

76.
Memo. to Conservator, East Scotland
(Copy to Director, Scotland)

From: R.A. Innes.

History of Clashindarroch Forest

I attach four copies of the
Chairman's Comments on the Clashin-
darroch Forest History.

R.A. Innes

17.7.52.

Mr. Doolidge 

You will not have time to deal with
this paper, which I consider is totally
unfair to "local Officers." It is not worth
taking this up.

The summary on P.3 is sound.

Will you please pass to Peniston, for
issue of copies to District & Forest, and
for discussion with me.

76

18.7.52



Meeting in The Hill Hotel, Huntly, on the Evening of
12th June, 1952

A resume was made of the Historical Accounts of Clashindarroch, with particular reference to the Silvicultural Notes.

1. The Chairman, Mr. Gosling and Sir Henry Beresford-Peirse were much in agreement with the conclusions drawn by Mr. Woolridge. It was agreed that apart from certain areas which would come on gradually on their own, the checked spruce problems were behind us.
2. Mr. Gosling reminded us that there were other areas needing attention. There were areas of European larch which had suffered less severely from "die back" but which in his opinion were not satisfactory.
3. The moist old arable areas now carried Sitka spruce. They should have been planted with that species or with Norway spruce in the first place, he thought.
4. The worst areas on the calluna slopes had been beat up from time to time with Sitka spruce. These required attention, as has been recorded earlier.
5. The one big repair job yet to be done on Clashindarroch was the treatment by beating up of the less severely affected "die back" areas. This was a job which should receive early attention. The choice of species for beating up was discussed. *Abies grandis*, and *nobilis*, *Tsuga* and Douglas fir were suitable, but it was realized that the presence of roe deer would not permit the use of these species. It was realized by all, that in Clashindarroch, real control of roe deer would become nearly impossible. Every effort must be made to keep numbers down. The use of Hybrid larch or Japanese larch was recommended. It was thought that a high proportion of the 780 acres of European larch which had not been treated would require some attention.
6. The Chairman said that he was very pleased with the development of Scots pine on plough on Clashindarroch. On the higher ground they had suffered less from snow damage when planted in mixture with spruce. We should investigate the matter and find out what did happen in a snow storm. In heavy snow fall areas, the intimate Sitka spruce/Scots pine mixture would probably be best.
7. Mr. Oliver said that the strain of pine used in these conditions was important. The better, high altitude Glenlivet stands of pine would probably be suitable.
8. Mr. Gosling said that what he had seen at Gartly Moor showed that we had benefited from the lessons on Clashindarroch, and we knew how to tackle these areas.
9. The Chairman urged us to try out as many different species as possible in mixture with pine. His advice was to do enough of such trials to give us experience. We must work ahead of the Research Branch.
10. Lord Robinson thought that a paragraph should have
/been

been spared for the White Geese area, the success of which stood out in a wilderness of failure.

'No comment'.

'T.H. Woolridge'.

Memo. to Conservator, East Scotland
(Copy to Director, Scotland)

From: R.A. Innes.

Clashindarroch Forest History

On checking the Utilisation of
Ground Schedule (Table II, page 6)
I find that the total comes to
20,148 acres and not 21,148 as
given. There is a discrepancy of
1,000 acres between Tables I and II.
I should be grateful if you would
clarify the position for me.

R.A. Innes

27.8.52.

7695 under
Agriculture

29/8/52

HISTORY OF CLASHINDARROCH FOREST

CHAIRMAN'S COMMENTS

The history has now been well compiled and brings together the main facts in a readable way. Most of the points which I have made following various inspections have been noted, except the last inspection of June 1952.

The main block of Clashindarroch was acquired during my absence in the Antipodes at the Third British Empire Forestry Conference. My first impression on seeing it was that we had taken on a difficult area; high lying and probably harsh climatically for the most part, surface vegetation not encouraging but soils better than might have been expected. It was not to be anticipated therefore that afforestation operations were going to be plain sailing. With this in mind I asked for a series of pilot plots to be laid down to test species and conditions.

The first plantations flattered only to deceive. The two main species planted were European larch and Sitka spruce. The former started off very well, the latter as usual looked well enough for a couple of years and (as usual) went into check on heather sites. There was little change in planting procedure for a few years, that is until caterpillar ploughing was introduced, when a small unpromising area of Sitka spruce on a poor site was interploughed and Scots pine planted on the plough. Ploughing became general wherever possible from about 1936, but seems to have been neglected during the war, to be strongly resumed thereafter.

The value of mixing pines and Japanese larch with spruces on heather ground was well established experimentally by the middle 40's, but the idea was slow to take hold at Clashindarroch. I found, for example, on my inspection of 1949 that Sitka spruce was still being planted pure on heather ground and it

I consider the
statement is
completely one-sided.
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18.7.52

Local officers
like Johnson
Edwards who
knew the answer
in '37 were not
allowed to use
their knowledge
until the Chairman
realized that
most 'checked'
spruce is failed
spruce. He did
this only in '49
when repair work
was already in
hand.
H.S.
18.7.52.

was clear to me that local officers did not fully appreciate the advances which had been made. I insisted, therefore, that the Research Branch should be brought into the picture forthwith and later drew some diagrams showing how by the use of local data predictions could be made of probable results from mixing species (see Headquarters file 115E/50). Improved rehabilitation methods have since been adopted.

I mention this point mainly because of its general interest, which is the difficulty, in a widespread undertaking such as ours, of getting improvements in technique universally known and put into practice.

My inspection of June 1952 was of great interest to me. The previous one (1949) had followed the extraordinary frost of 1947 and new plantings (and underplantings of Sitka spruce) were not looking well. In the interval we had been favoured by an absence of Spring frosts (excepting a relatively mild one of early June 1952) and the trees had obviously benefited, in particular Abies grandis and underplanted Sitka spruce.

Of outstanding interest was the absence of fresh die-back and the recovery in European larch in all except the worst (very frosty) sites. From an examination of individual trees it seemed possible to date the beginning of the recovery to 1946 or 1947, or occasionally to 1945. The course of the epidemic seems to have run approximately as follows:

Earliest plantations	P.30	
First Chermes attack reported	1937	{ age 7 years }
Die back beginning	1938/39	{ " 8/9 " }
" " severe	1940	{ " 10 " }
" " apparently catastrophic	1944	{ " 14 " }
Recovery beginning	1945/46	{ " 15/16 " }
Dominant crowns practically normal	1952	{ " 22 " }

Most of the dominant trees seem to be out-growing the kink formed at the point of die-back and in a few years only slight evidences of it will remain.

The main effect of larch die-back, therefore, was under-stocking, the degree of which must vary from place to place.

under- or inter-planting. Enumerations should be made and experiments carried out forthwith.

A few other points in 1952 were, very briefly:

- (1) The success of the pine-spruce mixtures of P.37 at White Geese. Too little advantage was taken of this pointer which is outstanding.
- (2) The high promise of the more recent pine-spruce mixtures on ploughed ground.
- (3) The good growth of Scots pine at lower elevations.
- (4) The growth of Mountain pine on the upper fringes of plantations. The neglect of this species in mixture with Sitka spruce on poor and exposed sites is surprising.

There is still a lot of useful information to be gathered up and applied at Clashindarroch and I cannot urge local officers too strongly to make a habit of systematic study of results to date.

Clashindarroch has had a somewhat expensive and chequered career, but will in the end make a satisfactory forest.

R
July 16th - 1952

CLASHINDARROGH FOREST

HISTORICAL ACCOUNT

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INTRODUCTION

Mr. Horne and Mr. J. M. Kennedy have produced this historical account of Clashindarroch although I must take responsibility for the views expressed in section 10 - Silviculture. Kennedy, who knows this big forest better than anyone, has claimed for several years now that what may be proved at Clashindarroch may also be disproved: Be that as it may there is no doubt that the major lessons to be learned at Clashindarroch are now understood and are incorporated in our forest practice in this Conservancy. There is still a lot to be learned about hardy races of our commoner trees and about exposure and about the succession to pioneer species, and we are already started along some of these exciting trails.

The checked areas are now behind us. Should anyone feel depressed let him walk through S.S./S.P. on plough P.38 Lag Valley, and see Sitka thrusting up through pine at over 1000' elevation: Let him see a whole small valley Compartment 224, etc., planted with one-year seedlings of S.S./S.P. on plough in '48 and now growing vigorously, or let him tread the wonderful forest floor where once was heather under J.L. and H.L. in many places through the forest. Clashindarroch is already an achievement and will soon be a highly productive forest.

In a history one should reminisce, and I remember Mr. Gosling saying to me some years ago, "It isn't that we don't know the right thing to do, it's getting everyone to do it!" In my case he was mistaken: I didn't know, but it was an encouraging remark. Clashindarroch has taught us the right thing to do: We must now get everyone to do it.

STATE FOREST OFFICER.

GLASHINGARROCH FOREST

Historical Account

I. Situation

The area mostly lies to the West of the Huntly Rhynie road and is bounded on the West by the rather elevated county boundary or the Gartly Parish line. The agricultural lands on the East side are bounded by the River Bogie while the South boundary crosses the Rhynie Gairach Road. The farthest point of the North boundary almost reaches the River Deveron about $3\frac{1}{2}$ miles West of Huntly.

The Forest derives its name from the Shooting Lodge of that name which was acquired with the first acquisition.

II. Area and Utilisation

The areas at time of acquisition and at 30.9.51 are as shown in the tables which follow:-

TABLE I

Clashindarroch Forest History

From	By	Date	Plantations Acquired	Plantable exc. Col. 4	Nurseries	Agricultural	F. W. H. excl. Col. 4	Unplantable excl. Col. 4	Other Land				Total
									Land Permanently transferred	Land temporarily transferred	Land permanently transferred	Land temporarily transferred	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Duke of Richmond Gordon & Lennox	Purchase	1929		7978		2520	350	6917					17765
Daniel Ferguson Lockhart	Purchase	1930		425									425
Mrs. Annie Wright Barrie	Purchase	1938		162		1		91					254
George Watson Thom	Purchase	1944		60				49½					109½
John McRae	Purchase	1944		143½		13		18					174½
Garnet Ewert Lambert & Another	Purchase	1945		1672		223		526					2421
Disposals to Aberdeen County Council													21149
Miss Grant				75									102
TOTALS:				10439.75		2756.6	350	7601.5					21147.8

II. Area and Utilisation (Contd.)

At the time of acquisition farming was not in the prosperous state that it is today. This was particularly the case as regards hill sheep farming. The low-lying farms which were mainly arable subjects were well farmed but the upland places which were mainly B.F. sheep farms with a little in-by ground were not properly worked and the poor prices for wool and mutton at the time made these difficult to let at economic rents. The higher Calluna moor was given over to Sport and it is doubtful if much sheep grazing was done there.

Rabbits and hares probably far outnumbered sheep.

As can be seen from the Tables which follow much land still remains in agriculture. This land is, of course, the best and most fertile land and will probably always be farmed. The number of persons engaged in Agriculture cannot be much smaller now than it was at the time of acquisition. It is estimated that three or four shepherds at the most have been "put off the hill". The production on the lands remaining in agriculture today is without doubt greater than the total was in 1930. One very progressive farmer who farms 2315 acres has done considerable areas of re-seeding and is now raising Hereford cattle on what was formerly calluna moor.

His suggestion that parts of Clashindarroch could have been broken up by wide green belts of grass by re-seeding is worthy of consideration in future planning of big acquisitions where the agriculture and forestry must be complementary. The woods would benefit the grazing and the grazing belts would afford first class fire protection.

The Forestry Commission has built 11 workers houses and 1 head forester's house. Six of the houses acquired with the land are used to house Forest Workers.

The farms are worked mainly as mixed farms. Of the 21 tenancies, 10 have B.F. sheep flocks. No sheep stocks are tied to the land. It is not intended to resume any more land from Agriculture Subjects under Forestry Commission management (at least not in the immediate

II. Area and Utilisation (Contd.)

future). With regard to the Department of Agriculture for Scotland managed farms, the Department of Agriculture for Scotland were prepared to make an area on the lower slopes of Tap o' Noth available for planting. The area was long and very narrow and in addition to the very expensive enclosure, fenced sheep passes would have been necessary. The proposal was considered uneconomical.

The method in which all the farms on the Forest are worked is such that it would be unwise to seek further resumptions.

Land for planting F.Y. 52, 53 and 54 has been reserved for Forestry Commission grazing tenants and entry secured.

The Shootings are let on lease at an annual rental of £500 (Clashindarroch). Grouse provide the main sport.

The bags for recent seasons are as follows:-

- Season 1948 - 327 brace Grouse, 43 brace Partridge,
10½ brace Black Game, 6 Snipe, 2 Duck,
13 Brown Hares, 7 White Hares.
- " 1949 - 720½ brace Grouse, 3 brace Pheasant,
14 brace Partridge, 8 brace Black Game,
2 brace Woodcock, 1 Capercaillie, 2 Snipe,
43 Hares, 5 Roe Deer.
- " 1950 - 876½ brace Grouse, 4 brace Pheasant,
47½ brace Partridge, 1 brace Pheasant,
99 Hares, 10 Roe Deer.

The Shooting on Gartly Moor is let separately to the National Trust.

The following bags have been obtained in recent years:-

- Season 1948 - 140 brace Grouse
- " 1949 - 137 brace Grouse, 6 Hares.
- " 1950 - 225 brace Grouse.

TABLE II

(a) Plantations

Acquired	Nil Acres	
Formed by Forestry Commission	<u>8082</u> "	8082 Acres

(b) In hand awaiting planting

Blanks after felling	Nil	"	
Burnt Area	Nil	"	
Other land	<u>1445</u>	"	1445 Acres

(c) Nurseries

(d) Agriculture

D.O.A.S.	13 tenancies	}	7695 Acres
Forestry Commission	8 "		

(e) <u>F.W.H.'s</u>	13	"	33 Acres
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(f) <u>Unplantable land in hand</u>			3890 Acres
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(g) <u>Other land</u>			3 Acres
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21,148 Acres

III. Physiography

The area is elevated and hilly, the bulk of the higher ground lying towards the West boundary, where we find a continuous belt above the 1250' contour extending to 3400 acres. Within this belt or just beyond the Forest boundary we have the Grumack Hill 1723', Cloichedubh Hill 1598', Hill of Haddoch 1711' and Leid's Hill 1571'.

Another block of 1130 acres over 1250' embraces Tap o' Noth and Hill of Kirkney. Other small blocks over 1250' occur as follows:-

- (a) Raven Hill and Cross Hill - 450 acres
- (b) Long Bank, Cransmill Hill and Quarry Hill - 250 acres
- (c) Clayshot Hill - 200 acres
- (d) Kyehill (Saughs) - 10 acres.

This gives a total of 5430 acres over 1250' elevation. The Tap o' Noth is a prominent conical feature rising to 1851'. The deep valley of the Kirkney and the Lag Burn almost trisect the area, each section being further divided by secondary valleys. Valley slopes vary from steep to moderate. Slopes of 20° to 25° are common on the Kirkney and Lag Valleys. The slopes are dry except at Boganeloch and Brown Hill where the gentler slopes are typically moist. The North facing slopes tend to be moist and mosses and peat are accumulating where canopy has been long in forming.

All aspects are found. The exposure is greatly moderated by the high proportion of valley slope within the plantable area. It is a serious factor on the upper slopes, ridges and plateaux.

Blasting is most common from the North West.

IV & V. Geology and Soil and Vegetation

We are fortunate in having had these subjects dealt with in a thoroughly scientific manner by Doctors Muir and Fraser of the Macaulay Institute of Soil Science. A study of this work will repay anyone who has to deal with silvicultural problems of Clashindarroch. The soils of Clashindarroch are derived in the main from rocks which give fertile soils and they are not likely to prove a limiting factor in tree growth excepting, of course, at high elevations. It is the

IV. V. Geology and Soil and Vegetation (Contd.)

soil surface which has been our problem and the deterioration which it has undergone since enclosure. This will be dealt with under 'Sylviculture' but it is interesting to note that the change from nardus, aira flexuosa and erica spp. to calluna and vaccinium can now be observed on the recently enclosed land at Brown Hill, Bogancloch.

All three main classes of rock are represented as follows:-

- (1) Metamorphic. Knotted schists, phyllites, slates, contact - altered schists, mica schists, quartzite and flags.
- (2) Igneous. Norite, hornblende schist and serpentine.
- (3) Sedimentary. Old red sandstone.

The area is extensively drift covered, the covering being thin or absent on the upper slopes, ridges and convex features generally. The drift is specially strong in the region of the hornblende schist, norite, contact altered schists and pebbly grit bands. The comparative lightness of the third and last glaciation explains the close correspondence between the drift and the subjacent rock types. The parent materials occur in the form of (a) residual soils, (b) drift soils, (c) colluvium and (d) alluvium. Impeded drainage is most evident in soils overlying the till.

The following is the soil classification adopted by Messrs. Muir and Frazer.

	<u>H. M. Steven's suggestion for choice of species.</u>
A. <u>Brown Earths</u>	
Normal Brown Earths	N.S., S.S., S.P.
<u>Creep Soils</u>	E.L., J.L., S.P.
Brown Earths with Gleyed C Horizon	N.S., S.S.
B. <u>Podzolised Soils</u>	
Concealed Podzols	E.L., S.P., J.L.
Normal Podzols	SP/SS, SP/EL, J.L.
Peaty Podzols	SS/SP or SS/PC
C. <u>Gley Soils</u>	
Ground Water Gleys	N.S., S.S.
Surface Water Gleys	S.S., N.S.
Peaty Gleys	S.P. (S.S.)
D. <u>Peat Soils</u>	
Hill Peat	S.S. (with slag)
Basin Peat	N.S., S.S.
E. <u>Old Arable Soils</u>	N.S.

Vegetation. Here again we are indebted to the Muir-Frazer report for

I & V. Geology and Soil and Vegetation (Contd.)

a very detailed classification of the vegetation and its correlation with the soils. Their scheme of classification is as follows:-

1. Grassland

- (a) Recently cultivated
- (b) Semi-natural

2. Heathland

- (a) Grass Heath
- (b) Dry Heath

Calluna/Erica cinerea
Calluna/Vacc. myrtillus
Calluna/Arctostaphylos
Calluna/Aira flex./Vacc. myrtillus
Exposure Types (Calluna/lichen)

(c) Moist Heath and Submoorland

Calluna/Aira flex.
Calluna/Vacc.
Calluna/Nardus
Submoorland - calluna/scirpus, calluna/erriophorum

3. Moorland Types

Basin Peat - Calluna/erriophorum/scirpus
Hill Peat (sub Alpine) - Calluna/scirpus, calluna/erriophorum.

4. Flush Types

Humose Flush - Ald/Wi., holcus, jun. art.
Peaty Flush - Nardus, Carex, Narth.
None-humose Flush - Aira caesp.
Ferruginous Flush - Stunted forms of usual flush plants.

VI. Meteorology

The annual rainfall varies from 35" to 40". The higher figure applying to the higher ground towards the West and South West boundary. The distribution of the rainfall is illustrated by the following averages over 26 years for Huntly (500').

<u>Jan.</u>	<u>Feb.</u>	<u>March</u>	<u>April</u>	<u>May</u>	<u>June</u>	<u>July</u>	<u>August</u>	<u>Sept.</u>	<u>Oct.</u>	<u>Nov.</u>	<u>Dec.</u>	<u>Total</u>
2.43	2.20	2.47	2.59	2.71	2.03	3.25	3.05	2.76	3.24	3.68	3.02	34.24

These figures do not indicate much risk of drought.

The prevailing wind is Westerly but North and North West winds can be very severe. Snow can be very damaging to young crops of S.P. Snow drifts lie late in depressions and on North slopes. Severe frosts are frequent in spring.

The climate is generally severe in winter and as so much of the planting is now done on plough frosty weather frequently holds up the work for lengthy periods.

VI. Meteorology (Contd.)

The incidence of frost and exposure at Clashindarroch would be worth a close study. As pointed out at one time by Mr. James Macdonald, frost may be dammed up by bends and constrictions in the long valleys, and the effect of it may be felt much further up the sides of valleys than would be expected. In the same way exposure may be severe in unexpected places and there is no doubt that in some cases e.g. the south side of Lag Valley exposure is much less severe than the present planting line suggests.

VII. Risks

Frost. If we assume that frost is a major cause of die-back in European larch, it must be reckoned as the greatest risk at Clashindarroch. Although frost may severely damage spruces, and even on occasions, kill them, fatal results have never been sufficiently widespread to call for repair treatment.

Blast. Apart from the high exposed regions, blast can be damaging at Clashindarroch on newly planted areas in almost any elevated situation. Severe losses in current year's planting can occur after cold winds in April, and this applies particularly to 1 + 1 S.S. and two-year seedlings of any species. Big plants may also suffer. A one-year seedling can often sustain such damage and make complete recovery.

Fire. The main risk is from muirburning on marching properties. The risk has been largely offset by the provision of a bulldozed ring trace which it is proposed to complete in F.Y. 52.

The Forest is well roaded for its stage of development and the easy access afforded to any part of the area is valuable help in fire protection. No fires involving loss of woodland have occurred during the life of the Forest.

Vermin.

Rabbits. The large areas of agricultural land which border the Forest have always been a menace and netting has been done for all plantings. The rabbit question is being tackled by a team of five trappers. The purpose is to aim at extermination on the planted and plantable land and the agricultural land under the control of the

VII. Risks (Contd.)

Department of Agriculture for Scotland and the Forestry Commission.

The D.O.A.S. readily agreed to our trapping and shooting on land managed by them.

Mountain Hares. These often cause considerable damage in winter. The trouble is that upper march fences are drifted up with snow annually. Beyond our march fence there is a vast area of high moorland where hares are very numerous. They are controlled by frequent drives during the winter months.

Roe Deer These are increasing substantially - partly on account of war-time fellings and partly due to the shelter afforded by the young plantations. Strong control measures are necessary if their numbers are to be kept within reasonable bounds. It is doubtful if we are justified in protecting them at any season of the year.

Capercaillie. Not common - no damage recorded.

Black Game. These are increasing - damage has been recorded in recent years - control necessary.

Insects and Fungi. The only insect and fungus of serious importance are the Larch/Spruce aphid and the Larch canker. Together they have contributed to the melancholy state of the E.L. plantations.

VIII. Roads

Road construction started in 1947 under Directorate - not Conservancy - supervision, with the idea of completing a South to North connection within or near the forest boundary.

To do this, it was proposed to join the roads running up the Kirkney burn from West of Finglenny to the Drumfergus roadhead at Three Sisters and also to join from just North of Tillathrowie to Bailliesward.

Early and heavy snow led to the abandonment of this work in early December.

In F.Y. 1948/49 the above two roads were completed, under Conservancy supervision, using a hired excavator and tippers, a Commission bulldozer and forest labour. As these roads might be required through-

III. Roads (Contd.)

out the year for the movement of personnel, they were metalled partly from quarry waste, and partly from rotten rock excavated on the road alignment. The latter material proved unsatisfactory, and had to be resurfaced in 1950.

In November and December, 1948, the road up the long valley was bulldozed by hired equipment, and the first 600 yards through agricultural land was metalled from stone excavated from the roadside. Owing to forest labour having to be withdrawn for planting, there was not time to drain this road properly, and there was considerable water damage in the winter of 48/49. This damage was repaired by autopatrol and culverts added in the summer of F.Y.49.

It was now clear that ground conditions for roads in this forest were with certain exceptions very favourable, and it was decided that for fire protection, forest management, and some early thinnings, a system of properly constructed earth roads would probably be adequate, and could be justified.

From the summer of 1949 to September, 1950, approximately 8 miles of F.W. road and 11 miles of fire tracks were constructed. The F.W. road was shaped by autopatrol and culverted, the fire tracks were left as bulldozed.

In addition, one mile of road from West of Finglenny to Bogancloch was metalled. This completed the road from South to North within the Forest.

The total mileage constructed since 1947 is $6\frac{1}{2}$ A.W., $10\frac{1}{2}$ F.W., $11\frac{2}{3}$ Fire tracks. It is estimated that this forest may require over 100 miles of road or track before it is completed.

Costs are difficult to ascertain accurately as much of this work was done by the forester, and the engineering progress report was not submitted. From the engineering reports available the cost of F.W. road appears to be £350 per mile allowing S.R.O. rates for bulldozer and autopatrol. Additional culverts will probably be necessary which will put the cost up to approximately £400 per mile.

The main disadvantage that this forest suffers from, as regards

road construction, is that if earth roads do not prove adequate, there are no supplies of gravel or suitable rotten rock, so that surfacing will entail blasting and crushing stone, and therefore additional expense.

IX. Labour

Labour supply has been plentiful and of fairly good quality up to the present. The normal estimates cover a squad of 40 men - but only 35 men are on the squad at present. The size of the planting programme of recent years would require a squad too large to be employed at other seasons. This has been overcome by obtaining help at planting time from the Bin where planting programmes are now small, and by the payment of bonuses for higher production.

X. Sylviculture

It is with a good deal of humility that one sets out to write on the Sylviculture of Clashindarroch Forest. Much thought has been given by many good men to the problems of the forest and much first class practical work has been and is being carried out in this rigorous and inhospitable region. Nevertheless, we have our failures, some of them on a big scale, and it is a good time to pause and ask ourselves if we are good enough men to learn the lessons now bound up in this forest.

In 1944 I. Gillespie wrote a descriptive, historical and critical report on Clashindarroch. This excellent report gathers together the knowledge we had at that time including opinions of inspecting officers and the essence of the work of Muir, Frazer and H. M. Steven. It is the first real attempt to go back over work done and to draw conclusions of how failure should be treated and future work carried out. The recommendations of this report deal chiefly with the two biggest problems at Clashindarroch - larch die-back and failed sitka - and an attempt will be made here to give an up-to-date appraisal of these two matters. In addition, these notes will include points of sylviculture on which Clashindarroch now gives a lead and points on which further investigation is required. The danger of thinking we now know too much will be avoided so far as possible.

The soils of Clashindarroch are within normal climatic and physical

limits, fertile, and there is no reason to suspect that they will not make satisfactory forest soils. On some of the best soils spruce has failed and larch has died back. So far as we can now see, the answer to the failed spruce is known and is incorporated in our forest practice: the reason for die-back larch is not known.

The planting of pure S.S. on moist heaths was encouraged from the beginning. Presumably, the good soil and the vegetation supported this choice - moist heaths according to Muir and Frazer, being chiefly ericaceous with *vaccinium* spp., *calluna* and occasional *nardus* and *aira flexuosa*. The tentative schedule prepared in 1929 indicates however, that sitka was thought to be suitable for the bulk of the uncultivated hill. (See Gillespie's report). Optimism was sustained until about 1936 when it began to be obvious that the 'check' of notched pure spruce on moist and *calluna* heaths was to be permanent, and that drastic action would be necessary. Even then the hopelessness of the situation was not realised; ploughable areas began to be ploughed and filled up with S.S./S.P., but the steep slopes were still expected to come away and further pure spruce was planted. We now know that deterioration of surface conditions particularly on north-facing slopes was proceeding fast as heather dominated the vegetation and became luxuriant. Under the heather, conditions were constantly moist and the formation of peat began. *Sphagnum* is now common on these slopes even on the down-side of drains. Not even S.P. introduced in every third row of S.S. (See report of Chairman's visit of October, 1941) could tackle these conditions. This treatment continued for several years (see the recommendations on Gillespie's report, June, 1944) but we now know that even had the pine succeeded in growing it would have been insufficient in quantity to have brought away the spruce.

PROGRESS OF REHABILITATION

/Failed

FAILED SPRUCE

Areas B.U. with S.P. after ploughing in F.Y. 36-39.

<u>P. Years</u>	<u>Compts.</u>	<u>Areas of S.S. B.U.</u> <u>Acres</u>	<u>Plants Used</u> <u>Thous.</u>
31	10, 17, 19	22	24
32	7, 39, 40, 43, 44 and 45.	64	60
33	36 and 39	23	21
34	37	5	1
Totals		114 Acres	106 Thous.

In F.Y. 51 the following failed areas were treated:-

<u>P. Years</u>	<u>Compts.</u>	<u>Area of S.S. & SE/SF B.U.</u>	<u>Plants Used</u>		<u>Total All Spp.</u>
			<u>Spp.</u>	<u>Thous.</u>	
32	43, 50 and 51	21	J.L. S.P.	21) 4)	25
33	36, 38, 41 and 42	41	J.L. H.L. P.C.	34) 4) 23)	61
34	32 to 35, 37, 50 to 53	91	S.P. J.L. H.L. P.C.	20) 63) 13) 42)	138
35	50, 102, 115, 118, 119, 120, 121, 122	33	S.P. J.L.	22) 20)	42
37	35	3	J.L.	5)	5
	Totals:	189	S.P. P.C. J.L. H.L.	46) 46) 143) 36)	271

See page 15a for F.Y. 52 areas.

The first attempt to treat checked S.S. by ploughing came in F.Y. 36. The method was simply to deep-plough between rows of spruce doing as little damage as possible and to beat up along the ridge with approximately 1000 S.P. per acre. By 1939 a total of 114 acres had been treated in this way. The treatment was stopped and not resumed until after the war.

In 1949 all remaining failed spruce areas were surveyed and scheduled for treatment. In the summers of '50 and '51 they were ploughed wherever possible and beaten up with S.P., J.L., or P.C. and it is obvious from areas ploughed that about 20% of the spruce will survive to take part in the crop. Where ploughing was not possible on steep slopes, thorough mounding was done and J.L. or P.C. planted with phosphate. Altogether since 1936, 528 acres of failed S.S. have been

In F.Y.52 the following failed areas were treated:-

P.Years	Compts.	Area of S.S. & SS/SP B.U.	Plants Used		Total All Spp.
			Spp.	Thous.	
30	11,12	13.3	J.L.	7.2	7.2
31	15,16,17,19	19	P.C. J.L.	15.8) 8.7)	24.5
32	39,40,44,45, 49,63,64,66, 69	45	S.S. P.C. J.L. S.P.	14.1) 36.5) 7.1) 2.6)	60.3
33	62,76,77,91, 93,94,97,98	50.2	H.L. J.L.	25. 40.)	65
34	32	1	P.C.	1	1
35	48	.6	J.L.	1.3	1.3
36	165,169,170	3.9	J.L.	4.	4.
40	195,196	5.5	P.C.	4.9	4.9
41	220,221,222	9.	J.L.	9.	9.
43	226,227,231, 234,236,237	65.5	J.L. S.S. P.C.	8.7) 19.7) 51.8)	80.2
44	157	16.5	P.C.	16.	16.
	Totals:	229.5			273.4

treated either by ploughing or beating up on mounds and the task is reckoned to be now finished. Many small areas of 'checked' spruce will still be untreated but there is a strong likelihood of these areas being brought away either by surrounding plantation or existing nurses.

In prescribing treatment for the large scale rehabilitation work of '50 and '51 many factors had to be borne in mind. Among them were the following:-

Whatever was done had to be certain of success.

The success of the '36 to '39 treatment outlined above.

Once the ploughs were on the ground, ploughing at five feet was only about 30% more expensive than 'band' ploughing.

Success had to be achieved within a reasonable period of time.

Sylviculturist (North) after investigating the subjects of side-effect and nursing at Clashindarroch, showed what might be achieved by band-ploughing as against ploughing at 5 feet. It was clear that 'band' treatment was extremely slow in its effect, and probably almost ineffective for some of the worst sites. Ploughing at 5 feet intervals, between rows of spruce, was therefore adopted as the standard method of treatment.

The choice of species for the treated areas was made along the lines of safety first. Where it was judged that a proportion of spruce would recover beating-up was done with S.P. with the object of forming an intimate mixture. P.C. was used instead of S.P. where appropriate. J.L. could not be used in this way, but where it was possible to get in pure groups or where complete replanting was necessary, J.L. was selected on account of its proved pioneer qualities on difficult sites.

DIE-BACK OF EUROPEAN LARCH

The first note of warning regarding the E.L. was sounded by the Chairman during his 1935 visit, when he expressed a doubt regarding the large acreage of E.L. on old arable sites, which he considered really spruce sites. He thought there was risk of "pumping" and the Acting

Assistant Commissioner and Divisional Officer concurred. Apparently canker was not then sufficiently bad to cause alarm while the H.L. on calluna sites still earned unqualified praise. After his visit the following year the Chairman made the comment, "Much of the larch which I saw is making much better growth than I would have expected from a superficial inspection of the surface vegetation." Sir Alexander Rodger likewise expressed surprise at the good growth of H.L. on calluna sites during his visit in 1937. Mr. W. L. Taylor made a similar remark in March, 1939, with reference to the Lag Valley E.L., while the E.L. in Long Valley showed signs of heavy chermes attack the previous year. It was remarked that the large areas of pure E.L. would encourage this insect.

On 26.3.40 Mr. Newton wrote the Acting Assistant Commissioner in very grave terms and reported advanced degeneration on the old arable sites, chermes and canker being then rife. He stated that chermes was also active on the calluna sites but canker was just beginning in their case. He also drew attention to the considerable acreage of E.L. involved at this forest.

We find no mention of the shoot moth until the Chairman and the Acting Assistant Commissioner visited Clashindarroch in October, 1949, by which date its activities were freely advertised by dead twigs even on the relatively vigorous larch on calluna sites. At the conclusion of this visit most of the E.L. on old arable areas was pronounced "manifestly hopeless" by the Chairman and it was agreed that replacement of dead or dying E.L., principally with large S.S. plants on mounds should proceed right away. As regards the calluna sites, it was considered best to wait and watch. In September, 1943, the district officer was asked to report on the condition of the E.L. on calluna sites and his report revealed a greatly worsened state of affairs on the southerly aspects particularly near the valley bottoms.

Following the visit of the Chairman and Acting Assistant Commissioner in June, 1944, a discussion was held in the Huntly Hotel in order to thresh out policy and procedure with regard to E.L. in particular. The Chairman, Acting Assistant Commissioner, Divisional

Officer, District Officer and Research Forester were present. The Chairman opened the discussion by suggesting that all E.L. on old arable sites was definitely doomed and that the old method of replacement of random deaths should be replaced by systematic beating up. This was agreed. The Acting Assistant Commissioner urged that it was too early to despair of the bulk of the E.L. on calluna sites and that only the worst of it should be tackled at once.

The following work was finally proposed for F.Y.45:-

- A. As regards old arable sites still untouched, underplanting of 50 acres if available, with 870 large S.S. per acre on slit mounds, the plants to be set between the E.L. lines as follows:-

- (a) as to 30 acres, by alternate interlining at 5' spacing
- (b) as to 20 acres, by complete interlining at 10' spacing, staggered, so that every S.S. plant had four others about 7' distant from it.

Areas already treated (old arable or calluna) with S.S., but below the 870 per acre standard, were to be made good as far as possible by the interlining method. Where N.S. previously used, this species was to be adhered to in making good.

- B. As regards the E.L. on calluna sites, it was finally decided that a belt 10 chains wide, extending to about 20 acres, be selected in Lag Valley, embracing both aspects, and treated as under (a) above, further treatment of calluna sites to be subject to developments. On the lower calluna-pteris-grass slopes within the belt D.F. and Tsuga were to be substituted for S.S. on a small scale (say, one acre each).

No further cutting out or brashing of larch was to be undertaken except as later required to give S.S. freedom to develop.

The above work was carried out and additional similar work, until by 1949 220 acres of larch on heath sites had been treated. About that time it was noticed that die-back was no longer progressing and further treatment of die-back areas was suspended. Sitka had established itself remarkably well in heather under the larch, and although it had suffered in some places from frost, serious damage was negligible. At the present time (1951) it is clear that die-back has abated and that the bulk of european larch on heath sites will make a satisfactory though somewhat thinly stocked crop. Some of the beating up with S.S. is now seen to have been unnecessary.

On old arable sites larch has consistently been a complete failure

and has been replaced by a crop of pure S.S.

NORWAY SPRUCE ON OLD ARABLE GROUND

One of the minor failures at Clashindarroch has been that of N.S. on old arable fields at Old Forest. This spruce on some twenty or thirty acres maintains a perfectly good colour and has simply refused to grow at other than a snail's pace for the past twelve years. Many learned opinions have been given but there is a clue if we compare it with an old field (C.259) planted in F.Y.48 and behaving in much the same way. The fields at Old Forest were dirty when planted and today are so full of couch grass that for 4-5 inches below the surface there is nothing but grass roots and dry earth. The field in C.256 is much the same and across the way is a field free of couch C.259. The spruce in the couch-free field is growing normally.

PREPARATION OF GROUND

The only form of preparation of ground apart from ploughing, which might have been practised on any scale at Clashindarroch, is heather burning. In fact, there was until 1951 very little heather burning before planting. Now it is the practice to burn as close to ploughing as possible.

CHOICE OF SPECIES

The area was visited by Mr. R. L. Robinson, Technical Commissioner, in September, 1929, after which he drafted a schedule attached^{page 35}, laying down the approved choice of species and methods of planting for the various types of land which he defined. He regarded this area as unique in the division by reason of the large percentage of elevated ground of doubtful economic plantability which it contained. Experiments were to be instituted at once (P.30), in doubtful ground to decide timber limit, best species and best methods to use. He described his schedule as a first attempt to define vegetational types with reference to plantability and he looked to the local officers to extend and improve it as more knowledge came to hand.

If we take the schedule to imply that species were to bulk in the

programme according to the order in which they are named, then it was not faithfully followed. The good early promise of E.L. was misleading.

As regards the "Safe Land" we note (1) Old Arable Soils. A disproportionate use of E.L. and a corresponding avoidance of S.S. up to and including P.35 S.P. is used pure or mixed with E.L. in P.30 and 31, while J.L. is used fairly freely in P.31, in which year the N.S. proportion shows a definite drop. The avoidance of S.S. in favour of E.L. or J.L. is, however, the most striking feature up to P.35. In P.37, however, there is a decided reaction and both E.L. and J.L. disappear from the arable sites, while N.S. is favoured at the expense of S.S. This preference for N.S. is even more marked in P.38 and 39 (Old and New Forest and Corshalloch), this species being carried to 1250' in the New Forest area. Some SS/PC on the plough furrow was used in P.37 at Corrydown where the elevation is over 1300'. Since P.39, the only planting of arable sites has been at Saughs - P.44 - and S.S. has been the main species used. (2) Bracken. On the very limited area of bracken which occurs, E.L. has been used. (3) Juncus with aira caesp. etc. on a humose soil. N.S. has been the main species on alluvial flats but it has also been used rather than S.S. on fresh flushes on inclined ground. (4a) Moist heath - (on lower uncultivated slopes). This type occurs most frequently on the northerly aspects and both S.S. and J.L. have been used fairly frequently. E.L. has also been used on creep soils where humus layer is thin. In the earlier years there was a tendency to venture N.S. on this type. The altitudinal sequence E.L., J.L. and S.P. sometimes noted on the northerly aspects is unfortunate in view of the exposure. Where S.S. was used in place of J.L. or S.P. and went into check, it was freely condemned by Mr. Edwards as being the wrong species (F.Y.38 Census). This judgement confused the problem of establishment with the question of the ultimately best tree. The free use of S.P. on the upper northerly aspects in Long Valley, etc. is surprising, at least now, in view of the exposure. More respect was shown for this factor in the case of E.L. Up to P.36, pure E.L. was used much more extensively than

SP/EL mixture. In P.37 the E.L. acreage dropped sharply and remained low in P.38 and 39, no E.L. being planted after the latter year.

From P.40 onwards, there has been a growing tendency to use SS/SP mixture on this type after previous ploughing where at all possible. Moist grass heath types over basic igneous rocks have been mainly planted with spruces and especially S.S. (4b) Dry Heath. This is found typically on the southerly slopes, which show an overwhelming predominance of E.L. mainly on creep soils, the proportion of S.P. being very low though it does figure in P.33 and 34 (Hill of Glashindarroch) and P.38 (Finglenny) pure or mixed with H.L. There is some pure S.P. at the top end of Long Valley (P.33) on the southerly aspect at about 1150' elevation and this shows blast effects though less severe than on the opposite slope right down the valley. The J.L. on this aspect has grown well but shows rather crooked growth, but mild in degree compared with the Corrydown J.L. on old arable sites. In P.40 (Corshalloch) we find S.S. flourishing on the plough furrow on dry grass heath over creep soil. Since pure S.P. is undesirable for climatic and economic reasons (snow or wind), it is difficult to suggest anything better than SS/SP for this type over schists, and this has been used at Craigwater, P.43, on unploughable slopes.

Dry grass heath types over basic igneous rocks (mainly Brownhill so far), have been planted with S.P. or SP/EL, the oldest sample of the latter being in P.33 and 34 at Brownhill. In P.33, the larch is Silesian and not very promising but it carried Chermes from the nursery. In P.34 it is native and much healthier and better grown. There are further samples of SP/EL in P.38 and 39 at Brownhill which are promising. (5) Tops of slopes, exposed plateaux at plantable levels. (Calluna-lichen). This was classed as doubtful land in the schedule and probably includes the areas of peaty podsol with pan planted with S.S. at Corrydown (C.19), and Raven Hill in P.31 and 32. They went into check but were interploughed in F.Y.36 and beat up with S.P. in F.Y.38 with decided success. The Research Branch experiments at Drumfergus occupy an exposed terrace on a peaty podsol with pan, while their Kirkney plots also include an area of calluna-lichen. In P.32,

C.s 45, 46 and 49, there is an area of calluna-lichen with J.L., JL/PC and a small area of S.S. still in check. The pure J.L. is very slow and sickly but better in mixture with P.C. The P.57, SS/SP on the plough furrow round the Drumfergus experimental area shows the correct treatment for this type.

(6) Upper parts of 4a and 4b. (Eroded Calluna). The Research Branch experiments in Long Valley are partly on this type and partly on dry heath (calluna-erica cinerea type). The P.39 SS/SP on the plough furrow east of Quarry Hill is on eroded calluna (1100' - 1250') with partial shelter and is fairly promising. The same applies to the P.38 ploughed area on Kemp's Hill with SS/SP, SS/PC, M.P., and S.P.

During the war years a mixture of one-third S.P./two-thirds S.S. was used indiscriminately. Present ideas on choice of species are given under 'conclusions'.

PLANTING

(a) Spacing. Normal spacings have been in use except in the case of one year seedlings where a 3 feet spacing was employed on 5 feet furrows. At the present time normal spacings are used for all ages of plants.

(b) Type of plant used. Clashindarroch as other forests, suffered in early years from the big plant held over in our nurseries for the sake of economy. Between '34 and the war there was an attempt to use more 1 + 1 pines and larches and this practice was again resumed after the war. Planting of one-year S.P. and S.S. heathland seedlings was practised on a minor scale in '48 and '49, with considerable success (C.224). One year seedlings of E.L. have also been planted - P.32 - with success.

(c) Methods of planting. Draining and mounding has been frequently practised on wet spruce sites and turving occasionally on moist spruce sites. The bulk of the planting off plough at Clashindarroch, has until F.Y.50, been simple notching for all species. From F.Y.50 onwards wherever planting is done off plough it is given either a turf or is pitted.

- (d) Annual rate of planting. This is given by species and P.year in the table in this text.
- (e) Manuring. Manuring was not practised at Clashindarroch until post war years. It then became standard practice to manure all species with ground mineral phosphate, on difficult sites.
- (f) Success of establishment. All species except spruces have become established reasonably quickly. The question of the establishment of spruces is discussed under 'conclusions' to this section.

PLOUGHING

Horse ploughing of old arable ground before planting was a regular practice during P.30-32 inclusive. This was discontinued from P.34 onwards until P.37 and 38, when some tractor ploughing was done in the more elevated Corrydown fields. Gransmill, Finglenny, Old and New Forest and Corshalloch (P.35, 37, 38 and 39) are unploughed. Tractor ploughing of calluna heaths began in 1936, stopped during the war years and recommenced in 1946. Ploughing has always been done at 5' spacing. To begin with it was done as deeply as possible, but from '49 onwards it began to be apparent that deep ploughing was difficult to justify on some of the better soils, and more attention was paid to killing out heather and providing a good planting medium with a broad, shallow slice.

Planting on plough is a subject whose finer points are still under discussion but on which in a general way, Clashindarroch can give useful information. From time to time planting in the bottom of the furrow, or a step at the side of the furrow or on top of the slice, has been in vogue. There is no doubt that provided peaty sites are avoided planting in the bottom of the furrow for pines and larches can be successful and has advantages of shelter and moisture initially. Clashindarroch can show in C.157 where the furrow bottom has for no apparent reason, been unsuccessful for both pine and spruce. Step planting has been largely successful for all species but frequently a slow start and great irregularity of growth occurs. Planting on top of the slice has on occasions (C.254 P.48) been very nearly a complete

failure. The reasons for this are that the plant was placed with its roots in the spoil of an enormous slice from the R.L.R. plough, and although placed well down the roots were not nearly at the original ground surface. After weathering roots become exposed and in the worst cases plants are swung by the wind and topple over. Our present method is to pare down the slice mechanically by an attachment to the tail of the plough, or by hand, and to plant through the slice with roots well onto the original ground surface. This is a method well understood by the men and it promotes consistency and gets uniformly good results.

Selection of type of plant for plough follows normal selection for weed free areas.

Apart from instances where planting on top of a huge slice has led to failure through weathering of soil from roots, plantations on plough have been so far, highly successful.

BEATING-UP

Normal B.U. has been necessary on the following scale:-

P. Years	Area (Acres)	B.U. carried out	
		Plants Used	Period
30 to 34	1898	865m	F.Y.'s 34-37
35 to 39	1922	296m	F.Y.'s 36-47
40 to 44	1018	37m	F.Y.'s 42-48
45 to 49	1768	313m	F.Y.'s 47-51
TOTALS:	6606	1511	--

WEEDING

This has been an expensive item due to the very heavy growth of whins on the drier areas planted with E.L. and particularly on the Die-back areas where S.S. was later introduced.

The moister grass areas called for weeding twice annually for three to four seasons.

Ploughing reduced cost a little but on the moister areas to no great extent.

Much money was spent on heather weeding of spruce on unploughed

areas. It was thought that this would bring them out of check - a forlorn hope.

MIXTURE OF SPECIES

From appendix I it will be seen that mixtures apart from SP/EL were the exception rather than the rule until '37 when attempts began to be made at nursing S.S. with pines. The mixture of SP/EL has no advantage so far as die-back is concerned and the nursing of spruces with pines is discussed freely under 'conclusions'. S.S. has been introduced into mountain pine belts and slowly with constant attention the spruce is coming away. Speedier and better results could be obtained with SP/SS or PC/SS on plough or with band-planting on unploughable ground.

RATES OF GROWTH

Tables giving height growth and volume tables are attached at appendices III and IV.

PAST TREATMENT OF ESTABLISHED PLANTATIONS

Past treatment of the older established plantations has mainly consisted of brashing on a rather lavish scale. This has been criticised by inspecting senior officers from time to time. It provided the only useful work for a big planting squad during periods of hard frost and snow, which are only too common. Now that larger areas are coming into the pole stage men will be employed in brashing a bigger area on a less intensive scale. Later it may be desirable to do Pre and First thinnings with Forest Labour and sell standing 2nd and Sub. thinnings only.

Thinning to date has only been on a small scale.

The following thinning has been done:-

F.Y.	Pre Thinning	1st Thinning	2nd and Subs. Thinning	Vol. Produced
	Acres	Acres	Acres	H.ft.
44	1	-	-	295
47	-	11	-	2097
51	-	2	12	9400
TOTALS:	1	13	12	11,792

Though the areas coming in for Thinning in the immediate future will not be big it has been considered necessary to divide the Forest into a North and a South thinning series of three annual blocks in each. This division has just been completed and a thinning plan prepared. The following table gives the proposals for the next three Forest Years:-

F.Y.	Pre Thinning	1st Thinning	2nd and Subs. Thinning	Total Acres
52	70	46	1	117
53	80	4	-	84
54	96	-	13	109

Areas to be treated are mainly J.L., H.L. and good S.S. and N.S. mainly at Balliesward.

One standing sale of thinnings has been concluded at Clashindarroch. This was for 8550 h.ft. of P.30 (Balliesward) S.S. in F.Y.51. The price obtained was £364 approximately 2/- per h.ft.

RESEARCH

The following note has been supplied by Sylviculturist (North):-

Clashindarroch forest has been used as a site for experimental work from its acquisition. A very large programme was initiated in 1931 and the work may be divided into two main projects. First, Clashindarroch forest was selected for one of a group of experiments designed to compare the survival and growth of European larch from seed of various Continental and Scottish origins. The plants were raised in six different nurseries and planted out in three different forests, Clashindarroch being the poorest and only a marginal locality for European larch. Not only has the growth on the middle hill slopes at Clashindarroch been very much inferior to the two other localities chosen, but the success of seedlings as compared with transplants was poor and the growth of Alpine larch little more than half that of the Scottish provenances.

A considerable collection of plots of European larch of different provenances has been built up in succeeding years at this forest.

They perpetuate the strains of many well known stands which have now been felled, and they form useful comparisons with plants from the same seed and nursery treatment which have been planted at Drummond Hill and Lael forests.

The second main project was to follow up the earlier Teindland experiments on the eastern heaths. Much of the land at Clashindarroch is of a better type with no hard pan, but on the other hand, altitudes and exposure are much greater than at Teindland. The first three experiments at Mytice (2-4.P.31) were in fact placed at too great an altitude (1150' - 1400') and have given no results on the subjects for which they were designed, burning, slagging and arrangement of mixtures. The Scots pine, European larch and Sitka spruce are all growing extremely poorly though there is a slight improvement from top to bottom.

Three experiments at Drumfergus (5-7.P.31) were designed to test various species and mixtures on completely ploughed ground. They now present an interesting series with Scots pine, *Pinus contorta*, Japanese larch, Sitka spruce, *Pinus contorta*/Japanese larch and *Pinus contorta*/Sitka spruce. The nursing of Sitka spruce by Scots pine, *Pinus contorta* and Japanese larch in adjacent square chain plots is strikingly demonstrated here. Volume plots are now being established in many of these plots.

Directly planted controls were added to these experiments in 1933 and present a striking contrast, as growth was only half as fast in the early years.

Lastly in 1931 a collection of small blocks of species around the perimeter of Mytice was started at altitudes from 700-1400 feet. Many failed, but *Pinus contorta* is growing slowly at 1400 feet being $3\frac{1}{2}$ feet high at sixteen years from planting while prostrate mountain pine has formed a dense hedge three feet tall. Lower down the most interesting species is Serbian spruce (9, 10, 14.P.31-33).

In 1933 similar trials were made on the ridge above Long Valley with mountain pine, Scots pine and Japanese larch with Sitka spruce at 1260 feet. Mountain pine both prostrate and upright are good and there is some hope that the Sitka spruce in their shelter will get away.

Other species are very poor (11 - 12.P.33).

1933-35 saw four small experiments laid down with phosphates; semsol applied to both newly planted and checked Sitka spruce produced only a very transient increase in growth, while it killed European larch when placed in the planting notch, though basic slag did not (P.T.'s 33/122, 13.P.33 and 20.P.35).

In 1934 there was an attempt to find the effect of 'bad notch planting' the roots being bent or tied up. Surprisingly the result was completely negative, Scots pine, Pinus contorta, European larch, Japanese larch and Douglas fir all grew equally well in all treatments. (16.P.34 and PT 35/1).

Also at this period there were a series of trials of plants maltreated at lining out by cutting or pruning the root systems. Very small differences were shown by any of the species, Scots pine, European larch and Douglas fir. The latter species is noteworthy as having formed excellent plots at the foot of Mytice (PT 35/1 and 24 and 25.P.37). A Pinus contorta provenance experiment was commenced in 1934 and added to in later years. Growth has been slow at the high elevations at which it is situated. The progeny of home collected seed from Ruttle Wood, Beaufort and from Inchnacardoch forest, are outstandingly good. Continuing the larch provenance work, comparative trials of European larch were planted in 1933 and of Japanese and hybrid larches in 1938.

The European larch experiment confirms the result of the 1930 trial and indicates the superiority of plants from Scottish seed collections. The hybrid larch experiment shows the superiority of the first generation hybrid, but does not suggest that the second generation hybrid will be inferior after the poorest trees have been removed in the first thinning. The third generation hybrid seems likely to be definitely poorer in quality. The Japanese larch experiment shows no difference between provenances that is not directly related to the vigour of the individual parent trees from which the seeds were collected.

26.1.37 is a large replicated spacing experiment with European larch which has given interesting results when altitude is taken into consideration. Close spacing has undoubtedly increased top height in the plots at the highest elevation.

In 1938/40 three nursery extensions dealt with the problem of the treatment of over-grown planting stock (28-30.P.38-40). Treatments include wrenching in the lines of the European larch, cutting back of Japanese larch and Douglas fir and undercutting of Douglas fir. Generally no improvement was effected in subsequent behaviour. A further trial of wrenching 2 + 0 European larch as an alternative to lining out shows possibilities.

In the early forties, die back of European larch became very severe in the forest and one of a series of heavy thinning trials was commenced; but though the appearance of the crop is greatly improved there is little evidence yet of greater increment on the selected trees (32.P.43).

Two of the post-war series of ploughing trials are located at Clashindarroch. One in the Mytice area shows remarkable growth. Pinus contorta averages 5' after 6 years while Douglas fir is 4' (35.P.45). In both this experiment and a joint trial with the Conservancy at Corshalloch (36.P.47), growth of Sitka spruce has been doubled on complete ploughing, and undoubtedly this is largely due to the elimination of heather. This observation is being followed up by screefing trials in the single furrow Corshalloch plots and an experimental plot laid down for Dr. Leyten of the Oxford Soil Party.

In 1949 an investigation into the growth of various species at Clashindarroch was carried out for Lord Robinson with particular reference to checked Sitka spruce. Charts showing the effect of ploughing and mixture on Sitka spruce were prepared and an experiment on salvage by ploughing, nursing and manuring laid out to incorporate the results obtained (38.P.50).

Recent work has included also an experiment on position of planting on ploughed ground which demonstrates clearly how on dry areas the

furrow and on wet the ridge should be used (39.P.50). Finally in 1951 a joint sowing trial was laid down with the Conservancy.

In conclusion it may be said that of 44 trials laid down some 27 are still current and include a wide variety of interesting experiments.

CONCLUSIONS

Starting Spruce

Plantations on plough at Clashindarroch show that Sitka spruce can be grown without difficulty on ploughed moist heaths provided that it is given a pine nurse. On some good ground the nurse could be dispensed with but since heather returns quickly on most sites after ploughing and since pine appears to help the spruce to form canopy quickly, the advantages of nursing are accepted. The ordinary run of ploughed calluna ground will take an intimate mixture well - P.38 Drumfergus - but where conditions become at all difficult and the choice of S.S. is made on account of exposure, a mixture of spruce alternating at least with 3 pine is best since it allows the sitka to check for a few years without harm.

Where we cannot plough, spruce is a risky choice even with turf draining and nursing, and we must make our choice among the pines and larches giving them turfs wherever possible. The danger of these sites is the deterioration after enclosure particularly on North facing slopes. We now know the importance of getting our trees away quickly and to get this is worth spending more on hand work than we have been in the habit of doing.

We should be unwise to allow what has happened at Clashindarroch to prejudice the opinions we hold of the usefulness of Sitka spruce. We know how it has failed and how it can succeed; there is no doubt about the tree's exceptional qualities in withstanding blast and in recovering from frost injury; the soils of Clashindarroch are sufficiently fertile for spruce and rainfall is reasonably high. Our real failure would be if we now were to lose faith in this tree.

Die-back Larch

The History of Clashindarroch has come to be written and it can now

be seen that what happened to the greater part of our larch plantations (excepting those on old arable) has been happening to larch ever since it was introduced to this country. That is, it has been dying back, recovering, and going on to form an adequate if somewhat thinly stocked plantation.

The shunning of old arable land for larch and the selection of more promising strains of this tree has come to be part of our forest practice and need not be dwelled upon here. It should, however, be noted that there is no consistent evidence at Clashindarroch for suggesting that E.L. suffers less from die-back in mixture with pine.

Choice of Species

It would be a mistake to confuse the problem of choice of species on the checked areas with those of the choice of species on new ground similar to Clashindarroch. With burning, ploughing, good planting and more experience of what to expect of our trees, new ground of the Clashindarroch type presents not so many problems as it did. On the checked areas a very real problem exists in the unploughable north-facing slopes where luxuriant heather cannot be burned. We are tackling this by using J.L., H.L. and P.C. with thorough hand work and phosphate, but there is still, because of our inability to burn, too much hope included in the mixture.

On new ground wherever the plough will go and there is shelter, the choice of species is wide. In recent years there has been wide-spread indiscriminate planting of S.S./S.P., and however much we dislike such unimaginative work there is no doubt that it will be successful. Having regard to shelter much more D.F. could have been planted with a pine nurse where necessary. Norway spruce in many places could have replaced sitka. Grandis, Tsuga and Thuya could have found a place on the lower slopes. Where there is exposure a sitka/pine mixture remains the best choice wherever the soil will support spruce. Where on these exposed sites, the soil is too dry or infertile for spruce we come upon another of our problems. Scots pine is not a tree for the high exposed places, Japanese or Hybrid larch is not yet proven and we must fall back

on contorta or mountain pine. However useful mountain pine may be as a nurse for spruce it is not a desirable pure crop. Too little seems to be known about contorta to plant it on a big scale although some desirable types such as I.D. 26/58 (Alberta) seem to be emerging. Obviously the watchword here must be caution, and the evidence at Clashindarroch points to the following procedure on exposed, dry, ploughed ground.

Where raw humus or peat is not too deep and mineral soil is turned up by the plough, limited use can be made of pure J.L. and H.L. and of a mixture of PC/SP. Both pines should be carefully selected but particularly the S.P. should come from a race we know to do reasonably well in exposure and under snow.

Where ploughing cannot go deep and turns over little but raw humus and peat we must rely more upon contorta.

Pure S.P. should be avoided at all costs in exposed situations.

We would like to know more about the use of shelter belts of MP/PC/HL. etc. planted in a North and South direction on exposed sites and we also want more knowledge of hardy types of S.P. and P.C. We are taking active steps to get this information.

Before leaving this point of dry exposed sites, it should be said that there is quite a strong case at Clashindarroch for carrying S.S. on to fairly dry sites. In such cases it would form not more than 25% of a mixture with SP/PC, P.C. or M.P. ^{or} with the larches in bands, but there is a body of opinion confident that with present-day ploughing and planting, sitka may be started, nursed, and carried with certainty to the pole stage on such sites. It should not be forgotten that the rainfall on these hills is most likely in excess of 40 inches and is well distributed throughout the year.

On new ground where the plough cannot go we should distinguish between North and South-facing slopes and between exposed and sheltered sites. The South-facing slopes are usually of a better quality and were frequently selected for E.L. On these slopes existing plantations would support a choice from amongst J.L., H.L., D.F., S.P., N.S., and

SS/SP and planting would normally be by screef and notch. The North-facing slopes should be treated as being much more difficult for the starting of trees. They will frequently support all the above species but the risk of starting spruce even with a nurse is too great and it should be discarded in favour of the other trees and P.C. Whatever is planted on these slopes should be given the best possible hand treatment - a big screef with cultivation or a turf. Where exposure is severe our choice would be limited to J.L., H.L. and P.C.

These notes on choice of species have dealt in a general way with a subject which is infinitely varied and which can on the ground be contradictory to a puzzling degree. It is what a close study of existing plantations at Clashindarroch suggests as future policy and it may be summed up as follows:-

Whatever it is decided to plant, the choice of tree and method of planting must be made according to the well-established rules of good forestry practice.

Ploughing should be done wherever it is possible to plough.

The best pioneer tree on unploughable ground is J.L. This tree will give forest conditions in which other trees may be established, quicker than any other. There is hardly any high quality J.L. on Clashindarroch and the use of this tree should be limited accordingly.

Scots pine should not be used except perhaps in mixture with P.C., where exposure is severe or where soil is shallow and ground conditions poor.

Spruce on sites other than old arable and fresh flush should be mixed with pine. Canopy is formed much more quickly even although the spruce might grow satisfactorily on its own (see White Geese P.37). If properly treated S.S. will grow almost anywhere on plough at Clashindarroch and its inclusion as a small percentage of the crop even on unlikely sites should be considered.

A greater variety of trees should be planted.

As suggested in the section on Meteorology the incidence of severe frost may be much wider at Clashindarroch than we would expect. Frost

may be an important factor in larch die-back and after the severe frosting of S.S. in April, 1948, damage extended far up the sides of valleys. This latter was however, a peculiar frost in that although quite mild in intensity needles up to three years old were killed. Very occasionally trees were killed outright, but more often Pityogenes finished them off. Normal late frost damage does not appear to be very much more damaging at Clashindarroch than elsewhere, but it is a factor which must be given full weight when considering choice of species.

Planting and Ploughing

Planting on heather ground off the plough is a subject in which the Commission officers should be well versed. It is a matter of putting what we know into practice and we do not claim any advances in technique at Clashindarroch, although we would admit to many shortcomings over the years.

Planting on plough has been dealt with under the appropriate section.

Tentative Schedule on Choice of Species (T.C. Sept. 1929).

Type of Land	Vegetation, Soil etc.	Treatment	Species.
(1) Reclaimed Land (a) Arable (b) Semi-derelict	Generally well drained clean land	Notching on plough furrows where possible.	S.S., N.S., E.L., perhaps some J.L.
(2) Bracken (limited area)	Generally well drained deep soil. Little or no peat.	Semi-circular spades or notching	Exact species can be used. E.L., D.F. &c.
(3) Juncus &c.	Wet. Some peat of a good type.	Draining or turf-planting	S.S., N.S. in hollows.
(4) The bulk of the uncultivated hill slopes (lower parts only) A. Damp Ground	Calluna, mosses, ladder fern, bearberry. 6" or more of peat.	Some draining and turf planting. Some mattock planting.	S.S., J.L.
B. Dry Ground	Erica cinerea/calluna/sometimes whin	Notching, some mattock planting.	Chiefly S.P., E.L.
<u>Doubtful to Useless Ground (Experimental (small scale)).</u>			
(5) Tops of slopes generally exposed plateaux, elevation not sufficient to exclude otherwise	Dwarf heather with lichen; shallow peat over hard stony ground.	Various methods of cultivation to break up hard ground.	M.P., P.C., S.S. and others.
(6) Upper parts of 4A and 4B	Heather with increasing depth of peat, sometimes in hummocks.	Intensive draining mound and turf preparation.	S.S., P.C., M.P., and others.