japanese larch were successful when slag was applied.

With the development of the heathland nursery technique came many trials comparing stock from nurseries at Wareham, Harwood Dale and elsewhere with normal planting stock from long established nurseries. The success of the heathland plants has been striking and must very largely account for the excellent experimental plantations at Broxa.

A number of other trials compare plants from different nursery manurial regimes and plants subjected to different handling or treatment prior to planting, for instance puddling or root or shoot pruning. In a large number of cases results were negative in that if the plants were fit for planting at all such differences in treatment did not affect survival or growth. This information was of importance even though there is little to see in the actual experiments to-day.

7. Note on experiments at Harwood Dale. This reserve is on ground which was unploughable at the time when the planting was carried out. With present equipment a great deal of this land could in fact have been ploughed and present policy is only to plant land that can be ploughed. Thus the Harwood Dale experiments are now of rather less interest than those elsewhere in the district, particularly as they are concerned largely with methods of planting. Losses have been high in many of the experiments and in others spruces and larches have checked or failed. The most important early trials are of the Anderson group system with intensive hand cultivation of patches.

Little new work has been done at Harwood Dale in the last ten years apart from trials of heathland nursery planting stock and trials of Sitka spruce in mixture, both on lines similar to the trials at Wykeham and with comparable results.

8. Other experimental work. In addition to the work already described there are at Allerston three provenance trials containing a number of plots of the same species raised from seed of different origin, two of these, at Wykeham and Harwood Dale are of Pinus contorta and the third at Harwood Dale is of Japanese and hybrid larches.

Work on the raising of plants from seed in small temporary heathland nurseries at Allerston commenced in 1934. In 1941 a very successful heathland nursery was established at Harwood Dale, thus paving the way

for the 72 acres of Conservancy nursery of this type now in use in the district.

In recent years much of the field work of the Oxford Soil party has been carried out at Allerston and a small number of experiments have been laid out to their design in order to aid research in the more fundamental aspects of the site and their relation to tree growth on these moorlands.

A great proportion of the work carried out in recent years has been concerned with the nursery extensions and field manuring experiments for Dr. Crowther.

Also there has been a series of experiments on the position of planting on plough furrows and a most successful series of direct sowings with Scots pine and Sitka spruce using complete fertilizers. Other species also show promise.

9. Summary. The group of forests forming the Allerston area contain one of the largest concentrations of experimental work in the country. The trials cover all phases in the establishment of plantations on the heaths which are a dominant feature of this area. The main results obtained have been in the preparation of the ground for planting by ploughing, improved methods having led to greatly increased survival and growth and increased the range of species available. It is possible that still further improvements may be made in the method of ploughing. Interaction of species in mixture has been a major study and the use of nurses may still further extend the number of species. A large number of experiments deal with forest manuring, method of planting and type and treatment of planting stock. The results most widely applied at the present time are those concerned with the raising and use of heathland stock and the application of phosphate at planting. Recently, sowing has been found to be a promising method of establishment on ploughed ground.

Fundamental studies on the soil and its relation to tree growth are at present being carried out at Allerston and there have been already a number of investigations into root development.

It may be concluded that the experimental work has led to very great changes in technique in the area and also improved greatly the value of these heaths for afforestation.

"J. W. L. Z. "

### Nutrition Committee Experiments at Broxa

The experiments were planted in 1947, 1948 and 1949 as part of the investigations carried out by the Chemistry Department of Rothamsted Experimental Station and the Research Branch on behalf of the Sub-Committee on Nutrition Problems in Forest Nurseries. The nursery experiments were concerned mainly with the use of compost, fertilizers, partial sterilization and other soil treatments on the growth of seedlings and transplants of Sitka spruce and Scots pine in heathland and old established nurseries. The forest experiments were mainly extension experiments, testing each year in two or more forests, the behaviour of seedlings and transplants raised with contrasted nursery treatments. There were, in addition, a number of experiments on the effects of fertilizers applied in the forest soon after planting. Most of the experiments were of complex factorial designs.

All three planting sites are on strongly leached heathland soil over so-called "Calcareous Grit" with very vigorous Calluna cover. In each year of planting ploughing preceded planting by not more than a few months. The plantings were made with alternating pairs of Sitka spruce and Scots pine in specially prepared patches along the sides of the furrows on deeply ploughed land.

#### 1947 plantings

The 1947 plantings were parallel with others at Dartmoor and Decoy Heath, Wareham. Four years after planting the mean heights in inches were:- (All the plants had received a dressing of ground phosphate rock shortly after planting)

	<u>Sitka spruce</u>	<u>Scots pine</u>
1 + 1 transplants	42	34
1 + 0 seedlings	40	34

One-year seedlings had thus reached substantially the same height as one-plus-one transplants. Plants raised with compost or fertilizers in the nurseries gave closely similar performances in the forest.

In a manuring experiment fertilizers applied shortly after planting greatly increased the heights of Sitka spruce and Scots pine.



Height in inches, 1950

	<u>Sitka spruce</u>	<u>Scots pine</u>
no nitrogen, no phosphate	22	27
phosphate alone	36	34
nitrogen + phosphate	39	36

Potash also increased heights of Sitka spruce and Scots pine.

1948 plantings

The 1948 plantings were parallel with those at Dartmoor (Sitka spruce and Scots pine), Gwynno (Sitka spruce) and King's Forest (Scots pine). They included many lots of small one-year seedlings raised in the drought of 1947. Some of the experiments were preliminary tests on unusual nursery treatments.

One of the experiments tested separate batches of one-year seedlings and one-plus-one transplants from Sugar Hill Nursery, Wareham. These had been raised with compost on repeatedly composted ground in the older part of the nursery and with fertilizers alone on a new part which was carrying its first crop after clearing from heathland. All four lots were tested with and without fertilizer at planting time.

Height in inches

At planting early 1948	After four years in the forest, late 1951	
	Planted without fertilizer	Planted with fertilizer

Nursery Treatments

Sitka spruce

1 + 0 seedlings, with compost	2.5	33	38
1 + 0 seedlings, with fertilizer	2.0	34	42
1 + 1 transplants, with compost	7.2	35	47
1 + 1 transplants, with fertilizer	5.6	28	44

Scots pine

1 + 0 seedlings, with compost	1.9	22	29
1 + 0 seedlings, with fertilizer	2.1	30	33
1 + 1 transplants, with compost	2.5	28	36
1 + 1 transplants, with fertilizer	3.3	30	39

Percentage deaths, 1950

Sitka spruce

1 + 0 seedlings, with compost	2	3
1 + 0 seedlings, with fertilizer	0	6
1 + 1 transplants, with compost	0	2
1 + 1 transplants, with fertilizer	3	8

	Planted without fertilizer	Planted with fertilizer
--	----------------------------------	-------------------------------

Percentage deaths, 1950

Scots pine

1 + 0 seedlings, with compost	16	30
1 + 0 seedlings, with fertilizer	3	5
1 + 1 transplants, with compost	2	0
1 + 1 transplants, with fertilizer	0	0

Deaths were high only for Scots pine seedlings raised with compost.

Fertilizer applied in the forest slightly increased the number of deaths.

Both one year seedlings and one-plus-one transplants grew very well, some of the seedlings reaching the same heights as the transplants. Although this Calluna heath is usually regarded as unsuitable for Sitka spruce, both seedlings and transplants of Sitka spruce grew taller than the associated Scots pine. The average height of Sitka spruce with fertilizer in this experiment was greater than in three parallel experiments at Dartmoor, Decoy Heath and Gwynno, in which the planting material had come from the same nursery plots. Phosphate fertilizers had striking effects on the growth of both species in this forest. Nitrogen increased only the height of transplants. Potash had no effect.

1949 plantings

Parallel series of experiments were carried out at Gwynno (Sitka spruce), King's Forest (Scots pine) and Mason's Bank, Kerry Forest (Sitka spruce and Scots pine).

There were no consistent differences in the Broxa forest between plants from nursery experiments with compost and those with fertilizer. In preliminary tests seedlings raised with formalin or acid treatments in established nurseries were as good as those from two relatively young nurseries on acid soils.

Deaths of both transplants and seedlings were negligible.

A mixed NPK fertilizer greatly increased heights of seedlings and transplants of Sitka spruce.

Height in inches after two  
growing seasons in the forest

	<u>Sitka spruce</u>	<u>Scots pine</u>
<u>Seedlings</u>		
no fertilizer	8	8
fertilizer	15	10
<u>Transplants</u>		
no fertilizer	14	15
fertilizer	21	16

From tests done in adjoining experiments it appears that the height increase from this NPK fertilizer is attributable mainly to its phosphorus.

Conclusions

1. Establishment and subsequent growth benefit enormously from deep cultivation.
2. The choice of Sitka spruce as a species for planting generally over a wide area of these moorland sites has not met with the success anticipated, especially on the Calluna ground, and on the well drained calcareous grit and soils. It would seem that, if planted at all in this District, this species should be reserved for wet peat and silt soil types.
3. It is doubtful whether planting should have been attempted on the steep, hard stony slopes of the exposed Langdale Rigg.
4. Planting conifers under a hardwood overwood leads to costly complications at a later stage. Even when girdled, scrub oak takes years to die, and does not break up for many years.
5. Initial bulldozing of main road alignments, rides and fire breaks greatly facilitates access, transport of plants, transport of labour etc., in addition a firm foundation is laid for the subsequent development of the road system.
6. An effective and cheap method of nursery construction has been evolved, without losing the valuable top soil which resulted from the use of bulldozers.

(Sgd) E. M. Conder

## History of Langdale Forest

### APPENDIX I

#### Notes from Inspection Reports

1. Assistant Commissioner 17/9/36
2. Chairman - 18/7/37

Inspection of proposed acquisition near Hackness (Broxa Moor).

Comments made on trippers.

Planting on Moor - Scots pine with 25% Sitka spruce on exposed parts.

" slopes and dales - European larch with beech, sycamore and possibly oak on lower slopes.

Valley bottoms to remain agricultural.
3. Chairman - 18/7/37

Instructions to increase proportion of Sitka spruce in Scots pine/Sitka spruce mixture. 50% on Calluna vegetation type, Sitka spruce to be slagged when planted.

Molinia-Myrica and bracken-bilberry merging into Calluna - grass vegetation types should be pure Sitka spruce.

Beat up of Scots pine rows with Sitka spruce.

Poor parts of Calluna ground should be planted pure Scots pine and Corsican pine.

Ministry of Labour men to concentrate on access roads.
4. Assistant Commissioner - 5/10/37

Planting programme laid down as 300 acres per annum.

More F.W.H.'s to be constructed.

Ministry of Labour Camp to develop roads on Langdale.

Beat and get stone from quarry on Maw Rigg.
5. Acting/Assistant Commissioner - 6/4/41

Hinge turf planting to be carried out on Langdale Rigg; planting to continue to within one chain of top - mainly as shelter belt.

Scrub clearing to be discontinued on Broxa Beat.

Planting of Norway spruce to be carried out under scrub, and scrub to be ringed within 2 yrs. of planting.

6. Chairman - 19/7/42 (Meeting of Advisory Committee on Forest Research)  
Demonstration of ploughing with the Massey Harris Grub Breaker.  
Area on east of Silpho-Harwood Dale road to be planted with Japanese larch. Also turning places for cars to be provided.
7. Deputy Director General - 7/8/47  
Nursery inspection. Advocated wrenching and thinning in "stand over" 2 yr. seed beds.
8. Chairman - 15/8/47  
Visit to heathland nurseries, and to Research areas.
9. S.F.O. - 24/7/48
10. S.F.O. - 5/8/48
11. Director - 2/3/49  
Instructions to clear scattered Scots pine on Broxa Moor, except belt along main Silpho road to be kept for amenity and regeneration.
12. Chairman 10/5/49 (Visit of National Committee (England))  
Hardwoods to be planted along roads and ride sides as a general practice.
13. S.F.O. - 18/6/49  
Small nurseries at Broxa to be abandoned. Ecological reserves to be established.
14. Conservator - 19/5/50  
Visit to nurseries with nurseries officer.
15. S.F.O. - 3/11/50
16. S.F.O. - 21/12/50
17. S.F.O. - 24/1/51  
Inspection of current scrub clearing work in Langdale Side Wood.
18. S.F.O. 12/4/51  
Visit to Forest Workers Training Scheme at Birch Hall
19. S.F.O. - 20/7/51  
Inspection of further scrub clearing work to be done in Langdale Side Wood by contractor.

## History of Langdale Forest

### APPENDIX II

#### Supervision

##### Divisional Officers

A. D. Hopkinson	1937 - 1939
R. E. Fossey	1939 - 1947

##### Conservators

G. J. L. Batters	1947 - 1950
C. A. Connell	1950 -

##### State Forests Officers

W. Forsyth	1947 - 1950
P. F. Garthwaite	1950 -

##### District Officers

R. E. Fossey	1937 - 1939
A. Paterson	1939 - 1947
J. B. Stocks	1947 - 1948
P. F. Garthwaite	1948 - 1949
E. M. Conder	1949 -

##### Head Foresters

T. E. Anderson	1946 - 1950
W. R. Gough	1950 -

##### Foresters

E. W. Marsh	1937 - 1939
G. Woodward	1939 - 1940
E. Fawcett	1940 - 1946
J. D. Chisholm	1946 - 1948
E. W. Marsh	1948 -
J. Mennell	1948 - 1951)
J. D. Chisholm	1948 - 1951) combined under J. D. Chisholm 1951 -

## History of Langdale Forest

### APPENDIX III

Notes on previous tree crops and land use on Broxa Moor and adjacent dales; compiled by J. Mennell and W. Hopper, Broxa - January 1952.

#### Breaday Top - Compartment 162

No cultivation of this area can be recalled - though there are signs. All flat ground was covered with self sown Scots pine of very good quality - felled in early 1930's.

#### Breaday Slopes - Compartments 163, 161

This land was all planted with European larch of exceptionally good quality and was about 100 years old when felled (presumably in 1930's).

#### Whisperdales Slopes - Compartments 151, 152, 153, 156

\* All the land on the slopes round Whisperdales was planted with oak and larch. The larch were boosted with crushed bone  $\frac{1}{4}$  in. -  $\frac{1}{2}$  in. in size.

#### Cow Heights - Compartment 126

The top of this feature down towards the point was at one time cultivated - amounting to some 8 acres. The slopes were mainly hardwood, oak and beech; the oak were very large. These woods were felled 70 years ago.

#### Hard Dale Valley - Compartments 123, 124

This was cultivated about 120 years ago, and never planted up since (though there is now a small block of 4 acres of beech about 50 years old).

#### Broxa Moor - Compartments 111, 112.

No cultivation on this section of the moor can be recalled - except of course the existing two small fields.

About 20 acres of Scots pine and European larch was planted 103 years ago in present Compartment 110. This was felled and converted on the site in 1930 - 31. The sawmill was sited near the present Broxa office.

#### Barnscliffe

The land below <sup>\*</sup>the present contour ride from the ruin (Compartment 101A) to Compartment 106 has never been planted. The ground was cultivated at

one time, but just drifted back to heather, with briars in places.

Below the ruins (Compartments 102, 103) the hardwood was felled (date not known) and extracted by oxen and taken to Whitby for ship-building; it was cut into short lengths and blocked out. The present hardwood stand on this area was presumably planted subsequently (some may be regeneration) and appears to be about 90 - 120 years old.

The lower part of Barnscliffe (Compartments 106, 107, 108 and 109) contained very good quality European larch 80 - 100 years old when felled during the 1914-18 war.

#### High Langdale Side Wood - Compartments 45 - 51.

The bulk of this was felled about 70 years ago, and was said to be 140 years old; it consisted of very large trees, mainly oak with some alder and birch.

#### Account of the Preparation of a Heathland Nursery in 1949 - by Forester J. D. Chisholm.

It was decided in the early summer of 1949 to open up a new heathland nursery at Broxa; I was accordingly instructed to begin work near Springwood with a view to preparing a 5 acre nursery, mainly for seed beds. The acreage was subsequently increased to 12, and it was later found necessary to line out on 7 acres out of the total.

The site consisted of a flat area of moorland lying between two deep ravines some 200 yards apart; the general aspect is south, the centre being somewhat raised to give a slight fall to east and west. Ground vegetation consisted of a thick covering of heather, with some scattered birch and Scots pine scrub not more than 6 ft. high. The area is exposed and windswept in winter, with a rainfall of about 25 in. per annum. The soil consists of a calcareous grit with an iron pan in most places lying at a depth varying greatly from 10 in. - 18 in. or more below the surface; the accompanying profile illustrates the detail.



### Soil Profile

A0	0 - 3 in.	Peat
A1	3 - 6 in.	Leached grey sandy soil with small rock fragments; stained in many places from A0.
A2	6 - 10 in.	As A1 but less staining; more rock fragments and more compact.
A3	10 - 10.5 in.	Thin layer of black peat formed by dead roots; not always present.
B1	10.5 - 11 in.	Dark layer of humus and sand.
B2	11 - 11.3 in.	Dark brown pan, hard, often with compacted rock fragments. Not present everywhere.
B3	11.3 - 30 in.	Red-orange-brown sandy soil with rock fragments - often large, but not excessively hard; some clay content.
C	30 -	Yellow buff sandy soil rock fragments increasing in size and less clay.

Three machines only were employed from start to finish.

1. Red Spot Fordson Major with rotary hoe attached.
2. Ferguson Tractor with spring-toothed cultivator. (The teeth were all set in a line to provide a rake, or sweep).
3. D.4 Caterpillar tractor drawing a Killifer subsoiler.

The first operation was to remove the heather and small scrub, for which purpose the Fordson rotary hoe was set to cut (at the most) 1 in. below the surface. This completed, the rotary hoe blades were set at zero, and the area covered again; the object being to beat out any humus and peat left adhering to the heather roots. This operation took 40 hours at a total cost of £15. 9. 2.

The second operation aimed at clearing the heather from the area. The Ferguson and spring toothed harrow was employed for the purpose, taking sweeps of about 100 yards at a time, working from the sides towards the centre. This was completed in  $131\frac{1}{2}$  hours at a cost of £53. 19.  $4\frac{1}{2}$ .

Thirdly the area was subsoiled at  $4\frac{1}{2}$  ft. spacing using a Caterpillar Tractor and Killifer drawn at 15 in. depth. This took 32 hours at a cost of £32. 8. 9.

Lastly the cultivation of the ground was undertaken by working the soil three times with the Fordson rotary hoe; first at 1 in. depth to break up the humus layer and any remaining heather roots; secondly at 3 in. depth to mix the humus layer and mineral soil; and lastly at 6 in. depth to obtain the correct texture of soil to a depth suitable for seed sowing or even lining out. These three cultivations were quite essential in view of the very hard and rocky nature of the ground, which could not have been broken up without the use of subsoiler and rotary hoe. These cultivations took  $55\frac{1}{4}$  hours at a cost of £21. 5.  $10\frac{1}{2}$ .

A rabbit proof fence was considered necessary, and 60 chains, including two swing gates, were erected by unskilled labour. Costs were kept low by employing the Caterpillar tractor and subsoiler along the entire fence line to facilitate the driving of fence stakes, and the Ferguson tractor and plough to open up a trench for turning out the foot of the netting.

#### Summary of Costs

1.	Initial cutting of heather (rotary hoe)	£15.
2.	Clearing heather from area	£54
3.	Subsoiling	£32
4.	Cultivation	£21
5.	Fencing (including materials)	£120
		<hr/>
		£242
		<hr/>

The work was completed in August 1949, the total cost of £242 working out at just over £10 per acre (excluding fencing costs). It is thought that this will compare favourably with costs of nursery construction anywhere, especially as previous experience on nearby sites using quite different techniques has indicated heavy costs of £60 per acre or more. For future guidance, however, it is thought that costs can be cut even more, mainly by an initial burning of heather; this might lower costs to about £7 per acre or less.



Langdale

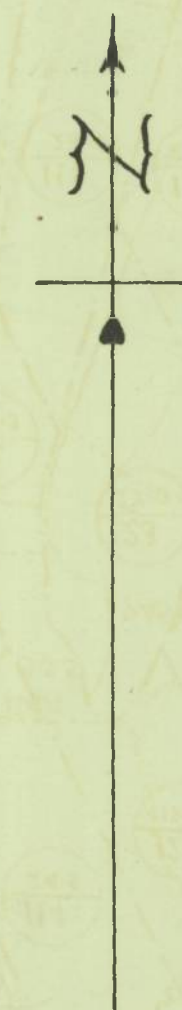


# — LANGDALE — FOREST

Yorks 61E, 62S.W, 76NE & 77N.W.

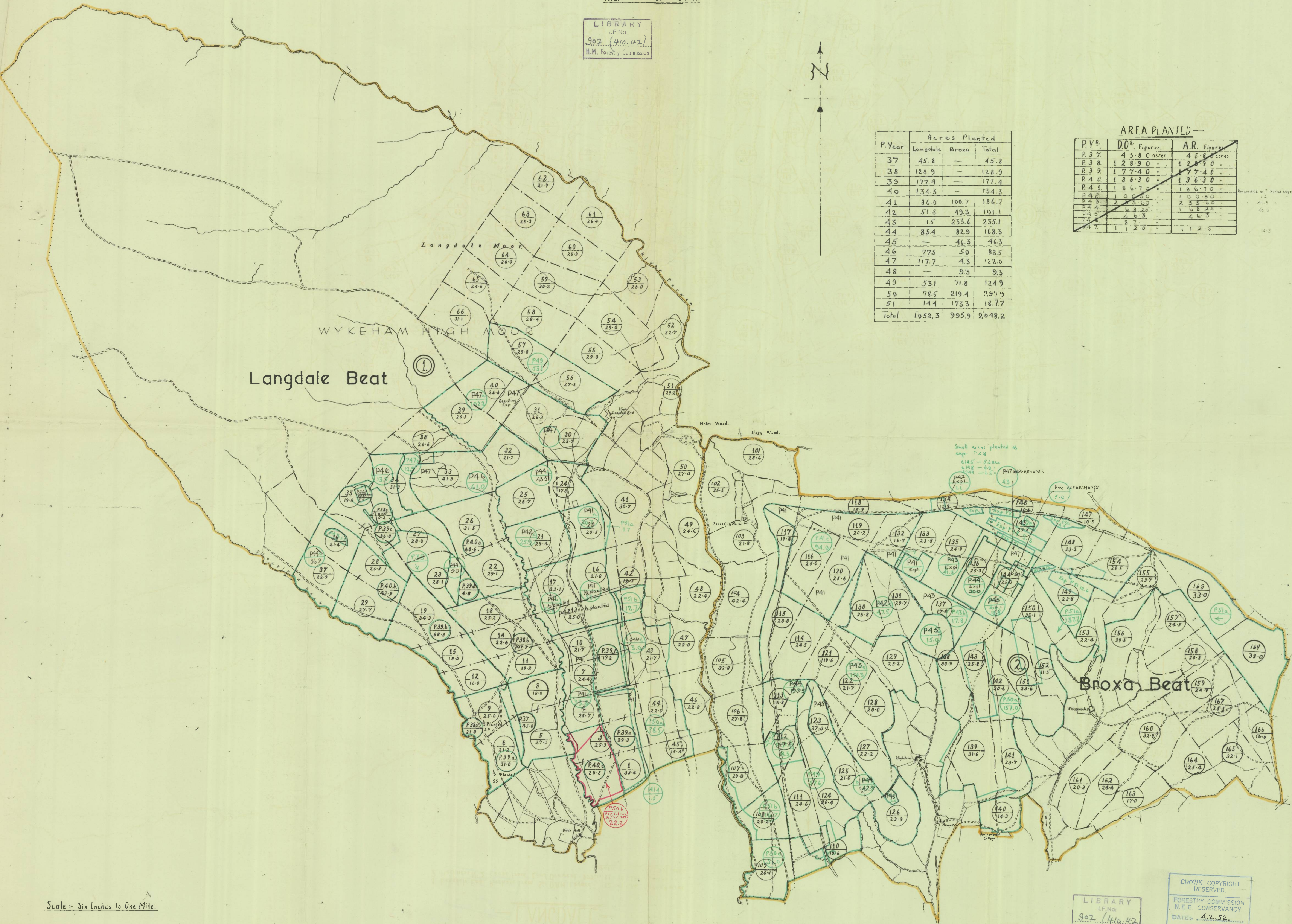
1. Langdale End. Purchase from Sir D.A.H. Legard. 12.11.34. 3619.508 acres
  2. Hackness No 2. Lease from Lord Derwent - 999 yrs. 11.10.38. 1924.433 "
- Total: 5543.941 acres

LIBRARY  
I.F. No: 902 (410.47)  
H.M. Forestry Commission



P. Year	Acres Planted		
	Langdale	Broxa	Total
37	45.8	—	45.8
38	128.9	—	128.9
39	177.4	—	177.4
40	134.3	—	134.3
41	86.0	100.7	186.7
42	51.8	49.3	101.1
43	1.5	233.6	235.1
44	85.4	82.9	168.3
45	—	46.3	46.3
46	77.5	5.0	82.5
47	117.7	4.3	122.0
48	—	9.3	9.3
49	53.1	71.8	124.9
50	78.5	219.4	297.9
51	14.4	173.3	187.7
Total	1052.3	995.9	2048.2

P. Year	AREA PLANTED	
	D.O. Figures	A.R. Figures
P. 37	45.8 0 acres	45.8 0 acres
P. 38	128.9 0	128.9 0
P. 39	177.4 0	177.4 0
P. 40	134.3 0	134.3 0
P. 41	186.7 0	186.7 0
P. 42	101.1 0	101.1 0
P. 43	235.1 0	235.1 0
P. 44	168.3 0	168.3 0
P. 45	46.3 0	46.3 0
P. 46	82.5 0	82.5 0
P. 47	122.0 0	122.0 0
P. 48	9.3 0	9.3 0
P. 49	124.9 0	124.9 0
P. 50	297.9 0	297.9 0
P. 51	187.7 0	187.7 0
Total	2048.2 0	2048.2 0



Scale - Six Inches to One Mile.

LIBRARY  
I.F. No: 902 (410.47)  
H.M. Forestry Commission

CROWN COPYRIGHT  
RESERVED.  
FORESTRY COMMISSION  
N.E.E. CONSERVANCY.  
DATE: 4.2.52  
INITIALS: W.S.