THE LON MOR INCHNACARDOCH FOREST FORT AUGUSTUS

A REVIEW OF AN EXPERIMENTAL RESERVE HOLDING

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1993

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1. Introduction

1.1 The Research Branch has been active in Inchnacardoch since the earliest days of the fledgling Forestry Commission, the first experiment, Inchnacardoch 1, planted in 1921. In 1925 the first experiments were laid down on the Lon Mor which translates from the Gaelic as the big waste or bog, a particularly apt description and daunting proposition in those days when the early pioneering researchers were confronted with a challenging treeless terrain, an area of deep peat flats and basins interspersed between irregular rock covered ridge and hillock landforms; a matrix of generally low nutrient status peatland and infertile organo-mineral soils.

Research work has continued on the Lon Mor since then, and elsewhere in Inchnacardoch, at a varying intensity although the input appears to have been most concentrated in the initial phase, 1925 to the late thirties, judging by the number of experiments and trials laid down during that period with a further spell of hectic activity in the immediate post war years. In 1960 the Lairg outstation was set up, and thereafter new experimentation on the peatlands and associated organo-mineral soils was largely confined to the northern counties of Sutherland and Caithness, at that time the scene of extensive afforestation on such nutrient poor sites. Inevitably, this refocusing of research energy on the establishment of LP and SS on deep ploughed blanket bogs resulted in a sharp decline in activity on the Lon Mor, and ultimately the closure of the Fort Augustus outstation in 1987. Currently there remain only two open experiments on the reserve.

The original enclosure, C172, is 26 ha to which was added the contiguous 22 ha West Lon Mor, C173, in 1946; the combined area of 48 ha represents a substantial land holding by Research.

1.2 The objectives underlying the present review were:

1. A brief summary of all existing trials and experiments within realistic limits - sections 3, 4 and 5.

2. To identify areas of homogeneous soils and growth where crops ought to be maintained and monitored; for example SS on deep peat and SS/LP self thinning mixtures - Section 6.2

3. To identify areas of homogeneous soils where existing crops are too varied to justify retention and successor experiments might be possible. Section 6.3

1.3 In no way does this review of experiments and trials claim to be fully comprehensive as compiling such an inventory would be a task of truly Herculean proportions bearing in mind the numerous small trials and the superimposition of extensions and new experiments upon existing experiments and trials. Additionally, treatments are not always fully or clearly recorded and reference to the experiment file is not always a guarantee of clarification. Much energy was expended on Preliminary Trials (PTs) in the twenties and thirties, and these are barely mentioned in this review; a catalogue of these informative trials merits a separate report in its own right - overall there were in the region of fifty such trials shared between the Inchnacardoch 'P22' area and the Lon Mor.

1.4 A brief historical resume of ground preparation and fertiliser practice seems appropriate in order to clarify what may appear a somewhat disjointed and confusing picture emerging from the summary of the various experiments and trials.

1.4.1 In essence ground preparation on the Lon Mor can be subdivided into two major phases: firstly a prolonged period between 1925 and 1952 when various turfing systems were tried, and secondly mechanical ploughing in the post war period from 1946 to 1959; the flirtation with direct planting, principally for demonstration purposes, in the initial years was very brief as Dr Mark Anderson was wholly

convinced that such an establishment technique was ineffective, certainly on low nutrient status deep peat. In reality, unravelling the various systems tried during the turfing phase is somewhat complicated whereas the techniques employed in ploughing were consistent and easy to understand.

Hand draining and turfing may be relatively recent innovations in this country but it is salutary to recall that such a system had been practised by the Belgians in the Ardennes since 1836, evolving in turn from an older Prussian system. In the initial years, 1925 to 1927, Mark Anderson developed shallow turfing systems, turves 10 to 15 cm deep with variable spacing between both the parallel series of turf drains and the spread out inverted turves. Between 1928 and 1935 the thicker Belgian turves, 23 - 25 cm deep, were in the ascendency, however, the mid thirties witnessed a return to a modified shallow turfing technique, turves cut in thin vertical slices the vegetation lying on one edge, for example experiment 112 P 39 (4.2). A form of mock ploughing, a grouped shallow turfing system, was also devised to mimic ploughing, turf drains cut for each row instead of servicing two, three or four rows, depending on the system. A horse drawn peat cutter was tried on the Lon Mor in 1927, but without success. It is interesting to see that the wheel has now described a full circle, the era of ploughing superseded by that of mounding, a mechanised form of turfing, on deep peats and peaty gleys.

1.4.2 The efficacy of basic slag in the establishment phase had already been demonstrated prior to the setting up of the FC by that indefatigable pioneer Sir John Stirling at Corrour, and on a smaller scale by the Office of Woods at Inverliever. Yet again this practice had evolved from Belgian experience, basic slag applied as required on Molinia peats in conjunction with their hand draining and turfing system. Not all experiments laid down during the initial years on the Lon Mor received a basal input of slag; experiments 10 (5.1.2) and 13 (5.1.4), both P25, are examples of

those not treated at planting. In those formative years considerable effort was channelled into experiments and preliminary trials designed to investigate the practical aspects of phosphate application in the early establishment phase: the method and timing of applications, placement of the fertiliser, for example experiments 12 P25 (5.1.3), 49 P28 (5.1.11) and 74 P29 (5.1.12), and the grade of phosphate. In the Belgian system slag was mixed with the soil and/or peat of the extracted plug, a practice followed in those early years on the Lon Mor, not simply where planting with the circular Belgian spade but adapted to be used with other methods; regardless of the method employed slag tended to be mixed with several times its own weight of soil. This was soon seen to offer no advantage over a straight fertiliser application and the practice abandoned; besides, mixing was a time consuming practice and transportation a considerable logistical problem. Growth in the first few years of 1925 and 1926 experiments given a basal dressing demonstrated the benefits derived from such a treatment and by 1928 a 2 oz application around every tree, as in experiment 49 P28 (5.1.11), was virtually standard practice. Basic slag was gradually superseded by Ground Mineral Phosphate (GMP), research having shown this to be a more effective form of phosphate. Proprietary brands of phosphate fertilisers, Ephos and Semsol, were first tried in experiment 43 P28 (5.1.9); Ephos featured in a later experiment, 87 P30 (5.1.16) along with Mineral phosphate and Potassic mineral phosphate. Although Semsol often seems to have been associated with more impressive height growth than other forms of phosphate there were inherent dangers in using this mixture of mineral phosphate and superphosphate. Superphosphate is readily soluble, and in dry seasons appears to form a concentrated soil solution toxic to tree roots; the first year losses in experiment 112 P39 (5.1.18) were attributed to Semsol. After 1936 use of phosphate fertilisers incorporating superphosphate appears to have been discontinued.

Both potassium and nitrogen fertilisers in various forms occasionally featured as treatments in the pre-war period, 1925 to

1939. A readily soluble potassium fertiliser, Kainit, was applied at planting with disastrous consequences in experiment 17 P26 (5.1.5.). An alternative slow release compound, Granite flour, was tried with no apparent benefit on its own in experiment 125 P39 (5.1.18). Potassic mineral phosphate gave the best height response in experiment 87 P30 (5.1.16); various potassic phosphates featured in Preliminary Trials, the results in terms of height comparable to that achieved by Semsol. A readily soluble source of nitrogen, Ammonium sulphate, was associated with heavy early deaths when tried as a basal fertiliser in experiments 43 P28 (5.1.9) and 83 P29 (5.1.14) either alone or with basic slag. Nitro-chalk was equally unsuccessful when applied with basic slag in experiment 87 P30 (5.1.16). Keronikon, a proprietary slow release hoof and horn compound was the N constituent of the basal NPK fertiliser application in experiment 125 P39 (5.1.18).

Additionally, Epsom salts, Magnesium sulphate, were tried alone and in combination with basic slag in the formative years, for example experiments 12 P25 (5.1.3) and 43 P28 (5.1.9), but only with a marginal height response which bore no comparison with that attained by phosphate.

The evolution of ploughing equipment suitably robust and capable of tackling difficult site types ushered in the post war era on the Lon Mor where the emphasis was on large scale trials and experiments, for example 135 P47 (5.4.3) and 138 P51 to 53 (4.2). In contrast with the pre-war phase areas of pure SS were confined to one afforestation experiment, 128 P46 (5.4.1), but even here on a relatively small scale within a larger matrix of SLP. Pure crops of SS were to reappear later in two restocking experiments, 177 (5.5.2) and 178 (5.5.3).

The nutritional requirements of SS and LP crops on low nutrient status deep peats and associated organo-mineral soils were ascertained through collaborative experimentation with the Macaulay Institute, Aberdeen. Although there had been involvement with the Institute since the earliest days, for example Dr Fraser's peat

isolation experiment in 1928 (5.3.2) and later with Dr Stewart in 125 P39 (5.1.18) it was from the 1950s onwards that a series of experiments ultimately unravelled the appropriate nutritional prescriptions; a notable example of these post war co-operative investigations is found in experiment 148/57 superimposed on the former 74 P29 (5.1.12), the latter originating as a somewhat complex phosphate fertiliser experiment.

Although definitive fertiliser regimes of either PK or NPK for LP and SS stands, pure or in mixture, on low nutrient status peat in excess of 30 cm were subsequently verified, remedial action where necessary in established experiments on the Lon Mor was rather limited.

1.5 The principal objectives underlying all experiments were inevitably relatively short term, in essence the establishment of trees on a restricted range of predominately nutritionally poor site types. When reviewing the current situation there seems to be little evidence to suggest that the long term implications were seriously considered; arguably these were an irrelevance at the time of establishment. Herein lies the predicament of the Lon Mor today, a sizeable overall area of under managed experiments and trials, management difficulties compounded by access remaining almost as difficult today as in 1925. Is this an acceptable state of affairs; if not what are the alternatives? These are the themes of the final concluding section (6).

Section 2 is an abridged outline of soil and site types, thereafter the various experiments are grouped and summarised in the following order:

Section 3 Species Trials

Section 4 Mixtures

Section 5 Establishment and nutrition of pure stands other than specific species trials.

Appendix 1 is a map of the entire Research reserve, a more detailed

map of the original East Lon Mor enclosure forming Appendix 2.

References (selective)

MacDonald J.A.B. 1945 The Lon Mor: twenty years research into wasteland peat afforestation in Scotland, Forestry XXVI, pp 14 - 21.

J.W.L. Zehetmayr. Forestry Commission, Bulletin 22, 1954 Experiments in Tree Planting on Peat - a mine of information and a further source of references up to 1953.

2. Soils and Site Type

The remit of this review precludes an in depth discussion of these highly pertinent topics. However, detailed information on the soils and site types of the Lon Mor and the wider Forest Region are readily available and referred to at the end of this section. The purpose here is to identify these sources, or at least the principal ones, and make a number of salient points.

A detailed FC soil survey of Inchnacardoch in the early 1970s included more intensive mapping on the Lon Mor; the maps and survey reports are of particular relevance to this review. Appendix 3 is a soil map of the Lon Mor, revised to incorporate the updated and current nomenclature and classification; of necessity the map has been reduced from the original 1:10 000 scale.

The Macaulay Land Use Research Institute, Aberdeen, mapped the soils of the Fort Augustus district on an extensive scale (1:250 000) as part of their Land Capability for Agriculture in Scotland survey instigated by the Secretary of State for Scotland following a recommendation in a 1972 White Paper on Land Resource Use in Scotland. The regional soil map and memoir, Western Scotland, are useful sources of information on both the immediate locality and the wider Western Moine Forest Region. The principal parent material of mineral and organo-mineral soils in the Inchnacardoch block, and in much of the Forest Region is classified as the Arkaig association, an inherently infertile drift derived largely from Molinian metasediments.

The original vegetation descriptions made when the experiments were laid down are generally detailed and of considerable interest, often accompanied by a map which may record peat depths. A notable change in the vegetation community since 1925 has been a general increase in the abundance of Molinia at the expense of Trichophorum, principally on rock cored ridge and hillock landforms, but also on the peatlands. This has been attributed to an interaction between a number of factors, primarily nutrition, drainage and cultivation.

Both unflushed and flushed peatlands feature prominently on the Lon Mor; a description of the specific types seems advisable here as they can thereafter be referred to in an abbreviated form.

1. Molinia bogs (flushed blanket bogs)

   9a Molinia, Myrica, Salix bog.

   9b Molinia bog; Molinia, Calluna bog.

   9d Molinia, Eriophorum vaginatum, Trichophorum bog.

   9e Trichophorum, Calluna, Eriophorum, Molinia bog.

2. Sphagnum bog (unflushed peatland)

   10b Upland Sphagnum Bog.

In reality peatland communities are not always consistent and clearly defined entities, subtle variations in micro topography on the bog surface often determining the intensity of local flushing or its absence. Likewise more pronounced changes in slope at ridge landform and peatland interfaces tend to be associated with a variable zone of more intensive flushing. Mapping techniques were different at the time of the Lon Mor survey; where the vegetation matrix varied within a viable unit the tendency was to identify the dominant peatland type and designate the unit accordingly. Subsequently the approach has been modified to recognise peatland complexes if differentiation of individual types proves unrealistic; arguably had the Lon Mor been mapped today some complexes would indeed have been identified and mapped. Similarly the Molinia dominant 9d flushed blanket bog was not mapped on the Lon Mor, but there is evidence of its presence in the original vegetation descriptions, and it seems likely that a present day survey would recognise a limited amount of this peatland.

The Lon Mor is a lower slope site, the elevation ranging between 150 and 185 m. The aspect is south easterly and the area falls within wind zone E.

References (selective)

1. Soil Survey of the Lon Mor. J.S. Innes, J. Davidson and J. MacDonald. Edited by D.P. Paterson, Forestry Commission April 1970.

2. Soil Survey Report on Inchnacardoch Forest. J.S. Innes, J. Davidson and J. MacDonald. Edited by D.B. Paterson Forestry Commission February 1972.

D.G. Pyatt. Soil Classification RIN 68/82

D.G. Pyatt and S.A.D. Brown. Site Classification and Survey in the Forestry Commission (in press).

Soil and Land Capability for Agriculture, Western Scotland, Regional Memoir and Soil Map (1:250 000 scale). Macaulay Institute for Soil Research, 1982; now the Macaulay Land Use Research Institute.

3. Species Trials

In essence most of the experiments on the Lon Mor, particularly the early ones, can be considered under a broad heading as species trials. However, this section is concerned only with either those experiments laid down to assess the performance of a variety of species or trials of individual species other than SS and LP.
The subsequent treatments quoted in this and the following sections are not claimed to be all embracing; the attempt has been made to highlight those considered relevant.

3.1 Experiment 18 P26

This experiment was originally a species trial, but by 1950 it had become more highly valued as an effective shelterbelt and has been regarded as such since. However, extensions in 1950, and more particularly 1953, re-established species experiments within the immediate vicinity of the original 1926 planting.
The various components of this scattered experiment occur on a rock cored ridge landform, a peaty gley/ranker complex predominating with occasional pockets of deep peat.
The original experiment combined planting on shallow turves, (by both the Belgian spade and side notching) and direct planting into the ground. Of the six species planted in a single long strip which incorporated the three treatments, side by side, only three survive and have grown satisfactorily in the southern sector. These are: SLP (23/506) and MP (23/507) both ex Ruttle Wood, and SP ex Altyre.
A number of extensions have been added to the original experiment.
FY27 A small cage erected as protection against blackgame.
FY28 The Birch and Rowan within the cage removed and replaced by various species of pine, most of which subsequently failed.
FY30 Basic slag (30% Phosphoric acid) applied to two separate areas south of the cage at 2 oz per plant.
FY50 'Mock' plough drains dug at 1.5 m intervals and rows of turves spread alongside in an attempt to mirror ploughing. Planted with

JL (48/38) 1+1 ex Newton at 1.2 m spacing; basal dressing of GMP at 11/2 oz per plant.

FY53 1. MP 50/76 ex Clashindarroch turf planted within the original strip where Birch had failed at the southern end of the belt; basal 2 oz GMP applied to each plant.

2. A small species trial was laid down to demonstrate the effect of shelter on the growth of various species. Three separate replications, one contiguous with the easterly edge of the P26 strip, the others detached on either side a relatively short distance away; blocks I and III to the west and east of the shelterbelt respectively.

The three blocks of the 1953 species experiment occur on a typical irregular ridge landform, a peaty gley/ranker complex dominant with occasional pockets of flushed blanked bog (9e). Shallow phase profiles and rankers appear to be particularly prevalent in the most easterly block III which straddles the ridge crest, the more difficult site conditions in the latter are reflected in a generally indifferent performance by the various species.

Small sixteen plant plots (4 x 4 arrangement). Shallow turf drains at 1.2 m spacing, notch planted at 1.2 m spacing; 42.5 gm GMP applied around each plant.

Red oak, a somewhat optimistic choice on this site type, was included and subsequently failed, the other species being:

SP, 2+1 48/11A, East England

DF, 1+1+1, 50/3, BC variety caesia ex Shuswap Lake

NS, 2+1+1, 48/35, Switzerland

SS, 2+1, 50/272. QCI

OS, 1+1+2, 49/89, Germany

WH, 2+1, 50/278, BC

RC, 1+1, 41/40A, Carnarvonshire

AG, 2+1+1+1+1, 47/32. USA

LC, 2+1+1+1, ident not known, ex Dornoch

Subsequent Treatments

February 1966 PK fertiliser, Fisons 48, applied at 565 kg/ha to blocks I and III to provide 49 and 94 kg elemental P and K respectively.

March 1974 PK in the form of Fisons double season broadcast at 565 kg/ha to blocks I and III; a Urea top dressing of 375 kg/ha supplying 150 kg elemental N/ha confined to block III.

Current State of the Experiment and Conclusions

Although there is some benefit from the shelterbelt the real effectiveness of this narrow strip seems questionable. On the flat ground to the north the trees are best described as scrub, the most successful growth occurring on the slope from the previously caged section southwards. The structure of the belt is of interest, MP to windward, a core of SP and coarse branched SLP with an easterly lean on the leeward edge. Essentially a stable belt of trees, albeit a few MP have blown. The inland LP of Mount Ida origin clearly pinpoint the site of the former cage, their superior form and branching habit contrasting with that of SLP. Unfortunately the experiment did not survive intact as originally conceived with Rowan sandwiched between the Mountain pine and Birch to windward.

The unthinned stand of P50 JL caps the highest point of the ridge landform, probably on a podzolic ironpan soil. The height attained appears to be impressive, but no figures seem to be available to quantify GYC; one tree has blown, otherwise the plot is stable.

The three blocks of other species, P53, are of interest. Unfortunately the plots are too small and certain species have been crowded out by more vigourous neighbours; likewise in block II the line of plots in close proximity to the SLP of the shelterbelt have tended to suffer a similar fate, variably suppressed by the pine. Overall SS and WH have been the most successful species, particularly in blocks I and II, the former to windward; LC, RC, OS and GF show more promise locally on a variable site type. The performance of DF, NS and to a certain extent SP, has been

disappointing. Growth is notably poor all round in block III, the easterly block, with more evidence of deficiency symptoms here than elsewhere.

Despite their small size it seems reasonable to retain the three P53 blocks and observe species interaction. Likewise retention of the so called shelterbelt seems justified, certainly the area of reasonable growth in the southern section, principally on historical grounds. However it may be of interest as regards species composition, stand structure and wind movement within and around the trees, albeit later additions of JL and the species plots have probably complicated matters concerning wind monitoring.

Reference

Bulletin 22 pages 35 and 89

3.2 **Experiment 19 P26**

An ambitions trial of SP, 2+1, Altyre provenance, on a weakly flushed blanket bog (9e) adjoining a ridge landform, the deep peat superseded by peaty gley in the western end of the rectangular block.

A parallel series of turf drains at 1.5 m spacing supplied the shallow turves which were laid out in groups of four between drains, the one tree per group planted alongside the drain and surrounded on all sides by turves. Planted in February 1926 by side notching, trees spaced at 1.5 m and approximately 2 m within and between rows respectively, two thirds of the experiment required replanting in April that year due to severe blackgame damage.

Subsequent Treatments

P27 extension Interplanting of SS, JL, White Spruce and Thuya, one plot of each species, within the year old SP in the northern half of the block which merges into the lower slopes of the ridge landform.

1928 The southern half of the experiment, ie the remaining area of

pure SP, was subdivided into a fertiliser plot and control, basic slag applied to the former at 5 cwt/acre.

1930 A further spot treatment of basic slag to alternate quarters of the fertilised plot at a lower rate of 1 1/2 cwt/acre equivalent to 2 oz per plant.

1953 extension Ground mineral phosphate (GMP) applied to half of the SS/SP and JL/SP plots, the remainder a control.

The experiment has been thinned regularly as and when deemed necessary.

Current State of the Experiment and Conclusions

Growth has been reasonable with very satisfactory survival within the plot fertilised in 1928 and partially so in 1930. Elsewhere, growth and survival have been very unsatisfactory; in part at least this may be due to a site interaction, most of the 1928 control and part of the interplanted northern section a shallower peat/peaty gley. Trees responded to the 1953 GMP top dressing, but it was too little and too late.

The trees remain windfirm. Stem form tends to be poor; crowns are generally light with apparently healthy foliage.

Inevitably growth has been slow, the mean heights in 1939 ranging from 0.7 m (control) to 1.5 m (twice top dressed), the differential growth response pattern was maintained after twenty one growing seasons (1946) when mean heights varied between 1.5 and 3.5 m, again the control and twice top dressed treatments respectively. In 1991 a top height of 16.3 m was obtained from a non specific height assessment within the area fertilised in 1928 and 1930; this equates with a GYC of 6. Within the control a top height of 6.3 m seemed to suggest that the gap between the two treatments had widened.

It is interesting to compare this older pole stage stand with the twenty year younger thicket stage SP in mixture with SS, experiment 130 P46 (5.4.2), where the pine is obviously stressed on an inadequately drained Upland Sphagnum bog (10b). One wonders how experiment 19 on a flushed blanket bog appeared at a similar age.

A convincing demonstration of satisfactory growth achieved by a less demanding species dependent on a phosphate input, albeit current practice would not consider SP a commercial option on such a site. The experiment merits retention simply to continue observation of this sixty seven year old stand of SP on low nutrient status peatland.

References

Bulletin 22 pages 36, 37 and 42.

3.3 **Experiment 36 P27**

An intensive trial designed to assess a variety of species other than pines on a homogeneous nutrient deficient Upland Sphagnum bog (10b). Nineteen species in total, some represented by both seedlings and transplants.

Two staggered rows of turves between drains, trees close planted at 2 x 21/2 ft (0.6 x 0.8 m) on shallow turves; transplants side notched, seedlings planted with the Belgian spade. Single row plots, each of fifty trees; treatments not replicated. No basal fertiliser; however, basic slag at a rate of 21 cwt/acre was applied to the northern half in April 1928 and to a swathe through the southern portion in November that year, the two treatments segregated by a narrow control with a further control strip on the southern perimeter. The northern half may have received a second treatment of slag in either 1929 or 30, but no record of this survives.

Subsequent Treatments

1964 Both slagged plots were treated with Muriate of potash, the previous controls maintained; a broadcast application providing 84 kg elemental k/ha.

1980 A broadcast application of compound PK at 575 kg/ha throughout the experiment giving an elemental input of 50 and 95 kg/ha of P and K respectively.

Light thinnings have periodically removed dead, suppressed and dying individuals as necessary.

Current State of the Experiment and Conclusions

A highly relevant pole stage demonstration with satisfactory stocking of successful species.

Seedlings tended to be suppressed by more vigorous transplants in the early years. Typically, initial growth was painfully slow; consequently the establishment phase was prolonged. There is ample evidence of enhanced growth initiated by nursing and nutrient poaching, for example SS which had a meagre mean height of 1.02 m in slagged plots when nineteen years old. Relatively late inputs of K and PK have boosted growth and improved the nutritional status of the various species surviving.

The most successful species, top heights (m) at sixty four years in brackets are: SS (18.7), OS (16.3) and WH (16.3); HL (14.5), JL (14.4) and NF (16.9) too have grown reasonably well. Abies balsamea is now regressing after an earlier period of promising performance.

A trial worthy of retention for on-going observation. The experiment demonstrates inadvertently the nutritional benefits resulting from mixtures and the efficacy of PK top dressings to all surviving species on this deficient peatland site type.

References

Bulletin 22 pages 41 and 54

3.4 Experiment 46 P28

Another pioneering trial, a follow on to the previous year's experiment 36 (3.3), which featured eighteen broadleaves, including nine varieties of willow, in addition to sixteen conifers, both seedlings and transplants; once again pines were excluded, presumably due to concern about blackgame damage.

Turf drains aligned ENE/WNW at 2.7 m intervals; trees spaced at 0.9 m within the single row assigned to each plant type.

The site is essentially an Upland Sphagnum bog (10b), albeit the original vegetation map and species list reveal the presence of Molinia as a minor component of the matrix, probably in weakly flushed pockets or ribbons rather than an intermittent distribution throughout the community; either way there is a suggestion that a 10b/9e complex may be the correct description. A higher nutrient status flushed blanket bog (9b) impinges on the north east corner adjacent to the main natural drainage channel. The site is not entirely homogeneous deep peat, however; pockets of organo-mineral soils occur on the eastern perimeter, a podzolic ironpan soil associated with a distinctive morainic knowe close to the burn, whereas the shallowing of the peat is not readily apparent elsewhere which implies the presence of a peaty gley. The southerly fringe merges imperceptibly into a subdued rock cored landform and appears to be a peaty gley, in part at least.

The provision of approximately 25 cm thick Belgian turves tended to be difficult due to the predominance of an upper Sphagnum peat of low humification and a consequent lack of cohesion. Planted by Belgian spade, 2 and 12 oz basic slag and soil respectively placed in the plug hole.

The erection of a cage over the easterly half of the experiment immediately after planting provided protection from marauding blackgame.

Subsequent Treatments

1939 A top dressing of GMP, 3 oz/tree, was applied to three quarters of the experiment, leaving eight plants at the west end of each row as an untreated control.

Current State of the Experiment and Conclusions

This trial gives the impression of being rather neglected. Stocking is decidedly irregular and patchy with sizeable open areas; overall it is more satisfactory at the eastern end although the survival of certain species, for example SS and P engelmannii, ensures local

continuity or near continuity across the plot. The generally poor growth and stocking in the western sector may be partly attributable to the establishment of a control here when the 1939 top dressing was applied and/or the absence of protection from a cage. Most species are experiencing nutritional stress to a varying degree, deficiency symptoms commonplace.

Survival is excellent in the ubiquitous SS forming the outside row on the southern edge where the deep peat merges into the organo-mineral/ranker complex; height growth is not impressive bearing in mind its age and there is ample evidence of unsatisfactory nutrient status. Undoubtedly the most interesting successful species is Picea engelmanii which has good form, reasonable colour and an impressive overall survival percentage. Abies balsamea having shown initial promise is now virtually dead; neighbouring Abies noblis are obviously stressed, especially in the NE corner where the row impinges on a high nutrient status Molinia bog (9b). A number of species have been reasonably successful, these include Picea alba and omorika, and Tsuga; JL and HL prosper at the east end where a large and coarse DF is one of the few survivors of that species. Two surprises are five Cryptomeria japonica and a couple of sizeable Thuya, both of these species apparently on a peaty gley. One dwarf and distorted Beech valiantly struggles on.

Obviously this trial is of interest due to various unusual species tested on an impoverished deep peat, but its future seems questionable especially when compared with experiment 36 (3.3). With the benefit of hindsight it is regrettable that no remedial fertiliser treatments were applied post 1939 as in its sister trial of the previous year, experiment 36. The choice of certain species like Elm on this site type was supremely optimistic; such is the true pioneering spirit.

Reference

Bulletin 22 page 54

3.5 Experiment 84 P29, P31 and P38

A trial of Scots pine origins and provenances, the various seedlots from a wide geographic spread in addition to a large Scottish representation; other sources were East England, Norway, Sweden, Finland, the Ural Mountains, Alsace and the Sierra Nevada, Spain. The initial, 1929, component had the most extensive range of seedlots; consequently it forms the largest part of the experiment. A well chosen typical Scots pine site, the experiment straddling three scattered rock cored morainic knowes in the north western corner of the original enclosure, well aerated podzolic soils predominating - either as ironpan or typical podzol with a variable depth of peat.

Dr Mark Anderson designed the experiment, individual seedlots planted in groups of 21 plants with a variable spacing arrangement varying from 0.6 to 1.8 m. Groups were 7.3 m apart centre to centre, most seedlots replicated three times if plant supply allowed; once on each knowe but on different local site types if practicable. In some instances groups of the same seedlot occur on the same knowe. Plants were either turf planted with a side notch or directly planted if the peat was less than 5 cm.

A basic slag basal dressing, 2 oz per turf, was applied to the P31 and P38 additions, the initial P29 component receiving a top dressing of 3 oz basic slag at 15 cm from the stem in FY39.

Current State of the Experiment and Conclusions

Three stable groups of apparently healthy Scots pine. Variable survival, height, stem morphology and crown density reflecting origin/provenance differences. Unfortunately a number of tally posts are missing and no map of the complete layout seems to be available. Typically the original vegetation description was very thorough; as elsewhere on the Lon Mor it is interesting to note how the Molinia content has increased at the expense of other species, notably Calluna and Trichophorum.

As might have been expected seedlots from the more extreme ends of

the range tested here have been the least successful in terms of survival and height achieved, for example those from the Urals and the Sierra Nevada; origins from N Finland have failed. In general home collected seedlots are superior in terms of height and survival, however vigorous growth is often combined with unsatisfactory from. Origins from South Finland and N Sweden (Alvsby) tend to have better stem morphology.

There seems to be no reason why this experiment should not be retained and allowed to grow on, albeit some refurbishment and replacement of tallies as required may be worthwhile; although identification of a few plots might prove to be difficult in the absence of an overall map.

References

Bulletin 22 pages 37 and 38

Report of Forest Research for the year ended March 1964 Part III pages 177, 178 and 179 and summary P194.

A Comparison between European Continental and British Provenances of some British Native Trees: Growth, Survival and Stem Form. R Worrell. Forestry Volume 65 Number 3 1992.

3.6 Experiment 116 CP P35

What seems a deceptively simple block of CP is in reality, true to the spirit of the Lon Mor, on close inspection subtly more complex. This species trial is not on a uniform site, most of it, about 75%, on the well defined slope of a sizeable rock cored hillock, the remainder on a flushed blanket bog (9e). The experiment was laid out as a series of seven three row strips, a total of twenty one rows parallel to the long axis of the block; in each row 33 CP were planted on turves, the latter derived from turf drains at 3.6 m spacing. A basal input of 3 oz basic slag was applied to the initial seven rows in from the SW, all remaining rows receiving 3 oz of Semsol; each fertiliser placed around the roots at the time of planting. Despite the small size, 5 - 13 cm, of the original

plants, 1+1+1 32/528 ex Altonside, initial survival was good, 88% and 92% with Semsol and slag respectively. Experiment beaten-up in 1937 with CP 33/25 (1+1+1+1) ex Altonside.

Subsequent Fertiliser Treatments

1961 Second 3 row belt in from the NW and SE sides given a top dressing of NPK: SAI CCF No 3 supply 98 kg N, 86 kg P and 83 kg K per ha.

1963 NPK top dressing applied to the whole experiment: SAI CCF No 1, providing 105 kg N, 46 kg P and 13 kg K per ha.

Current State of the Experiment and Conclusions

Stock varies with open spaces which frequently contain standing snapped dead trunks. Some sizeable breast height diameters. A paucity of foliage, the latter largely confined to the upper third of the trees, and needle retention appears to be restricted to two or three years.

In 1983 survival was reckoned to be 27% of the original planting. A top height of a 27.5 cm breast height diameter tree suggested GYC 6; however, only a few trees were measured.

As elsewhere on the Lon Mor Molinia now dominates the knowe vegetation community at the expense of Calluna and Trichophorum, the dominants when the experiment was laid down; Molinia then rated as occasional. The original vegetation description suggests that the plot extends on to a flushed zone of higher nutrient status Molinia/Trichophorum blanket bog at the slope and peatland interface, a localised zone of more intense flushing too small to map under normal circumstances.

Brunchorstia seems to have been observed, and verified by Pathology, from 1949 onwards, albeit the fungal infection appears to have had no adverse effect on growth.

An interesting stand, now fifty eight years old, of a species one might not have expected to find on such a difficult site. Worthy of retention, simply to see how the trees fare during the coming years.

References

Bulletin 22 pages 61 and 62

3.7 Experiment 147 P57

A number of attempts to grow Alder on deep peat had been made since 1930 (5.8.3, 5.8.4 and 5.8.5) but this was the first trial of the species on spaced ploughing. The ability of Alder to fix atmospheric nitrogen was well known and the experiment, as originally envisaged, aimed to capitalise on any resultant site amelioration and to investigate the nitrogen status of the site under Alder and LP, both pure and in mixture.

The site type is variable, predominately a high nutrient status flushed blanket bog (9b) flanked by peaty gley on the east and west. Whilst the central ribbon of the bog is undoubtedly 9b the original vegetation description suggest the presence of some Trichophorum in the peatland matrix; hence it seems likely that it may have been a 9b/9d complex.

There were five replications of seven treatments, each plot 15 x 15 trees planted in a "V step" on the furrow produced by the single mouldboard Cuthbertson plough; furrows spaced at approximately 1.6 m. All plants received a basal dressing of 1½ oz GMP.

Three Alder species are present:

Alnus glutinosa (1+2) 54/227 Ross Priory

Alnus incana (2+1) 54/651 Lower Austria

Alnus spuria (1+0) 56/222 Denmark

South coastal lodgepole pine, 55/682 Long Beach, occurs both within the experiment, either pure or in groups of nine where in mixture, and as a three row surround. The choice of this origin, then much in vogue, is now generally regarded as unfortunate on such site types with the benefit of hindsight and accumulated field experience.

Subsequent Treatments

Extension 62 (May 1962) A top dressing of P,K and trace elements with control, eight treatments in total, applied to plots 15 (A glutinosa), 20 (A spuria) and 21 (A incana).

P: GMP @ 4 oz per plant, providing 65 lb elemental P/ha

K: Sulphate of potash @ 2 oz per plant, providing 93 lb elemental K/ha.

Trace elements molybdenum and cobalt in solution with a non ionic wetting agent in water.

Underlying this experiment was a concern about premature loss of leaves and shoot dieback.

FY63 Most of the experiment received a top dressing of potassium superphosphate which supplied 40 and 80 lbs of elemental P and K respectively; the three plots of the 1962 extension were not included.

FY67 The SLP was now recognised as an unsuitable nurse for Alder, the mixture described as a nurse nursing a nurse. Consequently NF, (61/795) Oregon, was introduced as pure plots and in mixture with A Spuria and SLP. A pure NF plot replaced the A glutinosa/SLP mixture whereas SLP and A incana were cut out of A spuria/SLP and A incana/SLP mixture respectively. As before, the NF replacements in mixture were planted in groups of nine in a three by three arrangement.

A basal dressing of $^{1/2}$ oz GMP was spread around individual NF, the remainder of the experiment, with the exception of the P62 extension, receiving Muriate of potash (84 lb elemental K per acre).

FY68 Severe failure of the NF necessitated its replacement by QSS 59 (7111)1. A differential rate of GMP was applied that year, a basal input of 11/2 oz to individual QSS and the equivalent of 1 oz as a broadcast top dressing to surviving Alder and SLP groups and pure plots of these species. The FY62 extension plots were once again excluded. The western portion of the experiment was inadvertently overflown with PK during a Conservancy application to neighbouring crops in June 1976.

Current State of the Experiment and Conclusions

Since the experiment is sited on the windward edge of the West Lon Mor it comes as no surprise to find catastrophic windblow of the SLP within plots and in the buffer zone, due both to the prevailing SW wind funnelling up the Great Glen and to snow damage. However, amid the general carnage eleven Alder plots, almost all in the relatively sheltered central core of the experiment, are well established, of interest and potential sites for further research. Six of these are A glutinosa, four A incana and one A spuria; a map of their location has been lodged in the experiment file. Most are original pure plots, albeit two have a few SS interplanted; one of the latter, plot 30, ought to have been clear felled and planted with SS, but somehow the A glutinosa did not meet its intended fate. Although there are good examples of the various Alder elsewhere in the experiment a variety of reasons seem to exclude them from the list of good plots, for example variable survival, stocking and blown SLP.

Site type seems to be a factor influencing the success or otherwise of the various Alder species, the most satisfactory stands seemingly on deep peat, the poor plots generally associated with peaty gleys. Top dressings of P and K seem to be crucial to sustain growth and ensure survival; none of the earlier experiments with Alders were top dressed - see the following section, 5.8.

A glutinosa and incana are the most successful species. A spuria appears to have suffered natural coppicing as a result of regular dieback; consequently individuals tend to be small and bushy. Dieback occurs in all species; suckering is evident locally.

This experiment seems to warrant retention on two counts: firstly it is the only surviving Alder experiment on the Lon Mor, and secondly the prevailing interest in broadleaves on upland site types would appear to make it a potential site for further research.

3.8 Other Species Experiments

3.8.1 Experiment 66 P28

This experiment aimed to establish two year old Rowan seedlings from Inchnacardoch on a ridge landform in the north west corner of the original enclosure, the site intersected by the upper reaches of the burn draining the reserve.

Direct and turf planted, the latter by Belgian spade. No basal phosphate.

The last known assessment in 1934 revealed high survival figures of 95.6% and 95.3% for turfed and directed plantings respectively. The plants seemed to be healthy.

Nothing more is known, and all that remains are turf drains with a rowan by the burn which may be the progeny of the planted stock.

Despite apparently promising survival figures in 1934 the experiment appears to have failed. Would there have been enhanced survival with basal P?

Reference

Bulletin 22 page 65

3.8.2 Experiment 90 P30

A trial of Abies balsamea on deep peat. A variable site lying between the main water channel and experiment 39, a vigorous tussocky Molinia/Myrica community beside the burn superseded by a less vigorous variant of the same species which in turn merges into an unflushed Calluna/Erica tetralix (10b) matrix.

Three rows of thirty four plants; planted on shallow turves, 2 oz of basic slag placed under each turf.

Mean heights in 1960 reflected differences in the site type: 3.7 m on the high nutrient status peat beside the burn, 2.1 m on the other flushed bog type and 1 m on unflushed peat.

A few survivors struggle on on flushed peatland looking none too healthy; the species has now failed on unflushed peat.

Reference

Bulletin 22 page 54

3.8.3 Experiment 97 P32

An experiment designed to test the suitability of Alder as a choice of species on peatland.

The site appears to be an amalgam of weakly flushed blanket bog (9e) and Upland sphagnum bog (10b) adjoining the main outlet burn in the south end corner of the reserve.

Two replications of three Alder species: A rubra, 29/35, ex Forest of Dean and Bedgebary; A incana and A glutinosa both from the Royal Botanic Garden.

Turves laid on spread sand and silt from the neighbouring burn. One replicate treated with basic slag, 2 oz per tree.

Today there is the odd surviving Alder intermingling with Birch. Another instance where Alder has failed, its demise particularly rapid and complete where no basal P was applied. It was thought that losses were not wholly attributable to frosting and dieback. The post war experiment, 147 (5.7) suggests that survival is enhanced by later remedial top dressings of P and K none of which were applied in this instance.

Reference

Bulletin 22 pages 64 and 65

3.8.4 Experiment 102 P32

A further experiment continuing the theme of afforestation with Alder on deep peat. As in the previous experiment turves were inverted onto a layer of sand and silt spread locally onto the peat.

A scattered experiment, three of the variably sized sections A, B and C flanking the prominent tributary burn in the north eastern sector of the original reserve, the other, D, adjoining the eastern boundary fence.

All sites are flushed blanket bogs, those adjacent to the burn

generally of a higher nutrient status, particularly plot A at the junction with main burn where a pure Molinia sward predominated, the peat probably intersilted. Vegetation descriptions within the other two plots in the sequence included a variable proportion of Calluna, the central one, B, seeming nutritionally the poorest. By contrast D was sited well away from any periodic burnside temporary flushing influence, apparently on a weakly flushed blanket bog (9e).

Two species of Alder were tested in pure plots, Alnus incana planted in A and B, Alnus glutinosa in C and D; all trees originating in the Royal Botanic Gardens. Basic slag (32% Phosphoric acid) was placed beneath individual turves, 2 oz/plant, in plots A, B and D; the eastern half of C likewise treated, the remainder of this plot acting as a control.

The last know report, 1949, recorded good growth and survival, height ranging from 3.7 m on the outer edge of plot A to 4.6 m adjacent to the Lovat sitka. On the less favourable site B the majority of trees were dead or dying, the few survivors close to the drainside ranging between 3 and 4 m. A marked contrast in survival was apparent in plot C, 75% in the slagged portion where height increased towards the drain, declining to 25% in the control, the mean heights were 4.6 and 2.1 m respectively. Plot D had almost wholly failed with few survivors.

Dieback and lack of remedial fertiliser input appears to have contributed to yet another failure of a species which seemed to have considerable potential, an apparently ideal choice, especially Alnus glutinosa, certainly on the higher nutrient status deep peats and more intensively flushed peaty gleys. A few pathetic remnants continue the struggle in plot C. Suppression by the more vigorous ribbon of Lovat SS may have contributed to the demise of the plots contiguous with the burn.

Reference

Bulletin 22 pages 65 and 65

3.8.5 Experiment 108 P34 and P35

An Alder and Birch trial close to the northern boundary fence which was described as scrub in 1958; it has subsequently almost wholly succumbed.

This particular experiment was laid down on what appears to be a diverse site, an amalgam of flushed blanket bog (9de) and peaty gley.

The four species of Alder included A oregona which had shown considerable promise in an earlier trial in the "P22" area Inchnacardoch, its phenomenal initial growth outstripping that of all accompanying conifers and broadleaves. This Lon Mor experiment included a range of A oregona origins, two from the USA, one from Canada and one unknown obtained from the Royal Botanic Gardens. Three other Alder species featured in the experiment: a French origin of A viridis, and Italian origin of A cordifolia and A incana, two origins from the Swiss Alps and Austria respectively. The Birch were a Hamsterly provenance and Betula alba.

Twenty five plant plots the trees planted on shallow turves with 2 oz slag placed beneath the inverted turf.

The 1958 report is dismal reading. A oregona and cordifolia had failed completely. A incana from the Swiss Alps was the most successful Alder with 75% survival and a height range of 1.5 to 3.6 m; however, dying trees were noted. The majority of the other A incana were either dead or dying having grown reasonably well initially, but only five A viridis remained alive. The Hamsterly Birch were highly variable, but only one B alba had survived, attaining a height of 5.5 m.

Once again failure was attributed to frost, but subsequent experimentation with Alder suggests than an inadequate top dressing regime may have been a contributory factor. The sorry remnants are now enclosed within the Deficiency Garden, experiment 171 (5.3.6). Apparently at least one attempt was made to resuscitate the survivors with PK, seemingly in the late sixties when they were incorporated within the bounds of the deficiency garden

(Inchnacardoch 171 P69).

Reference

Bulletin 22 page 65

3.9 Others

There are a few instances where pure plots of species other than SS and LP are included within experiments, generally as a subsidiary component.

3.9.1 SP

Experiment 138 P51 and P52 (4.3); the P53 input planted in mixture.

P51: 48/615, Glenuig. P52: 48/643, Rannoch (tree 7).

3.9.2 JL

Experiment 125 P39 (5.1.18).

A sizeable plot of JL 36/18 Nagaro, Japan.

Experiment 18 P26 P50 extension 48/38.

3.9.3 HL

Experiment 138 P51 and P52 (4.3); the P53 input planted in mixture.

P51: 49/260, Dunkeld Avenue. P52: 50/67, Craigvinean

3.9.4 OS

Experiment 138 P51 to 53 (4.3).

All 49/89 Germany.

3.9.5 WH

Experiment 168 P68 (5.5.1). A restocking experiment half of which is a single plot of WH 62 (7111)1 of Masset QCI origin.

3.9.6 Miscellaneous

Four other species, one plot of each, were included with the LP experiment 149, P58 and P59 (5.4.5). sited on a weakly flushed blanket bog (93) on the southern edge of the experiment and exposed to the elements with an open view to the south and west.

Abies lasiocarpa has largely failed although there is one impressive survivor.

Picea glauca appears to be struggling with variable height and survival, and some deer damage.

Abies noblis is likewise stressed, but growth and foliage colour improve on the leeside of the plot.

Abies alba, again not at ease on this exposed situation, has a few survivors growing reasonably well.

4. Mixtures

The normal present day commercial afforestation mixture on this site type is normally SS/LP. Four experiments, ranging in age from forty to sixty two years since planting are of variable, but generally considerable interest, albeit the LP origins are not those now recommended. These are discussed in section 4.1

Scots pine is currently recognised as one of two alternative nursing species with SS, and there is scope to plant such mixtures within the Forest Region on morainic/flurioglacial landforms although a cogent case for SP alone or in mixture with Birch can be made for such sites, especially at present when species diversity is a major consideration. Scots pine/SS mixtures are a component of the extensive P47 field scale trials, experiment 135 (5.4.3); it seems more appropriate to discuss these mixtures in section 5 as they are part of a larger experiment. Likewise a checked SS/SP mixture on an ill drained Upland Sphagnum bog (10b), experiment 130 P46, is outlined in section 5.4.2.

Unfortunately intensive mixtures of the second alternative, the larches, and SS do not occur on the Lon Mor, albeit a successful example of JL nursing SS on deep peat in Inchncardoch 164 P65 occurs on neighbouring middle slopes. Hybrid larch is present to a very limited extent in one of the prescriptions tried in experiment 135 (5.4.3)

Mountain pine is another potential alternative nurse; however, a requirement of careful management is likely to preclude its usage in such a role at present. The species has proved to be a successful nurse in two experiments on the Lon Mor one of which is outlined in section 4.2; the other a relatively small component of the extensive field scale trial experiment 135 (5.4.3), again it seems more appropriate to elaborate on this experiment in section 5.

Various cocktails of other species and mixture patterns have been tried on the West Lon Mor in experiment 138 established between 1951 and 1953; this experiment forms the subject of section 4.3.

4.1.1 Experiment 55 P30

An experiment designed to continue research into comparisons between the subsequent performance of trees established on turves, either the deeper Belgian type or the shallow turf, of varying age. Laid out as two separate components, one of each turf type, separated by the main watercourse, Belgian turves to the west of the latter and a grouped shallow turf system to the east.

Originally five replications of three treatments:

A. turves cut and laid in 1928, two years prior to planting

B. turves cut and laid in 1929, one year prior to planting.

C. turves freshly cut in 1930.

Basic slag (2 oz/plant) was either spread beneath the shallow turves prior to planting or at the time of planting placed in the circular hole produced by a Belgian spade on the deeper Belgian turves. Spacing, 1.5 x 1.2 m in the Belgian section, 1.2 x 1.4 m in that of the grouped shallow turves.

A 1:1 mixture of LP (3+1) 26/58, Alberta and SS (2+1) 25.50, QCI, from the Golf Course and Auchterawe nurseries respectively. Planted in alternate rows, those in the grouped shallow turf component staggered.

Both parts of the experiment straddle what is essentially a weakly flushed blanket bog (9e), the original vegetation map recognising some variation both within the Belgian turf section and between it and that of the grouped shallow turf section. The draft final report suggested that this site variation may have contributed towards an overall inconclusive result from the FY62 PK application.

Subsequent Treatments

FY45 The largely checked SS prompted a top dressing application confined to the spruce; 3 oz GMP around each tree, with a three plot control established at the northern end of each turf type.

FY62 Three rates of PK (Muriate of potash and GMP) were applied to both LP and SS; a replicated layout with the FY45 control maintained was established in the Belgian turf section, but not in that of the

grouped shallow turves where levels of the three treatments were applied on a strip basis without retention of the original control. Tree pulling was attempted in 1971 but abandoned due to stem breakage and severing of root systems.

Current State of the Experiment and Conclusions

The Belgian turf section is brashed with good access whereas the grouped shallow turf portion remains unbrashed.

When viewed from a nearby ridge landform a number of dominant LP in the grouped shallow turf section appear to be dying back with relatively light foliage in the upper crown.

The crop is stable and a sizeable proportion of the SS have been successfully nursed to either dominant or co-dominant status without a nitrogen input. Needle colour appears reasonable despite overall additions of elemental P and K less than those currently recommended, particularly the latter, on such peatland site types.

Seventeen years after planting treatment mean heights on Belgian turves were marginally superior to those on the grouped shallow turf system; the combined mean for LP 2.8 m, that of SS 0.9 m. It was concluded that there was no improvement with advance ground preparation; in fact there was a suggestion that growth was inferior on older turves.

The root architecture of the SS may be of considerable interest, especially in the light of current concern about root development and consequent stability on deep ploughed peatlands.

The experiment offers an opportunity to study the irreversible drying and subsequent cracking of peat under a much older LP nurse than has been possible hitherto.

Reference

Bulletin 22 pages 50 and 51

4.1.2 Experiment 112 P35

An extensive field scale trial, mostly on Upland Sphagnum bog (10b) with a weakly hagged surface according to the original vegetation description. The deep peat thins towards either end of the rectangular experiment, a change in both microtopography and height of the SS clearly delineating the transition to organo-mineral soil types, a podzolic ironpan soil predominating. A sliver of peaty gley appears to impinge locally onto the central region of the eastern perimeter.

Turf drains at 3.6 m spacing are aligned NW/SE parallel to the longitudinal axis of the block, the turves spaced at 1.2 by 1.2 m. LP (2+1) 32/533 Alaska, SS (2+1) 32/7 QCI ex Altonside, planted by side notching in alternate lines, the experiment designed to maximise protection of the spruce by the pine, the latter forming the outer windward edge. Differential rates of Semsol were applied to the roots of both species, 3 oz to SS and 1 oz to LP.

Subsequent Treatments

Beating-up was required in P36 and P37 (LP only) with SS of similar origin, the LP from Shuswap Lake; supplied from Altonside in 1936 and locally from Inchnacardoch in 1937.

FY43 Six sections of checked SS treated with basic slag, 2 oz per tree, three at each end of the block largely coinciding with the zones of organo-mineral soils; three rows on the windward side not top dressed.

FY50 and 53 Thinning to reduce physical damage to the SS and encourage its growth by removal of competing LP to windward.

Current State of the Experiment and Conclusions

Overall this has been a moderately successful mixture on deep peat with an encouraging number of SS winning through. Where the deep peat is superseded by organo-mineral soils at either end the SS is totally suppressed, albeit retaining satisfactory needle colour. Growth within the deep peat section tends to be rather variable, and

the crop is somewhat open in part. The LP occasionally have an easterly lean and some localised instability is evident.

Although the LP is of Alaskan origin it has been recognised as probably an inland type and not from the coastal "panhandle" zone, the seed source currently recommended. The situation is compounded by significant early losses attributed to the Semsol and consequent beating-up with a Southern Interior seedlot from Shuswap Lake; differences within the crop are evident. Breast height diameters are occasionally very impressive, especially on deep peat. Crowns tend to be narrow with light foliage; locally the odd tree appears to be dying back.

In the establishment phase variable survival was correlated with differences in the vegetation community and ground preparation, the latter specifically drainage which was generally recognised as inadequate.

A further example of slow establishment on a deep peat with a woefully inadequate fertiliser regime by current standards which has not included K. The peatland component is of some interest which should be allowed to grow on, offering the opportunity to observe species interaction and stability.

Reference

Bulletin 22 page 50.

4.1.3 Experiment 137 P51 EK

A fully replicated six block experiment, the narrow linear layout straddling a variable landform. Consequently there are differences in soil type, peaty gley predominating with weakly flushed blanket bog (9e) edging in on the northern and southern ends, in the latter instance the boundary marked by a distinctive change in slope. An experiment designed to test the effect of heavy differential basal applications of GMP to SS and LP in mixture (alternate SS in alternate LP rows, 25 and 75% respectively of each species). Inputs of phosphate to individual SS ranged from 28 gm to an incredible 672

gm equivalent to 13 - 287 kg elemental P/ha. The LP treatments were a more modest 14 - 46 gm per tree.

The LP is an Albertan origin, 49/254, the SS a Harwood provenance, 48/609. Typically ground preparation was single furrow Cuthbertson ploughing.

Current State of the Experiment and Conclusions

The experiment is somewhat of a hotch potch, patchy growth probably attributable to a number of factors: site variation, treatment differences and interactions between treatments. Growth of the SS is notably impressive, however, on the distinct slope in the south central sector.

The SS appears to have responded well to increasing rates of P, but deficient or marginal levels of N and K throughout the duration of the experiment were considered to have reduced the value of the results.

Similar rates of height growth were achieved in this experiment, probably partially due to the choice of LP origins.

At sixteen years old SS yield classes were reckoned to range between 8 and 16.

The case for retention is somewhat shaky due to inconsistency in site type and variable growth of both species.

4.1.4 Experiment 140 P52

There are two parts to this experiment: an LP/SS mixture, the principal component, and three plots of NS, WH, and NF, one of each species, mixed with LP.

The LP/SS mixture experiment is extremely difficult to interpret on the ground due to a distinct lack of external and internal tally posts; however, this seems to be immaterial as the prime interest is now the mixture effect per se. The experiment occurs on deep peat, weakly flushed blanket bog (9e) in the western sector merging into an Upland Sphagnum bog (10b) in the east, this difference in site type clearly reflected in crop performance.

The purpose of this replicated experiment was to continue the theme of differential rates of basal GMP, the SS receiving, 2 - 24 oz placed in and around the notch within specified radii; 0.5 to 2 oz applied to LP. If practicable 1 oz was placed in the notch. It was hoped that the differential fertilising would equalise the growth of the two species.

The LP is reputably 50/292 Montana. However, there is strong visual evidence of an admixture of Lulu Island (NLP) origin material throughout.

The accompanying SS, 48/10, originates from British Columbia.

Planted on single furrow Cuthbertson ploughing. The mixture pattern of the preceding experiment 137 was repeated: 3 LP:1 SS in alternate lines of LP and LP/SS.

The three other mixture plots are on a variable site, largely peaty gley but with some weakly flushed blanket bog (9e) included. The additional species are:

NS 48/35 Switzerland

NF 51/215 Guisachan provenance

WH identity unknown.

Current State of the Experiment and Conclusions

On the unflushed bog in the eastern sector growth of what is now an essentially pure LP crop is unsatisfactory due to inadequate drainage.

Any interest in the experiment would focus on the mixture effect amply demonstrated in the western sector. Here SS frequently competes successfully with the LP in a stable, unthinned crop, the LP component often suppressed and either dead or dying out.

The only mixture plot of any interest is that of the LP/WH where, characteristically the Tsuga is stubbornly growing on, usually as a suppressed constituent of the crop which barely reaches the lower crown of the LP, although occasionally competing successfully with the latter. The inland LP is too vigorous to succeed in nursing the NS and NF.

Equal growth rates have now been achieved in this mixture; the differences attributed to site variation.

A self thinning LP/SS mixture with some claim as a subject for further study or monitoring, albeit this only applies to the relatively small western portion. Here and in experiment 137 (4.1.3) the choice of LP origin is more akin to that now recommended.

4.1.5 Summary of the LP mixture Experiments

Despite their relative small scale, an LP nurse of a generally inappropriate origin and an inadequate fertiliser regime which frequently did not include K, these stable and generally unthinned SS/LP mixtures may be of interest on a number of counts:

1. SS root architecture - offering a potential comparison between mounding and ploughing - and allied studies.
2. Peatland studies - the drying effect under a mature crop and potential consequences.
3. Monitoring long term developments in stand structure and the interaction between the two species.

These experiments ought to be retained on a long term basis, stability permitting. The case for retaining experiment 137 seems the least convincing.

4.2 Experiment 77 P29

This is an interesting example of an eventually successful close planted SS/MP mixture now a pure crop of spruce. A number of early experiments set out to investigate the effect or otherwise of differential rates of slag, basal and top dressings, on subsequent establishment. Prior to the initiation of this experiment such treatments had normally been applied to pure SS (see section 5); application to a mixture was a variant of the theme, widening the field of investigation.

The original five treatments included three rates of basic slag, 1, 2 and 3 oz, in combination with either one or two handfuls of soil

applied below shallow turves. Six replications of five forty plant plots; each plot four rows of ten trees, the two to windward MP. Shallow turves laid corner to corner in FY28 to give an approximate spacing of 0.8 x 0.4 m.

A 50:50 row mixture of MP 26/46, a Swiss origin, and QCI 25/5 planted by side notching.

The experiment occurs on a uniform area of weakly flushed blanket bog (9e).

Subsequent Treatments

1969 Early growth of SS was far from spectacular, at best a mean height of just under 3 m after seventeen growing seasons, the MP fairly consistently around 1.7 m By 1969 the mainly checked pole stage crop had attained a height range of 4.5 - 7.6 m and a dominant height of 8.5 m for MP and SS respectively.

PK was universally applied to six of the original treatment plots in each corner of the experiment in conjunction with either hydrated lime or urea, two plots treated with each of the combined fertiliser prescriptions, in essence two sets of treatment plots separated by a central series of plots retained as a control (PK treatment only). PK trials elsewhere had suggested that calcium had a role in increasing nitrogen uptake on deep low nutrient status peat. PK was applied as a compound fertiliser Potassium metaphosphate, a dressing of 315 kg/ha supplying 85 and 95 kg elemental P and K respectively.

Current State of the Experiment and Conclusions

The MP continue to thrive on the windward edge, otherwise the pine has been totally suppressed and died out leaving a reasonable stand of pure SS. Typically the growth of the spruce has been variable. Visual evidence of nutrient deficiency may not be wholly due to an inadequate fertiliser regime, unsatisfactory drainage could be a contributory factor; however, the crop appears to be stable.

The SS responded to the PK top dressing, but not significantly to

the additional nitrogen input. Hence the experiment is a pointer to the crucial role of PK in the fertiliser prescription for low nutrient status peatland.

This is a useful demonstration, one of an adjacent group of experiments of similar vintage (74, 76 and 83 sections 5.1.12, 5.1.13 and 5.1.14) which in combination convincingly illustrate many factors underlying the early establishment of SS, successful or otherwise, and the subsequent maintenance of satisfactory growth on this site type.

Reference

Bulletin 22 page 36

4.3 Other Species in Mixture

Experiment 138 P51, P52 and P53

This experiment was laid down over a three year period with the intention of assessing various species and mixtures which had not yet had an adequate trial on relatively recently introduced mechanised ploughing, in this instance single furrow Cuthbertson, furrows spaced at 1.8 m in 1951 and 52, and 4 .6 m in 1953. Pure plots of SP and HL are included. Row mixtures were adopted, either a 3:3 or 3:1 pattern, the former where growth was thought likely to be fairly even with shelter the foremost consideration; the 3:1 mixture provided a more intimate nursing environment for the subsidiary species.

The experiment is widely dispersed and straddles knowe and ridge landforms, slopes and basins; consequently there tends to be considerable variation in soil type both within and between the scattered component parts.

A basal dressing of GMP, 57 gms/tree equivalent to 32 kg elemental P/ha, was universally applied to each year's planting.

P51 block Unreplicated plots of LP in mixture with HL, EL, OS, DF, GF and WH; pure plots of SP and HL at either end. A ridge landform sloping down to the main burn. The principal soil types are

discrete areas of podzolic ironpan soil and peaty gley, flushed blanket bog (9b) impinging on the lower edge close to the burn. The LP is a Roseisle provenance, 49/251, originating in the region of Mount Ida in Central Interior, BC, a far too vigorous nurse. Significant windblow has devastated the central core, only three plots being of any current value; probably the most interesting is the thinned 3:1 LP/WH, now mainly an impressive Tsuga stand with extensive windblow on either side.

The pure HL (49/260 ex Dunkeld avenue) has attained an impressive height; however, in the adjoining 3:3 mixture the HL has had only limited success, the LP generally too competitive. Neither HL plot has been thinned unfortunately. In the remnant of the OS plot the spruce is well suppressed, barely reaching the lower LP canopy, but true to form the foliage appears to be healthy.

The P52 Contribution A more complex layout and the largest component of this species trial. The species planted in 1951 reappear with the addition of SP/LP, SP/HL and LP/JL in 3:3 combinations, and LP/NS and LP/NF in the more intimate 3:1 row design. Although the site type tends to be rather variable both within and between the two widely separated groups of plots peaty gleys predominate, occasionally merging into a ranker complex, weakly flushed blanket bog (9e) the secondary constituent. The LP is Lulu Island origin, a North Coastal seed lot, much in vogue at the time, but with the benefit of hindsight an unfortunate choice, trees tending to be spindly with sparse foliage and somewhat variable growth, ranging from poor to quite vigorous. Only the Tsuga plot appears to have been thinned.

In the most westerly block the most promising mixtures appear to be SP/NS and LP/WH, the latter with a substantial proportion of WH dominants of good form after thinning. Larches and SP vary according to site. HL, typically, is the most successful of the three larches in 3:3 mixtures with LP, JL tending to be less so with EL generally suppressed. The pure SP plot on the upper perimeter is on a wet, ill drained flat; stocking is unsatisfactory due to

dieback and windblow. OS soldiers on as an apparently healthy understorey, occasionally attaining sub dominant status.

The easterly portion of the P52 additions seems less impressive. LP has frequently proved to be too vigorous for any other species. The SP/NS mixture has not been successful on this occasion and HL is mainly in the ascendency in the SP/HL plot.

The NS is a Swiss origin 48/35, HL a Craigvinean provenance, 50/67, and the SP a Rannoch origin, 48/643 (tree 7).

P53 This year's input occurs on a flushed blanket bog (9b) close to the main burn. Site drainage is totally inadequate and the trees are suffering accordingly. This may be due to site preparation, the turves cut and spread from plough drains at 4.6 m spacing. Satisfactory growth has only been achieved in the SP mixtures towards the upper perimeter, although here too the ground surface tends to be wet. The SP/NS plot is again of interest, the latter species probably dominant overall. In the SP/HL the latter is clearly dominant; the SP have performed reasonably well, but some have died out. Between these plots and the burn the ground is very wet and now carries an indifferent, essentially pure crop of LP. The wedge of OS on the upper flank is patchy, open in part, but growth is reasonable, albeit some individuals appear to be under stress due to a lack of adequate drainage. The block is unthinned. The SP here are an E England provenance, 48/11A, the HL as in 1952. Throughout the experiment the OS is a German origin, 49/88.

Current State of the Experiment and Conclusions

Windblow has severely reduced the number of viable plots in the 1951 planting.

Lack of adequate drainage is a major problem in the 1953 extension. Drainage requires attention elsewhere throughout the experiment, but generally on a relatively local scale.

Thinning is not a practical proposition unfortunately; for the moment at least, the plots will have to be allowed to develop on a non thin basis.

The experiment demonstrates that species diversity can be achieved on suitable irregular lower slopes within the Western Moine Region with careful site selection and choice of origin/provenance of any alternative species considered. Knowledge of the silvicultural requirements and the growth potential of alternative species tends to be sparse and is an obvious avenue for further research.

This particular experiment has re-emphasised the potential of SP, LP, HL and WH as alternative species. NS too could have a role but the risk of Heterobasidion annosum may be a serious drawback to its usage. Serbian spruce, OS, is an interesting species which grows slowly, but could find a niche in British silviculture, especially as an understorey.

A trial of this size poses major management problems for Research which cannot be addressed properly largely due to difficult access. It seems unfortunate that such a trial cannot be followed through as a demonstration with timely silvicultural operations carried out on contract.

5. Establishment and Nutrition

The component parts of this lengthy section are as follows:

5.1 NS and SS experiments 1925 - 1942

5.2 LP experiments 1925 - 1928

5.3 Miscellaneous experiments 1925 - 1969

5.4 Experiments on mechanical ploughing 1946 - 1957

5.5 Restocking experiments 1968 - 1976

5.1 NS and SS Experiments 1925 - 1942

These pioneering experiments were established prior to the realisation that in addition to phosphorous, nitrogen and potassium had a key role in maintaining an adequate nutrient status in such crops on nutritionally impoverished peat in excess of approximately 30 cm. Likewise the interaction between P and K and the consequent need to apply these elements in tandem on such peats was not fully appreciated until comparatively recently when results from fifties and sixties nutritional experiments clarified the issue.

A salient feature of the Lon Mor is a legacy of unsatisfactory checked NS and SS experiments of the 1925 - 1939 period. Few attempts were made to alleviate well established deficiencies, and consequently stimulate growth, once the nutritional conundrum had been suitably addressed with the evolution of a prescription universally acceptable for low nutrient status peatland. One of the few pure SS successes is the pole stage extension to experiment 74 P29 (5.1.12). Neighbouring experiment 98 (5.1.17) and the strip of Lovat SS flanking the tributary burn are likewise generally satisfactory, the former probably due to fertilisation although this is not certain as the records are not explicit; the latter is on a strongly flushed site.

Two pure blocks of SS which have ultimately achieved satisfactory pole stage growth worthy of a special mention here are those in experiments 10 (5.1.2) and 12 (5.1.3)

5.1.1 Experiment 9 P25

An attempt to establish NS seedlings (2+0) and transplants (2+2) ex Beaufort Estate nursery on a weakly flushed blanket bog (9e). The layout was in the form of two separate eastern and western blocks, both rectangular, adjacent to the main burn in the south east corner of the reserve. Planted on shallow turves evenly distributed, centres 0.8 m apart, with a Belgian spade by the Experiment Officer in person, the treatments included the addition of mineral soil to the planting position, mixed with the plug, and the provision of wooden shelters (two boards nailed at right angles and supported by a short stake to form a small screen). Additional turves were planted with 2+1 SP.

Subsequent Treatments

May 1929 The western half of each section was top dressed with basic slag (18% phosphoric acid), 3 oz per tree, spread along the outside edge of the turf.

Current State of the Experiment and Conclusions

The forlorn moribund remnant of the western block is suffering from considerable environmental stress, an interaction between site type (an anaerobic substrate combined with inadequate nutrition) and exposure. Growth has been better in the few survivors in the eastern section, probably due, in part at least, to the shelter and nursing afforded by robust SP linking the two parts of the experiment; the nutrient status of these NS appears to be reasonable. Remains of the wooden shelters can still be seen in the western block.

The most successful transplant treatments were clearly those top dressed, slagged but not sheltered and slagged plus shelter, 1.7 and 1.9 m mean heights respectively at twenty one years, the final assessment in 1946. By contrast the 1929 control had even more meagre mean heights of 0.7 to 0.8 m, without and with shelter respectively. The overall survival of transplants was 82.5%, far

superior to that of seedlings (20%).

The mean heights of surviving seedlings were generally significantly less than their transplant counterparts, although the mean height of those sheltered without slag marginally exceeded the similar transplant treatment.

The shelter effected appeared to be beneficial, and at a later date this finding contributed to the widespread adoption of the practice whereby either a square or wedge was cut from plough furrows prior to planting.

Reference

Bulletin 22 pages 89 - 90.

5.1.2 Experiment 10 P25

A small experiment designed to investigate the effect of three different methods of notching into shallow turves on the subsequent establishment of SS, 3+0 seedlings and 2+2 transplants.

Parallel shallow drains, aligned perpendicular to the long axis of the block, were cut at 1.2 m spacing with two rows of turves laid corner to corner between them; this resulted in a staggered planting pattern, spacing varying between approximately 0.45 and 0.6 m.

Three notching treatments were tested:

1. A diagonal slash within the upturned turf.
2. A single notch from the outside to the centre of the turf.
3. A central cross to allow the turf to be opened out, the plant inserted with roots spread beneath. A turnip smasher was tried, but found unable to break through the tough turf; consequently a spade exploited the imprint of this tool.

The single plant plots of the six treatments were repeated in a standardised pattern, starting in the north west corner: seedling followed by transplant of notching technique 1 through to seedling and transplant of the third method, the series running to and from north west to south east.

The few surplus turves were planted with 2 +1 Scots pine.

The experiment straddles a variable site type, weakly flushed blanket bog (9e) at the interface with a ridge landform merging into Upland Sphagnum bog (10b), the latter probably predominating.

Subsequent Treatments

April 1927 Top dressing of high grade basic slag at one ton per acre applied to one half of the experiment; apparently the northern section.

FY1929 Drains deepened

Current State of the Experiment and Conclusions

An interesting small, self thinning block of stable pole stage SS. Ample evidence of unsatisfactory nutrient status; a tendency towards short needles and a paucity of foliage. However, current annual increments are generally reasonable. Rather variable heights.

The side notch proved both the most successful and quickest technique. Typically, early growth was slow and the plants checked. The slow early growth is clearly evident in a partial assessment of mean height in 1937: seedlings (0.3 m, control; 0.4 m, slagged) and transplants (0.6 m, control; 0.8 m slagged).

A demonstration of what can be achieved by SS on low nutrient status peatland without any inputs of either N or K, albeit when reviewed in the context of its age, rising sixty eight years, growth is obviously mediocre and well below potential attainment.

Historically the experiment is of interest, being one of the first to be laid down by Dr, later Professor, M L Anderson.

Reference

Bulletin 22 pages 9, 22 and 46

5.1.3 Experiment 12 P26

The experimental treatments included a basal application of basic slag, the first recorded instance of such a fertiliser treatment, applied to transplants of SS and NS, each 2+2 and planted in separate blocks. A line of SP (2+2) linked the two sections with a further two lines of this species west of the NS. All plants originated in Auchterawe nursery, and along with other materials required for the experiment were transported by pack horse.

The experiment aimed to compare two methods of planting on shallow turves, either with a circular (Belgian) spade or by side notching on the north side to the turf centre, in addition to five fertiliser and/or soil treatments with a control included. These five treatments were:

1. Control, nothing applied beneath the turf.
2. 2 oz Basic slag and 12 oz soil.
3. 1/2 oz epsom salts Mg (SO_4) and 6 oz soil
4. One handful of nursery soil.
5. One handful of leached morainic debris. In the NS section coarse silt form the main drain substituted for morainic drift.

All fertiliser/soil treatments applied per tree, either within the plug hole or spread beneath the turf.

The method of turfing, plot size and sequence of treatments mirrored that of other intensive experiments laid down that year: a parallel series of shallow turf drains at 1.2 m spacing, two rows of turves arranged corner to corner between drains, and a consecutive repetitive sequence of the ten treatments in single plant plots. The latter began with the Belgian spade/control, side notch/control, plots 1 and 2, and followed the treatments through to their ultimate conclusion, side notch/leached morainic soil (plot 10); starting in the north west corner the sequence wound its way back and forth parallel to the short axis of the block to finish in the south east corner.

Although on deep peat the experiment straddles the nutritionally significant divide between flushed and unflushed bogs, albeit the

blocks are conveniently sited on apparently uniform areas, the SS component on a Molinia bog (9e), the NS on Calluna dominant Sphagnum bog (10b).

Subsequent Treatments

November 1928 Top dressing of basic slag (18% Phosphoric acid) at a rate of 1 ton/acre, to twelve of the fifteen sections recognised within the SS portion, sections 4, 5 and 6 from the west end retained as a control. NS not treated.

January 1933 Further top dressing of high grade basic slag, 3 oz around each turf, confined to sections 10, 11 and 12.

March/April 1933 Sixty six boxes approximately 0.3 x 0.3 x 0.25 m, with slatted bases, placed between the turves in the most easterly sections, 13, 14 and 15, filled with compost and planted. the recommended compost a cocktail of old turf, rolled leaf mould or woodland litter, gritty sand and well rotted manure into which was planted SS 28/34 2+1+1 ex Altonside. What the actual mixture was is not clear, but topping up with sand from the main drain was necessary prior to planting due to settling of the original filling. The boxes are still in place.

Current State of the Experiment and Conclusions

An impressive small stand of SS, more so than that of neighbouring experiment 10, and comparing very favourably in terms of overall performance with the P28 experiments, 48 (5.1.10) and 49, (5.1.11) on similar peatland. Flushing from the adjoining ridge landform seems likely to have underwritten the relative success of the SS which has achieved a respectable height without inputs of either K or N, albeit, not surprisingly, there is some evidence of nutrient deficiency; recent annual increments appear reasonable. The self thinning process within this stable stand is of particular interest. The NS survivors form a checked thicket, a yellow hue the typical needle colour; this unsatisfactory nutrient status in probably aggravated by a neglected drainage system. The SP have been more

successful.

Four annual assessments were carried out form 1925 to 1928, thereafter the experiment was deemed to be completed as the results were sufficiently clear to recommend an application of basic slag at planting. The growth of SS was seen to fall off during the fourth year and this finding was to form the basis of the four year interval between basal and/or top dressing additions of P in experiment 74 P29 (5.1.12).

Subsequent early growth implied that planting with the Belgian spade had an adverse effect relative to side notching. It was thought that fertiliser spread beneath the turf might stimulate the production of a more ramified root system whereas with the Belgian method phosphate was concentrated within the immediate vicinity of the root zone.

The results from experiment 12, and later 17 P26 (5.1.5), provided the keystone for a more extensive trial with side notched shallow turves and a mixture of basic slag, Epsom salts and soil applied at planting - experiment 39 P27 (5.1.8).

A marginal beneficial effect seemed to be apparent from the Epsom salt treatment, but this was significantly less than that from slag. Only the small, close planted and self thinning stand of SS merits retention.

Reference

Bulletin 22 pages 67, 68, 72, 73, 80 and 81

5.1.4 Experiment 13 P25

This experiment continued the 1925 pioneering spirit with SS and NS seedlings and transplants, on this occasion of varying age, and once again planted with either the Belgian spade or by side notching.

Site preparation was similar to that in experiments 10 (5.1.2) and 12 (5.1.3): a parallel series of shallow drains 1.2 m apart between which two rows of thin turves were laid corner to corner. As before each species was planted in a separate block, that of NS a short distance to the west of the SS. What was described as good soil

from the Allt Graidhe was bagged and carried to both sections to be placed beneath all turves.

For both species the plants were two and three year old seedlings, and either three (2+1) or four (2+2) year old transplants; a total of four plant types and two planting methods, eight treatments in all repeated fifty times, in each section. In the SS section planting began in the east corner, the units criss crossing the block on a NE/SW alignment whereas in the NS plot 1 was in the NW corner proceeding to the NE thereafter tacking to and fro across the block on a similar E to W alignment to that in the SS. Once again, as in experiments 10 and 12, the layout of the various treatments adhered to a fixed pattern with one plant plots: notching of all plant types (2 year seedlings to four year old transplants), the sequence repeated with the Belgian spade. Notches were cut on the south side of the turves.

The two year old NS seedlings were imported from Beaufort Estate nursery, otherwise the remaining plant types originated locally from Auchterawe nursery as did SP planted on surplus turves. These SP bordered the western and southern flanks of the NS section, a belt of 40 trees and six rows respectively; surplus turves within the SS were likewise utilised by planting SP.

The site type is a relatively uniform unflushed Upland Sphagnum bog, 10b, the original description suggesting the presence of Molinia on a very localised basis.

Subsequent Treatments

September 1928 Differential top dressing with basic slag 18% (Phosphoric acid) and Epsom salts: SS, 2 oz slag and 1/2 oz Epsom Salts; NS, 4 oz slag and 1 oz Epsom salts; applied around the outside of the turves. Each of the two species components comprised eighteen sections and the fertiliser treatment differed between them, the control sections varying within each species. In the SS alternate pairs were treated (ie sections 2 and 3, 6 and 7 etc 16, 17 and 18 also acting as a control) whereas alternate sections were

treated in the NS (ie 1, 3, 5 etc).

1933 Preliminary trial 33/6

Four sections within the SS, two previously top dressed (10 and 11) and two controls (12 and 13), treated with DF litter (a bag per section) gathered from a young plantation in Inchnacardoch. Presumably an attempt to alleviate the already checked SS.

Current State of the Experiment and Conclusions

The SS section is a well stocked thicket/pole stage clump with a range of heights and variable deficiency symptoms; a number of SP are thriving within the matrix. The SS compares unfavourably with those forming the outside row of the neighbouring species trial, experiment 36, which likewise grew very slowly initially, but probably benefited form nursing by neighbouring Tsuga before responding to PK top dressings.

All that remains of the NS are a few pre-thicket sorry looking survivors backed by a row of reasonable and healthy SP on the western perimeter.

The 1948 assessment of the SS showed an overall low survival (33%) in the controls by comparison with slagged sections (81%) and mean heights of 0.8 and 1.3 m respectively. Interestingly, the mean height of the section treated with both slag and DF litter was far superior at 2 m, and the survival in the litter alone treatment (66%) greatly exceeded the overall mean of its control counterpart. The notches tended to dry out and open which had a particularly adverse effect on seedlings.

An interesting museum piece, but no longer of any relevance.

Reference

Bulletin 22 pages 22, 42, 46 and 81.

5.1.5 Experiment 17 P26

Another intensive experiment which in conjunction with experiment 18 (3.1) introduced Rowan and Birch to the Lon Mor whilst continuing to investigate how to establish NS transplants on low predominately nutrient status peatland (essentially Upland Sphagnum bog, 10b; some flushed blanket bog, 9e).

The experiment is contiguous with experiment 12, the site drained and turfed at the same time as the latter; consequently the turves were one year old when planted. The NS component is an eastward extension of the P25 NS, the Rowan and Birch adjoining the SS.

As before two methods of planting were employed: the Belgian spade and side notching. The four treatments included a proprietary potassium fertiliser, in the event with unforseen and initially disastrous consequences. These treatments were:

1. Control - neither fertiliser nor soil either below the turf or mixed with the plug.
2. 2 oz basic slag and 12 oz coarse sand per plant
3. 1 oz Kainit (14% K_2O) and 12 oz coarse sand per plant.
4. A handful of coarse sand per plant.

The fertiliser/sand admixture was either mixed with the plug material or, in side notching, spread around the plant. A lesson appears to have been learnt from the previous year, the notches now on the north side of the turves.

An overall total of eight treatments, repeated thirty and twenty times for NS and Rowan/Birch respectively; one plant treatment plots in the then customary sequential order as in experiments 10, 12 and 13 (5.1.2, 5.1.3, 5.1.4).

NS transplants (3+2) ex Auchterawe nursery. The Rowan and Birch were mainly seedlings collected from neighbouring Inchnacardoch and Port Clair forests.

The experiment was planted on the 1st of April; by the 13th of that month almost all the NS in the Kaimit treatment had turned brown.

Subsequent Treatments

1927 Beating up NS of the Kainit treatment - only two survivors, both side notched; NS 22/14 (2+2). The Rowan and Birch too experienced a high mortality with this treatment, all the Birch dying.

February 1939 Rowan in four SW sections pruned to 5 cm.

Current State of the Experiment and Conclusions

A failure. It is now difficult to separate the NS of experiments 12 and 17. Some unhealthy severely checked pre-thicket NS. A few Birch in the Birch/Rowan section seem likely to be later incomers. The early assessments again demonstrated the efficacy of basal slag and side notching.

Although the Kainit treatment was a disaster initially the fertiliser appeared to impart a beneficial effect to the follow-on beat-ups as reflected in their first year increments.

Reference

Bulletin 22 page 81.

5.1.6 Experiment 37 P27

The remnants of this experiment, three separate rectangular blocks, lie between the species experiment 36 P27 (3.3) and the impressive block of SS to the east, experiment 10 (5.1.2).

Originally a two block experiment was envisaged, but this was immediately altered with the addition of a third block; things never change. The relative positioning of the three separate blocks can be likened to a square bracket.

The experiment introduced the novel concept of a double turf, one on top of another, a treatment repeated the following year in experiment 53 P28 (5.2.3).

In two of the blocks, A and C, ground preparation was the intensive system as in the early experiments, for example 10 (5.1.2) and 12 (5.1.3), two rows of turves laid corner to corner between parallel

drains 1.2 m apart. A repeating series of six treatments was common to all blocks with three repetitions; each plot fifty plants.

Yet again SS and NS, seedlings and transplants, were tested. In this experiment all four plant types were represented in each block.

SS: transplants 22/20, 2+2; seedlings 25/5, 2+0

NS: transplants 22/14. 2+2; seedlings 24/12, 3+0

Block A Treatments

1. Control, side notched seedling.
2. Control, side notched transplant.
3. Double turf, that below holed with Belgian spade, upper turf side notched with seedling roots hanging down into the hole.
4. Double turf as above, but transplant instead of a seedling.
5. Double turf as in 3 and 4, but plug removed from upper turf by Belgian spade; seedling planted.
6. As in 5 with a transplant instead of a seedling.

Shallow turves throughout.

Block B

Here turf drains were spaced at 1.5 m, the turves approximately 45cm^2 on the ground surface and 30 m deep.

Before lifting every 3rd, 4th, 5th and 6th turf was holed to about 15 cm with a circular Belgian spade; on removal the turves were inverted as usual and spaced out as in the intensive shallow turf system. the treatments mirrored those in block A with the exception of the controls which were planted with the Belgian spade.

Block C

Shallow turves. Treatments as per block B, cut as in block A treatments 1 to 4 were side notched. Once again odd numbers planted with seedlings, even numbers with transplants.

A somewhat complex experiment, laid down on deep peat. The vegetation community varies between that of a flushed blanket bog (9e) and an Upland Sphagnum bog (10b); the original description suggests that the former predominates.

Current State of the Experiment and Conclusions

A failure. Most survivors occur in a small compact thicket, almost exclusively SS, in part of the southern block; the trees are checked and show a variety of deficiency symptoms. Elsewhere severely checked survivors are very few and far between, especially in the central block.

No map exists indicating which block is which and their internal layout, although now an irrelevance, is unknown.

There is no recorded fertiliser input, either basal or top dressing. If so the end result was predictable with the benefit of hindsight.

5.1.7 Experiment 38 P27

Dr Anderson needed no convincing that, in terms of subsequent growth and survival, a turfing system was far superior to any method of direct planting on low nutrient status peatland and associated organo-mineral soils such as those occurring on the Lon Mor and over much of the northern and western Highlands. It was hoped that this experiment would demonstrate the point and enlighten any sceptics; with this in mind it was strategically sited adjoining a turfing trial, experiment 39 P27 (5.1.8).

The experiment straddled a ridge landform and deep peat, the former a peaty gley and ranker complex, the peatland an Upland Sphagnum bog (10b).

Typically the species featured in the demonstration were SS and NS, seedlings and transplants; 100 of each plant type.

SS: 25/5, 2+0 seedlings and 22/20, 2+2 transplants.

NS: 24/12, 3+0 seedlings and 22/14, 2+2 transplants.

Two rows of each plant type were planted, firstly with a mattock, the other by V nothing starting next to experiment 39 and working eastwards.

There is no record of any fertiliser input.

Current State of the Experiment and Conclusions

The outcome was as intended, a failure.

Inevitably losses were very high. In 1934 they ranged between 32 and 93%, treatments not specified. The last known appraisal in 1938 noted a heavy death toll, the survivors in check.

In the early 1950s Zehetmayr in Bulletin 22 recorded that one live tree remained.

Reference

Bulletin 22 page 18

5.1.8 Experiment 39 P27

Encouraging initial results form a basal application of a combined slag, Epsom salts and soil cocktail in experiments 12 and 17 P25 and P26 respectively (5.1.2 and 5.1.5) were thought worthy of a more extensive follow-up trial. this unreplicated experiment was designed on that basis.

The rectangular block selected was subdivided into two equal half acre sections, a composite nineteen of the overall thirty eight rows receiving basal fertiliser, the remainder a control.

The ground preparation was a grouped shallow turf system as in the previous year's experiment 19 (3.2), the control side notched whereas planting was by the Belgian spade in the fertilised component, an amalgam of the 2 oz slag, 1/2 oz Epsom salts and 12 oz soil placed in the hole in addition to the broken down plug.

SS transplants, 2+2, 22/20 ex Auchterawe nursery.

The experiment straddles a rock cored ridge landform and deep peat, the principal soil types peaty gley and Upland Sphagnum bog (10b). The original vegetation description includes Molinia which implies the presence of a narrow flushed zone at the ridge interface and, as seems likely, flushed channels within the basin bog matrix.

Subsequent Treatments

The experiment became more complex with three top dressing treatments applied somewhat haphazardly to various rows in both the control and fertilised sections.

December 1929 High grade basic slag at half a ton/acre applied to six rows in each of the original sections.

April 1930 Sulphate of potash, applied to six rows, three in each section, treated with basic slag the previous December; rate again half a ton/acre.

1939 Ground mineral phosphate, 3 oz per plant applied within 15 cm of the stem, top dressing to twelve rows in the area given basal fertiliser, and to six rows of the original control. All the 1929/30 PK plots were included.

Current State of the Experiment and Conclusions

A central strip of at least ten rows has failed, providing good longitudinal access. The western sector is a more variable site type, predominantly deep peat with the ridge landform extending into the central area whereas the ridge landform is the major feature of the eastern sector. Overall the best height growth occurs on the organo-mineral soils of the ridge, especially in the east, rather than on deep peat. Growth tends to be variable throughout; more so in the west, a mixture of thicket and pole stage crop. In contrast the eastern strip is pre-eminently pole stage. Evidence of nutrient deficiency is common to a varying degree, but tends to be more clearly expressed on deep peat recent annual increments are small.

A comparison of this experiment and 74 P29 (5.1.12) demonstrates that PK alone is insufficient to promote economically viable growth of pure SS on this diverse site type; an input of nitrogen is essential. Variation in crop performance is accentuated by the contrasting site type. The experiment design is flawed, nutrient poaching the inevitable consequence of differential fertilization of single line plots. An experiment which seems to have outlived

any useful function.

Reference

Bulletin 22 pages 68, 73 and 74

5.1.9 Experiment 43 P28

A fertiliser trial, various proprietary fertilisers compared with basic slag.

Seven treatments replicated seven times; ten plant plots. Layout a latin square.

Treatments

1. 2 oz basic slag + 12 oz soil.
2. 1/2 oz Epsom salts + 12 oz soil.
3. 2 oz basic slag + 1/2 oz Epsom salts + 12 oz soil
4. 1 oz Epsom salts + 12 oz soil
5. 3 oz Semsol + 12 oz soil.
6. 12 oz soil applied to the root zone prior to planting; 1 oz Ammonium sulphate top dressing.
7. Control, neither soil nor fertiliser.

Side notched into shallow turves; SS (2+1) 25/5 from Beaufort estate nursery. Planted on the 24th March, the plants dressed with Silvan for protection; no information on the product is given in the file. The site appears to be a relatively uniform area of Upland Sphagnum bog (10b) although the original vegetation description includes occasional Molinia; close to the main burn.

Current State of the Experiment and Conclusions

A checked thicket stage block of very variable height showing a variety of deficiency symptoms; all in all a very sorry spectacle. With the benefit of hindsight the current state of the experiment is hardly surprising due to no subsequent fertiliser treatments, site type, inadequate drainage and isolation from any nursing benefit.

Right from the outset Semsol established itself as the most

effective basal fertiliser and maintained this advantage with a mean height of 1.1 m in 1946, significantly higher than any alternative treatment; although the trees were somewhat small a 97% survival was very satisfactory. The mean heights of the Ephos and various basic slag treatments were similar, ranging from 0.65 (slag + Epsom salts) to 0.7 m (slag alone) with very respectable survivals of 94% (Ephos) and 97% for the other two treatments. These results are in marked contrast with Ammonium sulphate (0.15 m, 7%) and the control (0.25 m, 13%). All survival figures relate to 1945.

The experiment appears to be of no further value, but the performance of SS in this instance is of interest compared with that in other early experiments, notably experiment 10 (5.1.2) which likewise seems to have been denied any top dressing treatments.

Reference

Bulletin 22 pages 68, 79 and 81

5.1.10 Experiment 48 P28

A fully randomised SS experiment, four treatments and four replications. Drains 4.1 m apart, Belgian turves at 1.4 m spacing, each plot eighty one turves (9 x 9).

Seedings and transplants of different ages.

2+0 26/50 QCI ex Craibstone nursery

3+0 25/5 QCI ex Golf Course nursery

2+1 25/5 QCI ex Auchterawe nursery

2+1 origin not known, ex Ratagan and Golf Course nursery.

Planted with the Belgian spade, a basal input of 2 oz basic slag and 12 oz good soil thoroughly mixed with the peat plug. Following planting in late February/early March the original 2+0 seedlings (26/25) were severely frosted and replaced by those above.

The experiment extends across the full width of a deep peat flat lying between a ridge landform and the principal burn. The original vegetation description confirms that the vast majority of the area is a uniform weakly flushed blanket bog (9e), a higher nutrient

status bog (9b) impinging to a varying degree in the four plots adjacent to the burn. An increasing amount of Calluna was noted in the two plots adjacent to the ridge in the north west corner, again a local pocket of 9b. it seems.

Subsequent Treatments

1930 Beating up all treatments.

1939 3 oz of GMP spread within six inches of individual stems; the four plots on the western edge acting as an untreated control.

Current State of the Experiment and Conclusions

An irregular, essentially checked crop of very varied height trees tending to occur in groups of similar size. A fringe of brashed pole stage trees occurs at the ridge interface and growth tends to be better adjacent to the burn, otherwise a thicket.

The unsatisfactory nutrient status is aggravated by inadequate drainage.

Tally posts seem to be conspicuous by their absence.

Despite the unsatisfactory performance of this sixty four year old crop survival remains remarkably good, erlier (1946) in excess of 90% in all treatments including those only receiving basal P. At 18 years, 1946, transplants were out performing seedlings, albeit none of the mean heights can be considered spectacular ranging from 1.7 - 0.7 m (transplants - top dressed and control) to 1.1 - 0.5 m (2 year seedlings - top dressed and control).

The efficacy of a basal and top dressing of P is clearly demonstrated, but the experiment goes no further, the crop left in limbo despite the later unravelling of the requisite fertiliser regime for pure SS on weakly flushed blanket bog.

The experiment appears to have little to recommend retention.

Reference

Bulletin 22 page 46.

5.1.11 Experiment 49 P28

A further randomised SS experiment, five replications of three turfing treatments. Sizeable plots, number of plants per plot not known.

A drain spacing of 4.1 m is the same for both Belgian and shallow turf systems whereas the drains of the mock ploughing group shallow turf ground preparation are spaced at 1.2 m

The experiment site is not wholly uniform although essentially a deep peat flat with a variable but limited amount of peaty gley extending from the adjoining ridge landform into the plots on the southern perimeter; the peat also thins in the north eastern corner.

The soil map categorises the peat as weakly flushed blanket bog (9e), merging into a localised pocket of higher nutrient status bog (9b) in the north west corner. the original vegetation description agrees with a 9e designation to the majority of the area, but suggests that 9d is a truer classification for the north west corner.

Planted with either a Belgian spade or by side notching, a basal mix of slag and soil, 2 and 12 oz respectively, worked in with the peat plug of individual trees.

SS 25/5 QCI 2+1 ex Beaufort nursery.

Subsequent Treatments

April 1930 Beating up in all treatments.

FY39 Top dressing of 3 oz GMP spread within 15 cm of the stem leaving the three plots on the western edge as a control.

1963 Thinning within the better growth area in the north western corner. Pathology Fomes inoculation experiment.

Tree pulling and root excavation - probably 1971

Current State of the Experiment and Conclusions

By and large a depressing sight, most of the crop checked, the nutritional stress aggravated by inadequate drainage. Although

growth is satisfactory on the northern and eastern perimeters the majority of the crop is nutrient deficient, either pole stage or thicket.

A stable crop with generally excellent survival. Tally posts and plot boundaries are conspicuous by their absence.

A good, accessible demonstration of the group shallow turf system, often referred to as mock ploughing, can be seen in the south eastern section.

At twenty five years the best height growth occurred in the group shallow turf treatment (mean heights 3.6 and 1.6 m, the latter without top dressing), the least impressive with the Belgian turf (2 m and 1.7 m, the latter without top dressing).

Once again the combination of two phosphate inputs was seen to be beneficial, but totally inadequate to stimulate acceptable growth without the addition of potassium and possibly nitrogen too on this peatland.

There appears to be no valid reason to commend the retention of this stand; if practicable a clear fell seems the ideal solution here.

Reference

Bulletin 22 page 21, 24 and 25

5.1.12 Experiment 74 P29

A continuation of research into the establishment of QSS on nutritionally limiting weakly flushed blanket bog (9e). This particular experiment was concerned with the maintenance of a satisfactory rate of growth, aiming to ascertain the most propitious time to apply a top dressing of P (basic slag) and the appropriate interval before a further application.

A somewhat complicated experiment with either one or two top dressings and an untreated control. The timing of the top dressing was based on the results of the earlier P25 experiments, 10 (5.1.2) and 12 (5.1.3), specifically the time interval when the effect of P, either basal or subsequent, was seen to wear off; this initially

unsubstantiated factor, X, was ultimately quantified as four years. In the event top dressings were applied as required throughout the thirties, the final treatment in 1943.

The layout comprised three sections, each effectively an experiment in its own right. A treatment unit consisted of three rows of ten plants, the shallow turves cut and laid corner to corner in the autumn of 1928, with twenty seven units per section and overall total of eighty one for the experiment. Each unit was approximately 3.7 x 3.8 m and separated from other units by a 0.8 m buffer of uncut peat.

A basal dressing, 2 oz high grade basic slag (18% P_2O_5) and two handfuls of soil, was placed beneath individual turves prior to planting with the side notch; close spacing, rows 1.2 m apart, trees spaced at 0.8 m within the rows. QSS 25/5, 2+2, ex Auchterawe nursery, height 20-25 cm. When top dressed 60 oz basic slag was spread evenly over the plot.

The vegetation community prior to afforestation was relatively uniform and compatible with a weakly flushed blanket bog (9e).

At the instigation of the Chairman a small trial was laid down in 1942, experiment 127, on ground adjoining the south western corner of 74. Turves were placed on brash removed from 74, every second row having been cut out in 1940, with a control; a total of seventy five turves, forty five and thirty in the brushwood and control respectively.

The mean height assessment at twenty years indicated that plots treated with a single top dressing, either one or two years post planting, had produced the best height response, 3.05 and 2.4 m respectively, compared with 2.1 m achieved by the control. There appeared to be no advantage with two top dressings in quick succession, the mean height again 3.05 m; the delayed input treatments were the least successful.

Subsequent Treatments

1957 An N, K and Mg factorial experiment was superimposed in conjunction with the Macaulay Institute, Aberdeen, the original 74 redesignated 148/57.

Fertilisers applied: Sulphate of ammonia (21%N) Muriate of potash (45%K) and Magnesium sulphate (10%Mg).

1962 An equalising amount of K was applied to those plots which had not received an input of this element; additionally N and K were broadcast uniformly throughout the experiment to maintain and boost nutrient levels.

Fertilisers applied: Muriate of potash (60%K) and Nitro-chalk (21%N).

The nitrogen input was increased to 170 kg of the element per ha as the 1957 treatment at 132 kg/ha did not raise N foliar concentrations to an optimal level.

Following these levelling and booster fertiliser treatments the experiment was treated as a single plot.

1968 Thinned.

Broadcast top dressing of urea to supply 170 kg elemental N/ha.

1971 Top dressing with Double Season PK; rate 575 kg/ha to supply 50 and 95 kg/ha, P and K respectively.

1980 Top dressing with PK compound at 575 kg/ha, supplying 50 and 95 kg/ha elemental P and K per ha.

Approximate total N, P and K elemental input to date (kg/ha)

N 470

P 548

K 462

The overall total constitutes a considerable amount of P, well in excess of what would be applied now in the standard regime for pure SS on this flushed peatland.

Current State of the Experiment and Conclusions

An impressive and stable sixty three year old stand currently growing at approximately GYC 12; a top height of 25.4 m was recorded

in 1991 with a standing basal area around 58.3 m^2/ha.

The experiment offers a stark contrast when compared with predominately checked SS crops of the same vintage, for example 48 (5.1.10) and 49 (5.1.11), which clearly demonstrates the crucial role of K and N inputs to pure SS in conjunction with P to achieve an economically viable crop on this site type.

Obviously a stand of this age and height is of considerable interest, particularly as regards stability. Hence a deserving candidate for retention.

Reference

Bulletin 22 page 73

5.1.13 Experiment 76 P29

The beneficial role of basal phosphate in initiating satisfactory early growth on low nutrient status peatland was fully appreciated by 1929 and this experiment set out to monitor the effect various times of application had on early growth.

The area was drained and turfed in October 1928, the turves laid corner to corner, and planted in 1930.

The experiment attempted both to test the hypothesis that an advance application of P in the nursery transplant lines would benefit subsequent performance in the field and investigate to the possibility that an advance application of slag in the field a year ahead of planting might likewise manifest itself in an enhanced growth response.

The nursery treatment consisted of an area of four year old SS (3+1) in Auchterawe nursery top dressed with basic slag at 10 cwt/acre.

On the Lon Mor the four treatments were as follows:

A. Control, No nursery treatment; 2 oz slag + 12 oz soil spread under the turf at planting.

B. 2 oz slag + 12 oz soil spread beneath turves one year in advance of planting.

C. Basic slag in the nursery only.

D. Nursery treatment and 2 oz slag + 12 oz soil spread beneath turves at the time of planting.

Thirty plant plots, planted in 1930 (QSS 25/5 3+2 ex Craibstone and Golf Course Auchterawe), each plot three rows of ten plants a 0.5 m buffer segregating individual plots. A fully randomised experiment with five replications. The site appears to be a relatively uniform weakly flushed blanket bog (9e); typically the experiment map shows peat depths at various plot intersections.

Current State of the Experiment and Conclusions

A small mixed thicket/pole stage stand of very variable height, the latter generally improving towards the adjoining experiment 74 (5.1.12), no doubt due to nutrient poaching. Open areas as a result of treatment failures. A checked crop with small current annual increments and ample evidence of nutrient deficiencies which may be aggravated by inadequate drainage. A useful demonstration when viewed in conjunction with the surrounding experiments 74, 77 and 83 (5.1.12, 4.2 and 5.1.14).

Mean heights at sixteen years (1945) were very similar for the three treatments where slag was applied in the field, 1.6 to 1.7 m, survival ranging between 88 and 93%. However, where the slag input was confined to the nursery the mean height was a meagre 0.3 m and survival was likewise poor, 36%. Hence there was no carry over effect from the nursery treatment and no additional benefit materialised from either a combined nursery/basal application or fertiliser placement a year ahead of planting.

By itself of no particular value, but can be considered a useful demonstration when viewed in conjunction with its neighbours.

Reference

Bulletin 22 page 73

5.1.14 Experiment 83 P30

Another early experiment designed to investigate the effect of various fertilisers on the growth of pure SS.

As in experiments 74 (5.1.12) and 76 (5.1.13) the plots are thirty plants in a three row by ten plant arrangement, planted on shallow turves placed corner to corner. Five replications of four treatments laid out in a chessboard pattern.

Turfed in October 1928 fertiliser treatments applied immediately before planting by side notching in March 1929.

The following four treatments were:

A. Control, no fertiliser.

B. 2 oz basic slag plus 1 oz Epsom salts below the turf.

C. 1 oz Ammonium sulphate below the turf.

D. 2 oz basic slag + 1 oz Epsom salts + 1 oz Ammonium sulphate below the turf.

Typically, care was taken both in the experiment design and in the site preparation to minimise interaction between treatments.

Current State of the Experiment and Conclusions

Open with patchy stocking due to treatment failures. An informative look see experiment when compared with its neighbours. A small pole stage stand of variable height, the latter not comparable with the adjoining 77 (4.2) and 74 (5.1.12). Typically, nutrient deficiencies are evident in a crop which has had a totally inadequate fertiliser input judged by current standards, the deficiencies probably exaggerated by poor site drainage.

The final assessment in 1946 after sixteen years was relatively straight forward as two treatments, the control and Ammonium sulphate on its own, had failed although a height was recorded against each of them two years previously in the 1944 assessment. There was comparatively little difference in mean height between the two surviving treatments: 2.5 and 2.8 m, basic slag/Epson salts and the trio of basic slag/Epsom salts/Ammonium sulphate respectively.

5.1.15 Experiment 85 P29

A small trial to see whether broken down peat - from an old peat stack in the P23 area of Inchnacardoch - spread below turves would have any effect on subsequent growth.

Twenty one turves were laid out on top of a peat dressing on an Upland Sphagnum bog (10b), two untreated rows acting as a control. The species planted was again QSS 25/5, 3+1 apparently without either basal P or a top dressing of that element.

An assessment, probably 1939, recorded a mean height of 16.5 cm on treated turves and 12.2 cm in the control.

Current State of the Experiment and Conclusions

Failed, a hardly surprising result when no fertiliser had been applied.

However, a slight transient beneficial effect from the added peat layer was noted - all in the eye of the beholder.

5.1.16 Experiment 87 P30

A small, close planted experiment to test the efficacy of various proprietary brands of fertiliser.

Five replications of six treatments, each plot two rows of ten plants, a total of thirty plots laid out in a chessboard pattern.

Turves 15 cm deep laid corner to corner; SS of unrecorded identity, 2+1 and 3+1, planted by side notching on a relatively uniform weakly flushed blanket bog (9e).

Treatments, all fertilisers applied beneath the turf, quantities given per individual plants:

A. Control, no fertiliser.

B. 2 oz high grade (14.65% P_2O_5) basic slag without soil added.

C. 2 oz Ephos, a phosphate fertiliser, P_2O_5 % unknown.

D. 2 oz Mineral Phosphate (26.56% P_2O_5).

E. Basic slag plus Nitro-chalk (15%N, 48% Ca), 1 oz of each.

F. 2 oz Potassic mineral phosphate (19.32% P_2O_5, 10% K_2O).

As in similar fertiliser experiments the drains between treatments were designed to minimise any interaction between treatments.

Current State of the Experiment and Conclusions

A very close planted severely checked thicket with variable height and survival. A range of nutrient deficiencies commonplace. The experiment is of interest as it clearly demonstrates the small scale intensive layout frequently employed in the early years.

After sixteen years, 1946, the last known assessment showed that overall the three phosphate only treatments had been the most successful, albeit the mean height of the basic slag treatment (1.1 m) was considerably less than that of both proprietary brands Ephos and Mineral Phosphate, 1.45 and 1.4 m respectively; survival was superior to all other treatments, ranging from 94% (basic slag) to 86% (Mineral Phosphate).

By comparison basic slag plus Nitro-chalk was not a success with a mean height of 1 m for the treatment, and by far the least impressive survival, a mere 26%, attributed to toxicity engendered by soluble Nitro-chalk in immediate contact with the plant roots.

Potassic mineral phosphate produced the best height response at 1.5 m, but survival was unacceptably mediocre at 64%.

The control achieved a mean height of 0.3 m with 50% survival.

The experiment may be described as a museum exhibit, an excellent demonstration of the intensive experimental design frequently used in the initial pioneering days on the Lon Mor.

Reference

Bulletin 22 pages 63 and 77

5.1.17 Experiment 98 P32

This experiment originated because of some concern about post side notching shrinkage on peat frequently leading to the opening of the wedge and subsequent demise of the tree in many instances.

The three treatments offered different approaches to the method of planting on shallow peat turves:

1. Control - the standard side notching technique.

2. T - notch with a peeling spade, plant roots spread out below the turf; the initial intention was to use a Schlich spade.

3. Dribble hole - here ingeniously made with the pick end of a mattock, the plant drawn through the hole from below.

In all instances 2 oz basic slag was placed below turves. The plants used were two year old seedlings, 30/29 ex Inverleith.

A fully randomised experiment with six replications of the three treatments.

Plots subdivided into three sections, each two rows of ten plants, separated by shallow drains; sixty plant plots, turves 0.6 m apart.

The experiment appears to straddle flushed blanket bog of variable nutrient status. Although the soil map categorises the site as a high nutrient status 9b the extremely vague description in the file suggests the presence of Trichophorum. In reality the site seems to have been a peatland complex (9d/9b), the nutrient status gradually improving towards the burn.

Current State of the Experiment and Conclusions

A thinned pole stage stand of SS which appears to be growing reasonably well; height declining towards the open area on the eastern perimeter. Plots no longer immediately identifiable, the tally posts having disappeared.

The 1946 assessment of the fourteen year old crop revealed that in this particular planting side notched trees had fared considerably better than both other treatments, attaining a mean height of 1.6 m with 69% survival by comparison with the T notch (1.4 m, 51%) and dibble (1.3 m, 54%).

The 1946 report on the experiment suggests that it was planted to leeward of Lovat SS flanking the burn. The combination of shelter and probably higher nutrient status peat accounted for the overall generally better growth in the western sector, merging into an

irregular, mainly checked crop with yellowish needle colour predominating outward from the burn side.

Thereafter the trail goes cold. Subsequent treatment of the crop seems likely, but there is no record to substantiate a fertiliser input.

Reference

Bulletin 22 page 22

5.1.18 **Experiment 125 P39**

One of two afforestation experiments, the other Inchnacardoch 124 P39, designed to evaluate the application of inorganic fertilisers during the establishment phase on deep peat; based on the conclusions of Dr A B Stewart of the Macaulay Institute for Soil Research and laid down with his co-operation.

The experiment features two species planted as separate components:

SS 36/37. Bella Coola, BC 2+1

JL 36/18, Nagano, Japan 2+1

Turf planted, 1.06 m between the centres: the records are not clear, but it seems likely that the vertical thin slice turfing technique would be employed. Seven by seven plant plots with three replications of the following nine treatments:

1. 1/4P: 1/2 oz GMP (12.6%P)
2. P: 2 oz GMP
3. $2^{1/2}$P: 5 oz GMP
4. P2/5 K: 2 oz GMP + 2 oz Granite flour (3.15% K)
5. PK: 2 oz GMP + 5 oz Granite flour
6. P3K: 2 oz GMP + 16 oz Granite flour
7. 2/5NPK: 2 oz GMP + 5 oz Granite flour + 3/16 oz Keronikon (12.5% N)
8. NPK: 2 oz GMP + 5 oz Granite flour + 1/2 Keronikon
9. 3NPK: 2 oz GMP + 5 oz Granite flour + 11/2 oz Keronikon

The method of application is not recorded.

Unfortunately no absolute control was included.

The form 1 description of the experiment categorises the site as deep peat over rock. In reality, as was pointed out by Angus MacDonald (memo January 1959), there are pockets of peat up to 75 cm, but over most of the area the depth is less than 30 cm. The vast majority of the experiment is classed as a flushed blanket bog (9e), but a more intensive survey in conjunction with this review confirmed the complexity of the site which is reflected in the performance of the SS. The easterly portion occupied by the SS is on a flat, mainly deep peat phase peaty gley, the slope increasing in the western sector the latter again essentially a peaty gley possibly superseded by podzolic ironpan soil in the north western corner. The JL component straddles a knowe flanked by deep peat on three sides.

Subsequent Treatments

Prior to 1958 records of work within the experiment are very sparse.

1958 October/November. Brashing, thinning and drains maintenance. November 2 oz GMP per plant applied to 1/4P treatment within the JL section.

1960 A repeat of the basal fertiliser application, but on this occasion the 1/4P treatments were an untreated control and Muriate of potash (KCL, 60% K_2O) and Nitro-chalk (15.5%N) substituted for Granite flour and Keronikon respectively; GMP remained the source of P. All fertilisers were applied in the same ratios as before to both SS and JL.

1963 Equalizing NPK top dressing applied to SS component only.

1968 Thinning, probably rather light.

1972 Broadcast application of urea at 375 kg.ha (150 kg elemental N) confined to the SS.

Current State of the Experiment and Conclusions

A self thinning crop of SS with the typical extremes in breast height diameter. Overall the least satisfactory growth occurs on the easterly flat; some evidence here of nutrient poaching adjacent

to the ALP of experiment 112 (4.1.2), heights generally deteriorating towards the northern perimeter. The most impressive height growth is in the western sector, especially adjacent to the JL; one sizeable surface root heading off into the larch.

The JL tends to have an easterly lean with occasional windblow in the western portion. Trees are generally tall, but growth is poor on the immediate western edge.

In 1957, after nineteen growing seasons, it was concluded that initial frost damage, the design and insufficient replication had a detrimental effect on the results; consequently, when subjected to statistical analysis significant differences between treatments were not always evident. The best height response was with P, a correlation between mean height and rate (mean heights 1.06 to 1.90 m) clearly evident. There was an obvious benefit from both K and N, each of these treatments having an overall mean height of 1.4 m. The final report suggested that the pole stage crop could be used for further experimentation which it duly was in 1960.

Severe frost affected both JL and SS in the early years.

The nursing effect of JL on adjacent SS was noted in 1954, J W Zehetmayr commenting that this was the first recorded instance of such naturally effected remedial treatment on deep peat; it had been observed previously on heathland site types. In reality, however, the zone of contact here appears to be largely an organo-mineral soil.

Although there is some potential for further use of the SS component, as suggested in the 1958 final report, care would seem to be necessary in order to select a relatively uniform portion. Inevitably this would be a relatively small segment of the whole area and may call into question the validity of such a selection. Site diversity alone within the JL would appear to rule out any further experimentation here.

Reference

Bulletin 22 pages 79 and 80

5.2 LP Experiments 1925 - 1939

None of the three experiments described in this section were intended to be pure LP stands. Two materialised as such more by accident than design whereas the third, experiment 52 P28 (5.2.2), and by far the most important of the three, still retains significant numbers of other species, SS and WH, introduced at planting and in the early establishment phase.

5.2.1 Experiment 47 P28

A small nursing and fertiliser trial on a weakly flushed blanket bog (9e). originally LP and SS planted at opposite ends of the same turf, the pine on the windward edge. Side notched with no basal fertiliser

LP 25/59 Mount Ida

QSS 25/5 QCI

Subsequent Treatments

FY39 Top dressing of 3 oz GMP to both LP and SS, the western quarter excluded.

FY46 A heavy crown thinning of LP in an attempt to release groups of SS; in the event unsuccessful.

1959 Unreplicated fertiliser trial applied to a now essentially pure LP stand: P, K, PK and a control (GMP and Muriate of potash).

1971 Tree pulling, leaving a substantial fringe at the south western end- predominately the FY39 control - and edge trees on the southern and eastern perimeter.

Current State of the Experiment and Conclusions

Now superseded by the SS restocking experiment Inchnacardoch 177 P74 - see 5.5.2. A fringe of stable LP, some with sizeable breast height diameter, are all that remains of the experiment; these were part of the FY39 control.

The delayed P input in FY 39 resulted in a pronounced height response from the LP; the SS needle colour improved, but only a

limited height response was recorded. The LP continued to grow reasonably well for ten to fifteen years when foliar analysis prior to the 1959 fertiliser trial indicated optimal P levels, but those of K were deficient. The fertiliser trial subsequently demonstrated that higher levels of K were achieved with a combined PK input rather than K on its own.

Continuing research on such weakly flushed blanket bogs has convincingly confirmed the PK synergistic effect, a top dressing of P on its own invariably depressing K levels. The stand attained GYC 8.

5.2.2 Experiment 52 P28

A drainage and species trial on a pre-eminently unflushed Sphagnum bog (10b), the depth of peat ranging between 0.3 and 4.0 m, mostly in excess of 1.2 m. Typically the original vegetation description was very thorough; unfortunately the accompanying map has been mislaid from the file. However, much of the ground surface seems to have been hummocky with incipient hagging/pool development and a Trichophorum/Calluna community; Molinia was present in two of the matrices recognized but only as a minor constituent.

The two acre block (0.8 ha) was subdivided into eight sections, each half an acre (0.2 ha). Drains were laid down at two distance specifications, four sections allocated to each treatment, the intensive (3.7 m apart) and moderate (5.5 m) with tree spacings of 1.2 x 1.4 m and 1.8 x 1.4 m respectively. Drains were regularly deepened in the intensive system but merely maintained without deepening at the moderate intensity. There appears to have been an initial growth response by LP on the former, a mean height at ten years of 1.2 m in the intensive network compared with 0.9 m attained with a moderate intensity.

The original planting design was inland LP 25/59, Mount Ida (ILP) in the central 0.4 ha core with two plots, each 0.2 ha of QSS 25/5 at either end of the rectangular block. Planting was on Belgian turves with the Belgian spade, 2 oz slag and 12 oz soil mixed with

the returned plug.

Extensions

FY38 small scale interplanting trials: SS 35/39, Olympic Peninsula, introduced into the LP and LP 35/21, BC, planted within the SS section. Ground prepared by shallow turfing, 2 oz GMP spread on the underlying vegetation.

FY40 Extensive interplanting treatments carried out over approximately 75% of the area with QSS, 36/23 and Tsuga 36/29, QCI, a plot of each species, planted within the LP core central block. LP, 37/39 Prince George (CLP) introduced to both end sections of SS which were in check.

FY41 Very heavy thinning of two outside rows of LP on the leeward side of each plot into which SS was introduced in 1940; elsewhere the canopy was not broached.

FY46 The overstorey in half of the FY40 interplanting plots, LP core section only, heavily thinned in an attempt to encourage the growth of the QSS and Tsuga.

FY51, 54 and 55 Observations on the height of the water table and an attempt to correlate this with crop performance. Assessment of vertical peat shrinkage. Drainage and turfing extension.

FY60 Factorial PK experiment superimposed on the original P29 LP. Four treatments: P, K, PK and a control (GMP at 517 kg/ha to supply 67 kg elemental P and Muriate of potash applied at 168 kg/ha giving 84 kg K/ha, the PK treatment a combination of GMP and Muriate of Potash). An additional input of K was applied to the K treatment in 1962 as the initial application was considered to be too low; Muriate of potash at 224 kg/ha supplying 112 kg elemental K.

FY68 The entire area top dressed with Fisons 48 (PK) at 564 kg/ha to provide 50 kg P and 95 kg K per ha.

Pathology section have carried out Heterobasidium inoculations in the south west corner in the not too distant past, actual date not known.

Current Sate of the Experiment and Conclusions

A sizeable portion of the core area has been devastated by windblow which was predicted in October 1982 by R Lines when he noted some wind/snow damage on drain edges; the majority of the blow seems to have occurred in the early eighties as far as can be ascertained. A limited amount of additional blow has occurred in the winter of 1992/93.

The SS are mainly suppressed, those at the eastern end have tended to be more successful, the outside edge adjoining experiment 46 (3.4) predominantly spruce, typically of unsatisfactory nutrient status. However, a number of SS have broken through in this eastern sector, especially towards the boundary with the LP core; SS have again succeeded locally in the NW corner, at the other end of the experiment.

The LP are commonly relatively light crowned with very occasional dieback and some snap.

As usual WH form an effective understorey, occasionally competing with neighbouring LP; their nutrient status appears to be satisfactory.

The drainage system is somewhat neglected and more blow seems inevitable.

The original objective was to evaluate the effects of the two drainage systems, but this was considered difficult because of differential spacing and consequently a variable input of P.

The experiment clearly demonstrates that successful crops of inland LP can attain GYC 10/LYC 12 on these impoverished low nutrient status blanket bogs.

The generally excellent stem morphology and lighter branching of the two inland origins contrasts most favourably with neighbouring south central seedlots, for example experiment 128 (5.4.1).

The benefits from superimposed PK top dressings are evident here, albeit their efficacy for satisfactory growth has been more convincingly proven in properly designed experiments.

The performance of SS in mixture with LP when compared with much of

the pure SS on the Lon Mor cogently demonstrates the argument for such mixtures on unflushed and certain weakly flushed peatlands, albeit inland origins are an unsuitable nurse.

In many respects an awkward experiment on which to reach a definitive conclusion due to the windblow. Interestingly the latter occurs by and large in the central core of LP within which the 1960 PK top dressing experiment was superimposed. The LP interplanted with WH has maintained its stability; likewise the mixture with a variable component of SS are largely windfirm. Retention on a look see basis would appear to be justified; this may well be the oldest stand of LP on such a peatland. The performance of WH as an understorey is of interest, albeit the plot is relatively small.

Reference

Bulletin 22 page 30.

5.2.3 Experiment 53 P28

Another experiment featuring the double turf method of ground preparation which had been tried elsewhere.

Most of the experiment occurs on a rock cored peaty gley/ranker landform, upland Sphagnum bog (10b) impinging, to a limited extent, on the north eastern sector. The experiment is reputed to be the first recorded FC experiment planting of LP on such a site type.

The experiment design incorporated twelve treatments, two types of turf and three species (seedlings and transplants of each), set out in rows and replicated six times; although individual plots are not always easy to decipher now the central drain aligned parallel to the long axis of the block is clearly visible.

With the double turf, as the name implies one on top of the other, a plug was extracted from the lower one, the tree planted in the upper turf with its roots hanging down into the hole below. An ordinary single turf acted as the turfing control.

The three species were:

LP seedlings 26/58 Alberta, transplants 25/59 Mount Ida

SS seedlings 26/50 QCI,. transplants 25/5 QCI

JL seedlings 26/16 Japan, origin of the transplants unknown

The planting tool was the Belgian spade. There is no record of a basal fertiliser input.

Subsequent Treatments

FY33 Phosphate top dressing: 3 oz of the proprietary brand Semsol mixed with powdered peat per tree, an untreated control retained. At some stage during the early years a cage was constructed over one row as protection against the attention of blackgame.

Current State of the Experiment and Conclusions

An open LP stand due to failures, particularly at the west end with occasional SS and JL understorey. There are only two reasonable plots of SS, both on deep peat at the eastern end, in one of these the spruce penetrates the lower crown of the pine. Here, and in the other less successful SS remnants needle colour is very satisfactory. Most of the surviving JL are well suppressed scrub with a few reasonable individuals adjacent to the restocking experiment 168 (5.5.1).

Typically the stem morphology of the inland LP is very satisfactory; trees occasionally lean eastward with the odd blown individual.

LP in all treatments performed more satisfactorily than JL which in turn was superior to SS, the latter a total failure in the control. The height and survival of transplants was significantly better than seedlings; however, a comparison between LP seedlings of Alberta origin with transplants of Mount Ida stock may not be particularly valid. The benefit from the top dressing was very evident.

At eighteen years (FY46) fertilised LP had attained 3.9 and 3.2 m on single and double turves respectively; the corresponding survival percentages of 90 and 60 contrasting with 70% (single turf and 40% (double turf) in unfertilised control. SS transplants grew exceeding slowly only attaining 61 cm (double turf) and a mere 48 cm on the single turf.

To establish a convincing case for the retention of this understocked stand would seemingly be difficult. The only two aspects of pertinent interest appear to be the long term stability of inland LP on a peaty gley/ranker landform and the historical factor.

Reference

Bulletin 22 pages 40, 42 and 46

5.3 Miscellaneous Experiments

EXPERIMENT 44 P28.

5.3.1 This experiment was certainly something out of the ordinary. A square chain of deep peat, 22 x 22 yds (1/10 acre/0.04 ha), was completely isolated, the peripheral drains dug down to the underlying mineral drift. The upper layer of peat was cut over to a depth of approximately 0.2 m and removed with an Oxford Roadless Barrow to be dumped 20 to 30 yards from the site. A basal dressing of basic slag (30% phosphoric acid) applied at 5 cwts/acre was raked into the surface.

The original vegetation description and map suggests that the eastern sector, approximately 60% of the overall area, was a weakly flushed blanket bog (9e), the intensity of flushing increasing over the remainder of the plot where the community seems to equate with a 9d. The depth of peat varied between 1 and 2 m, but shallows locally to a few cm very locally on the western perimeter where rock comes close to the surface.

Subsequent Treatments

1929 The ground was forked over; thereafter the south eastern side was ridged and lazybeds prepared for a potato crop, the remainder cultivated and sown with sandy oats. Five varieties of potato were planted: Epicure, Golden Wonder, Ben Lomond, Great Scot and Kerr's Pink. In July a top dressing of Sulphate of potash was applied to part of each crop at differential rates, 71 kg/ha and 36 kg/ha to potatoes and oats respectively. The meagre 67 kg of usable potatoes

harvested, equivalent to 3.6 tonnes/ha, was a very low yield by normal agricultural standards. The potato crop was reasonable with potash, without it rather poor.

SS, both 3+1 and 2+2, ex Auchterawe were planted on the spoil heaps outwith the plot.

Variety seems to have been a hallmark of Research work since the earliest days, 1929 being no exception when the summer workload in this experiment included manuring, hoeing, lifting and grading potatoes, cutting, transporting and threshing oats.

1930 Potatoes planted over the entire area. Lazybeds prepared as in the previous year, but aligned at right angles to those of 1929, a basal input of basic slag augmented by Sulphate of potash in July. The number of varieties planted was reduced to three: Golden Wonder, Kerr's Pink and Epicure; the overall total of 76 kg planted yielded 108 kg usable potatoes which were sold at £4.00/ton.

The plot lay fallow in 1931 and 1932.

1933 Shallow drains dug at 3.6 m intervals to provide turves for planting at 1.5 by 1.5 m spacing. The northern half was planted with JL, 1+1, ex J MacDonald, the remainder with SS, 2+1, ex Auchterawe. Five plants at the east end of each row were treated with Semsol, 3 oz mixed into the mound of loose peat.

1935 Six Azaleas planted in a corner between SS each given 4 oz high grade basic slag.

1939 A late beating up with SS 35/39 Olympic Peninsula, 1+1+1, and JL, 34/48 2+1+1+1.

1959 Thinning of mis-shapen JL.

Current State of the Experiment and Conclusions

At eighteen years old the SS had attained a top height of 7.6 m in this unreplicated trial and were reckoned to be the best example of the species on the Lon Mor. Although growth has continued to be reasonable this plot now no longer compares with experiment 74 (5.1.12), the latter having had the benefit of an intensive top dressing regime.

The SS plot is well stocked and reasonably healthy although there is some evidence of nutrient deficiency, notably P; current annual increments tend to be small, the tops frequently bushy and ill defined.

The JL is open with irregular stocking, a legacy of a difficult establishment phase, variable growth attributed to site differences. Additionally, blackgame caused considerable damage; stem form tended to be poor but this has been largely rectified by selective thinning.

Initial growth of both species appears to have been impressive. At seventeen years, 1949, SS with basal fertiliser were estimated to have a provisional yield class of 12 compared with 10 where none had been applied. The JL only grew satisfactorily locally, in that part of the plot judged to be better ground.

This small, unreplicated trial suggested that the excellent early growth of SS resulted from residual fertilisers rather than the agricultural crops per se.

The boundary ditch is now, in part, ill defined.

Retention is justified on the grounds of the unique pre-planting treatments; in essence the trial can be classed as a curio.

Reference

Bulletin 22 page 34.

5.3.2 Experiment 45 P28

Dr G K Fraser of the Macaulay Institute initiated a number of experiments to investigate the effect of drainage on deep peat; one of these was experiment 45.

As in experiment 44 (5.3.1) a square chain of deep peat, 22 x 22 yds (1/10 acre/0.04 ha), was completely isolated by peripheral drains dug down to the mineral drift.

Monitoring of the vegetation community and peat depths, the latter to detect shrinkage if any, has been carried out intermittently since with more intensive studies of moisture content and shrinkage

by Dr W O Binns (1962) and Dr D G Pyatt (1991).

Current State of the Experiment and Conclusions

Without a tree crop this square of peat remains much as it was in 1928. shrinkage has been minimal and any reduction in moisture content largely confined to the edge of the block; the Molinia content of the matrix has increased towards the perimeter, otherwise there appears to have been little change in the vegetation community. Worthy of retention for future appraisal should that be deemed desirable.

Reference

Bulletin 22 page 30

5.3.3 Experiment 59 P28

A direct sowing trial on a flushed Molinia blanket bog, predominately 9d, but merging into the more weakly flushed variant, 9e, in the eastern sector; peat depth ranging from 0.7 to in excess of 1.2 m.

Ten 7.6 m shallow turf drains opened at 1.2 m spacing, turves laid as per earlier intensive experiments, for example 12 P26 (5.1.3). Inverted turves scratched with an iron rake before and after broadcast sowing of SP ex Glengarry. Experiment caged.

Subsequent Treatments

October 1929 Alternative couple of sections top dressed with basic slag at 5 cwt/acre.

1935 Cage removed.

Current State of the Experiment and Conclusions

A group of reasonable SP; an absence of tally posts, but no doubt with care slagged and control plots could be differentiated.

A 1934 assessment found no seedlings in either the drains or between turves. In 1946 the mean height within the three slagged sections

was 1.45 m whereas the two controls averaged 0.8 m./ survival within the slagged sections was 9, 14 and 14 seedlings respectively whereas ten seedlings remained in each of the controls.

A successful trial, probably largely due to the cage.

Reference

Bulletin 22 page 88

5.3.4 Experiment 60 P28

A somewhat unusual approach to ground preparation on both an organo-mineral soil and a weakly flushed blanket bog (9e). Peat depth within the peatland component appears to have ranged between 0.4 and 0.9 m.

Three treatments:

1. Organic horizons stripped from a small morainic knowe within the confines of the experiment.
2. Morainic mineral soil spread to a depth of approximately 20 - 25 cm on the bog surface.
3. Organic material piled on the bog surface.

Site prepared in October 1927 and planted in February 1928 with three species: SS, 2+2, 24/15 ex Ratagan/Auchterawe, LP, 2+1, 25/59 from Auchterawe and SP, 2+1, from Auchterawe/Golf Course Nursery. Plants V notched and planted at 0.6 by 0.6 m in alternate rows; an overall total of seventy two plants of each species. The whole experiment then enclosed within a high cage.

Subsequent Treatments

1929 SP replanted with 2+1 SP ex Tulliallan/Golf Course Nursery.

Current State of the Experiment and Conclusions

An impressive group of the Mount Ida LP identifies the site of the experiment; no attempt was made to decipher the original layout.

The 1946 assessment clearly shows that the performance of the pines was far superior to that of SS, the mean heights of the LP considerably better than SP except on the mound of piled peat where

the average height of each species was around 2 m. The morainic material spread on peat proved the most successful treatment with LP averaging 3.7 m, SP 2.2 m. The severely checked SS had only attained 0.3 m on the morainic material and 1.5 m on the moraine; the species failed on piled peat.

A trial of little relevance to current site preparation practice.

Reference

Bulletin 22 pages 33 and 34

5.3.5 Experiment 75 P29

An extensive area, 0.8 ha, of Anderson group planting on a diverse range of soil types, each essentially a discrete unit. Predominantly Upland Sphagnum bog (10b) and a peaty gley/ranker complex; lesser areas of high nutrient status flushed blanket bog (9b) and peaty gley per se.

Following the cutting of a main drainage system in July 1928 the area was split into two equal portions, A and B, within each of which a different shallow turfing system was laid out in the autumn. a square block unit 7.3 m wide comprising three parallel shallow turf drains was common to both sections A and B, these secondary drains aligned approximately at right angles to the prevailing wind. In section A nine turves were laid corner to corner, in the triangular arrangement typical of intensive systems, between each turfing drain whereas in B four double turves variably spaced occupied each strip between drains with a transverse turf in the central row; all turves thrown to windward. The centres of these units were in the order of 7.3 m apart. High grade basic slag (18% Phosphoric acid) and two handfuls of soil were placed beneath turves prior to planting which taxed the skills of those concerned, understandably, as the planting scheme was, somewhat complex, especially in A; consequently some turves not to be planted were fertilised. The groups of thirteen trees planted varied in species composition depending on local site factors: on exposed knowes 3

Rowan/4 MP/6 SS, in moderately sheltered situations 3 MP/10 SS and where the site was considered to be sheltered a pure SS group was planted. On knowes and other exposed sites the Mountain pine was planted to windward.

P30 Extensions

75A Hylocomium moss spread between turves in alternate groups in two rows, each of six groups, in the eastern half of the experiment.

75B Another unusual treatment in the western half of the experiment. Row and group selection as in 75A, but in this instance Molinia seed sown between turves.

Current State of the Experiment and Conclusions

An open thicket, groups widely spaced; it will be some considerable time before the canopy closes over any significant proportion of the area, if ever, as seems likely judging by the current state of the crop. The Rowan has failed, leaving groups of MP/SS or pure SS. The SS frequently not much taller than neighbouring MP, are mostly checked with a distinct lack of foliage and obviously under considerable nutritional stress largely due to an inadequate fertiliser regime compounded in many instances by unsatisfactory drainage. The growth of SS is much improved in the area of flushed blanket bog in the more sheltered south eastern corner close to experiment 18.

The experiment has some historical value as a museum piece; the turfing systems and group layout can be identified and are of interest. However, this is a very dubious argument for its retention.

Reference

Bulletin 22 page 83

5.3.6 Inchnacardoch 171 P69

The two separate components of this experiment occupy ground adjacent to the northern perimeter previously the site of various nineteen thirties Preliminary Trials and the Alder/Birch experiment 108 P34 (5.8.5). an experiment designed and set-up to demonstrate major nutrient deficiency symptoms on SS and LP on low nutrient status peatland. In reality one part is on deep peat per se, albeit of medium depth, predominantly at the lower end of a 45 cm to 1 m range, the remainder on a peaty gley/flushed blanket bog (9e) complex, the peat generally varying between 30 and 55 cm.

The deep peat component marches with the eastern sector of experiment 125 (5.1.18), a rock cored ridge separating it from the other half of the experiment. The deep peat adjacent to 125 is largely a weakly flushed blanket bog (9e) which merges into Upland Sphagnum bog (10b) locally.

Tine ploughed in the summer of 1968. The herbicide Gramoxone was applied, at 11.2 litres/ha, eight days prior to planting in May 1969 with KLP 65(7114), Terrace origin, and Masset QCI, 62(7111)1, both ex Inchnacardoch nursery; the latter used for filler and surrounds too. Deep drain buffers segregated individual plots. The treatments were various combinations of the major elements N, P, K and the minor ones Mg and Ca, including an all nutrient treatment and a control; a total of six treatments replicated twice, once on each site type, with an unreplicated minus Mg plot. Treatment plots were split for the two species, each sub plot 8 x 7 plants at 1.5 m spacing along the furrow.

Fertiliser prescriptions broadcast at half rate post planting, the SS filler receiving Fisons Double Season PK at 575 kg/ha to supply 50 and 100 kg/ha of P and K respectively.

Subsequent Treatments

The whole experiment suffered deer damage during the summer and autumn of 1969 which necessitated the erection of a fence in December that year.

April 1970 Beating up within the experiment and filler; additional filler added.

September 1970 Hand weeding as required.

May 1971 Application of the herbicide Dalapon, to control Molinia.

The concept of a deficiency garden implies a heavy input of various fertiliser to induce the required nutrient stress symptoms and this was certainly the case here. A further half rate broadcast dressing in 1970 was followed by full rate treatments in 71, 74, 77, 80 and 83.

The 1969 filler areas were treated with Fisons Double Season, the same rate as at planting, in June 1973, the P70 filler area given phosphate (URP), 375 kg supplying 50 kg elemental P per ha, in March 1974.

Current State of the Experiment and Conclusions

A mixture of polestage and thicket, in part benefiting from the shelter of neighbouring experiments, especially 125. Much of the site was an ideal frost hollow, the trees experiencing severe early autumn frost damage in September 1972 and further frosting the following April. Frost damage was again recorded in May 1984, on this occasion poorer SS affected.

A height assessment of sixteen years showed that the all nutrients treatment to SS was the most successful in terms of height with a mean of 8.5 m equivalent to GYC 18; at the other end of the spectrum the no P treatment had only attained 3.7 m equivalent to GYC 8 in comparison to the control, no nutrients supplied, which meaned at 5.6 m or GYC12.

The experiment did not develop into an effective demonstration as hoped. However, it did indicate that an input of P is very important for both species, especially LP, at planting and that LP and SS can grow satisfactorily without N provided that PK levels are maintained. Inevitably growth and survival of both species were poor in the control.

All in all an experiment with no apparent future, now written off,

on a variable site type, this adverse factor compounded by early frost and deer damage.

5.4 Experiments on Mechanical Ploughing 1946-1959

5.4.1 Experiment 128 P46

An extensive trial plantation within the original enclosure on single mouldboard Cuthbertson ploughing at approximately 1.8 m spacing, augmented by turfing, as required, in any sizeable gaps. the majority of the site is a relatively homogeneous unflushed upland Sphagnum bog (10b), a peaty gley/ranker complex impinging on the north easter perimeter; however, the site type is more diverse in the section beyond the original boundary fence where organo-mineral soils, including podzolic ironpan soil around the summit of a knowe, appear to be pre-eminent.

The original planting was 3:1 LP/SS mixture, alternate plants in alternate lines, over most of the area; the vigorous SLP (41/7 USA) soon suppressed the SS, however. Two plots of pure SS (41/8 BC), each 0.1 ha, were incorporated on the eastern perimeter, one of these in the section beyond the fence. The rate of basal GMP varied according to species: 71 and 42 gm to SS and SLP respectively.

Subsequent Treatments

Draining, autumn 1950.

Subsequently a number of experiments have been superimposed within both the original mixture and the pure SS plots; what was initially a somewhat straight forward field scale trial has developed into a rather complex series of experiments.

1. 1953 Extension

Six treatments were applied to the SS in five discrete plots, each subdivided into two blocks, within both the mixture and pure component in an attempt to reverse the onset of check; these comprised three top dressing treatments with GMP, mulching with turves and pulling Calluna over a radius of 45-60 cm around each tree. Two rates of GMP were applied per plant, 57 and 227 gms supplying 48 and 193 kg of elemental P/ha respectively.

One half of each pure SS plot was unaffected by this extension; in essence retained as a control.

2. 1957 Extension, Experiment 148B/57

A magnesium trial initiated by the Macaulay Institute, Aberdeen, designed to test the effects of N (Sulphate of ammonia), K (Muriate of potash) and Mg (Magnesium sulphate) top dressing on SLP.

3. 1958 Extension, Experiments 153/58/1 and 153/58/2

153/58/1 A further Macaulay fertiliser trial exploring the potential of ammonia and granite applied to a relatively small area of SLP/SS beyond the fence; subsequently felled and replaced by experiment 178 P75 (5.5.3)

153/58/2 A cyanamide - limestone trial, presumably Macaulay initiated, in an area of SLP/SS on the eastern edge now the scene of catastrophic windblow.

4. 1960 Extension, to 1953 the Experiment

GMP top dressing to even up the P input to 260 kg elemental P/ha applied throughout the 1953 extension.

Thereafter N (Nitro-chalk) and K (Muriate of potash) top dressings superimposed on the pure SS plots only; two rates of N to supply 56 and 170 kg of the element/ha, the potash providing 84 kg elemental K/ha - FY60 extension. A severe frost in late May 1961 severely damaged all of that season's early growth.

5. Subsequent Treatments Applied to the FY60 Extension

FY1968 Top dressing of NPK, SAI No 2 @ 753 kg/ha, to supply 170 kg N, 36 kg P and 67 kg K per ha.

FY1975 NPK half in each plot top dressed with urea at 375 kg/ha (170 kg elemental N/ha).

6. Extension FY61

Potassium and Magnesium spray trial. A small experiment in SLP/SS on the western edge of the main section. Little information appears to be available about this experiment.

7. FY1970

One of the pure SS plots not treated in the FY53 and FY60 extensions top dressed with double season PK @ 565 kg/ha to provide 49 kg and 94 kg elemental P and K respectively.

8. FY1973

An extensive area of SLP/SS top dressed with PK; confined to eastern section of the main component and the western section of the area beyond the fence; assessment plot coinciding with one of the 1953 extension plots established in the former area.

FY1971 An unsuccessful attempt at tree pulling (SLP) in the section beyond the fence. Defeat seems largely due to the small size of the pine and the tenacious hold of their root systems resulting in stem breakage and severing of roots.

FY1975 Section of SLP/SS beyond the fence clear felled and replaced by a restocking experiment Inchnacardoch 178 P75 and P76 - see section 5.5.3.

Current State of the Experiment and Conclusions

An unthinned stand with extensive pockets of serious SLP windblow/snap, particularly in the relatively sheltered eastern sector which has had the heavier fertiliser input. When significant pockets of windblow actually materialised is difficult to quantify, but the early eighties seem the most likely period. Blow continues, apparently somewhat sporadically, the most recent additions during the winter of 1992/93. The contrast between the eastern and western half is visually quite clear with generally less vigorous growth of SLP in the latter although exposure may also have influenced crop

performance here.

The original mixture is now pure SLP with all the faults of that origin: sabre butts, curved stems and heavy coarse branching, this coastal seedlot comparing very unfavourably with the good stem morphology of inland origins in neighbouring experiment 52. Some rogue inland types have been identified in the matrix. The SS component of the mixture is totally suppressed, but frequently still alive and struggling on.

Occasional blow/snap occurs on the peaty gley/ranker landform and in the remnant of SLP beyond the fence.

The main interest in the experiment is now the pure SS plots on contrasting site types, deep peat and organo-mineral soils within and beyond the original boundary fence respectively. Otherwise the SLP is a potential candidate for clear felling; thereafter the homogeneous site could be considered for further experimentation.

Reference

Bulletin 22 page 29

5.4.2 Experiment 130 P46

A field extension of one year old SS and SP seedlings grown in compost (lime, basic slag, dried blood and C5 compost) treated soil in Inchnacardoch heathland nursery.

The experiment was laid out on an unflushed Upland Sphagnum bog (10b), site preparation by single furrow Cuthbertson plough in the autumn of 1945. A 1:1 mixture of alternate plants notch planted at 3 ft.

Seedlings:	SS 44/1 BC 1+0
	SP ex Rothiemurchus 1+0
Transplant controls:	SS 41/8 BC 2+2
	SP 42/100 Lovat 2+1

The trial was not a replicated design, the block of transplant controls sandwiched between two blocks of seedlings. GMP (25% P_2O_5 80% fineness) was applied at differential rates, 1 oz to SP and 2

oz to SS, over most of the experiment leaving a control strip, about one tenth of the overall area, extending the whole length of the western edge.

Subsequent Treatments

Beating up April 1948

Current State of the Experiment and Conclusions

A thicket difficult to penetrate, albeit a SE/NW aligned rack allows access from one side of the block to the other.

The trees are suffering considerable nutritional stress aggravated by an anaerobic, waterlogged substrate; site drainage leaves much to be desired. Viewed from the outside a number of SP on the western and southern edge are evidently dying. A stable but stressed crop the SS and SP of approximately equal mean heights. Stocking very satisfactory. Despite a lack of tally posts the various plant types are readily identifiable by narrow alleyways; likewise the control whose boundaries are clearly demarcated by exceedingly poor survival.

At planting the height of the SP seedlings was 5 cm, those of SS 5 to 7.5 cm; transplants of both species ranged between 5 and 15 cm. Despite the small size of the planting stock survival was generally very good, especially in the fertilised section; a severe spring frost in 1947 caused a number of deaths and the experiment was beaten up in April 1948.

At six years the two species were growing at approximately the same rate in the fertilised component, the mean height of SP and SS seedlings 0.7 and 0.6 m respectively with transplants of each species 0.9 m. By ten years the mean heights of SP seedlings and transplants were 1.3 and 1.7 m, those of SS 1.1 and 1.3 m; most of the SS were either severely checked or in a stage of semi check although the nursing effect was evident locally.

In 1949 100% survival was recorded within the assessment plots of most of the fertilised treatments, the SS seedlings the sole

exception (84% survival). By far the worst results materialised in the SS seedling control where survival was a meagre 52%.

Severe sawfly damage to the SP was noted in 1955.

Between experiments 130 and 128 there occurs a much neglected avenue of fame, two rows of LP planted in December 1951 by various eminent foresters from the Scandinavian countries, Denmark, Finland, Canada, France, Sudan, Mexico and a sizeable contingent from the UK. Unfortunately some tallies are missing, likewise trees, and the alley has a general air of decay, which sums up much of the present day Lon Mor.

A large question mark must hang over the future of this inadequately drained experiment.

Reference

Bulletin 22 page 38

5.4.3 Experiment 135 P47

In the summer of 1944 the chairman of the FC Sir Roy, later Lord, Robinson inspected Research experiments in north and west Scotland as he was concerned both to find out what positive results were materialising from these, and to ascertain how best this acquired knowledge could be developed and extended following improvements in ground preparation with the advent of mechanical ploughing. His tour convinced him that research work should continue and be expanded to meet the challenge offered by the increase in the potential area suitable for afforestation following the development of appropriate ploughing equipment. He therefore directed that Research proceed to look for potential sites, and that every assistance be given to them. By November 1944 the Research Officer, Scotland, reported that a suitable site for a large scale field trial had been identified in Inchnacardoch. After much discussion it was agreed to go ahead, silvicultural prescriptions to be given for individual blocks by four senior officers: Sir Roy himself; J A B MacDonad, Research Officer, Scotland; W H Guillebaud, Director

of Research and Education and A H Gosling, Director Scotland. Following ploughing in the autumn of 1946 the area was subdivided into four blocks, one for each of those providing prescriptions, by the Chairman in person who seems to have liked leading from the front.

The trial is split between three separate areas of differing size and straddles rather mixed terrain typical of the more difficult sites with which ploughing was now able to cope. Consequently there is considerable diversity in soil type distribution, albeit the principal constituents are restricted, essentially, to peaty gley and flushed blanket bog (9e). The various silvicultural prescriptions were based on a site classification which encompassed landform, slope and the dominant members of the vegetation community. Four site types were recognised with two sub-types:

1. Morainic or rock cored knowes, predominately organo-mineral soils.
2. Weakly flushed zones between and around ridge/knowe landforms, the depth of peat variable.
3. Basin peat, unflushed and flushed.
4. Slope peats, unflushed and flushed.

A variety of species feature in the experiment:

SP 44/85 ex Achnashellach.

LP 44/9 and 41/7 ex Roseisle and Loch Ard provenances respectively.

MP 42/501, Inchnacardoch provenance.

SS 44/1, BC.

P Omorica 43/24C, SE England provenance.

DF 43/5, unknown origin/provenance.

HL 43/220, Munches provenance.

Terpene analysis of LP 44/9 in 1981 indicated its origin as the Cascade Mountains, Oregon, which lie within the natural range of sub-species Murrayana known to be one of the poorest seed origins tried in this country; approximately one third of the original LP planted were of this origin. The remaining LP are of South Coastal origin.

A basal application of GMP was applied in and around the notch at 42 gm/plant, equivalent to 25 kg elemental P/ha, half the current recommended rate.

Beaten up with LP 47/57 USA, presumably in 1948.

Subsequent Fertiliser Treatments

1950 Top dressing applied to spruces and DF in block II: Superphosphate and Sulphate of potash, 14 gm of each applied to individual trees.

1953 Top dressing, as in 1950, applied to the spruces in blocks I and IV.

Alternate double rows of SS top dressed with GMP and Sulphate of potash, 42 and 15 gm of product respectively to each tree.

1976 An inadvertent top dressing by helicopter of block IV and part of block II, the rate supposedly 375 kg/ha URP to provide 49 kg elemental P/ha.

Two experiments have been superimposed on these trial plantations.

P72 Extension

A small scale polestage fertiliser experiment, two replications with a control, applied to SLP in block III. The PK treatment gave the best response relative to the control on the flushed blanket bog (9e) selected.

Inchnacardoch 184/77

A polestage SS fertiliser experiment more pertinent to current practice/interest than its 1972 SLP predecessor. originally a two row mixture of either SS/MP or SS/SP, the choice of pine dependent on site type. The pine was felled in 1975, a veritable labour of love, especially the removal of MP.

The experiment was laid down in a nutrient deficient stand, the GYC ranging from 6 - 8, and aimed to achieve a breast height diameter/basal area response. Two of the three replicates are on a flushed blanket bog (9e), the pure SS formerly SS/MP, the other on a peaty gley, the crop originally an SS/SP mixture.

Three rates of PK compound were applied with a control: a standard

application supplying 50 and 100 kg/ha elemental P and K respectively, the others half and one and a half times this rate. A response to PK was duly recorded, but it is not known if there was any benefit from either the original mixture or from the decomposition of the pine detritus.

Current State of the Experiment and Conclusions

Block I, Lord Robinson's prescription. Arguably the most successful of the four trial plantations with an emphasis on two row mixtures of SS and either MP or SP, LP conspicuous by its absence. The SS on flushed blanket bog towards the upper boundary of the main block, in part Inchnacardoch 183/77, appears to be nutrient deficient, although unsatisfactory site drainage may be accentuating the imbalance; a cut off drain at the ridge landform/peatland interface would have been beneficial here, and also in all neighbouring experiments beneath this significant break in slope. The SS/SP mixture effect has been particularly successful in the smaller lower block which, interestingly, occurs on a flushed blanket bog (9e) in a local basin; elsewhere this combination has tended to be successful on knowes, but less so in hollows. The SP/DF mixture, confined to a few sheltered knowes, is now essentially pure SP although some suppressed DF struggle on.

Block II J A B MacDonald's prescription. Silviculturally more complex than any of the other alternatives; LP is the overall dominant species. The LP is generally poor and patchy in the upper section due to unsatisfactory drainage - no cut off drain again - on flushed blanket bog (9e). Throughout SS are few and far between as they originally amounted to a meagre 12.5% of the overall total number of trees; however, the species is dominant locally, notably in the central section where there are pockets of LP blow. The OS content appears to be healthy although, typically, it occurs as an understorey to the more vigorous LP. SP and HL have generally not been very successful. The small separate lower block on a varied peaty gley, flushed blanket bog (9e) and podzolic ironpan soil

complex is in essence an LP crop with the usual stem defects and very occasional snap and blow.

Block III W H Guillebaud's prescription. LP again very much to the fore. Sizeable pockets of mostly old blow and snap in the upper section, the area of the polestage fertiliser experiment; stems typically sabre butted and/or leaning mixed with occasional bolt upright individuals. The choice of alternate pairs of LP/SS across the furrow in the central sector is interesting; however, most of the SS are suppressed with only the occasional tree winning though to the upper crown of the normally too vigorous LP. Serious blow in the central area occurs in association with a peaty gley/ranker complex. Although much of the crop is on its feet overall there are sizeable pockets of windblow throughout the block.

Block IV A Gosling's prescription again favoured LP, albeit with a sizeable content of SS and MP, each 25% overall, on the principal site type, flushed blanket bog (9e). The upper and middle sections of the block have been severely affected by mainly old blow and snap making access awkward, but as in block III a sizeable proportion of trees remain upright. The crop is more interesting towards the central and lower sections where stability improves markedly. here some of the SP/SS mixtures (60:40% radio) are promising with a number of SS dominants. In general, however, SS in LP mixtures tend to be suppressed, only an occasional tree competing on a par with the so called LP nurse.

In summary, an interesting and informative field scale trial, but time has shown the choice of LP origin to be unfortunate, either as a pure crop or as a nurse; other adverse factors are inadequate drainage and a no thin regime imposed by difficult access. Wind/snow induced blow or snap seems to rule out any further experiments in most of blocks II and IV. Much of the ploughing is parallel to the long axis of the blocks, up and down slope, and hence approximately at right angles to the prevailing wind which may have accentuated blow. the trials have shown the potential of SS on this site type, especially in mixture; the SS/SP mixtures are

particularly interesting.

A sizeable trial such as this imposes substantial management problems, by and large quite beyond the capabilities of Research personnel. In an ideal world most of blocks II, III and IV ought to be clear felled; the Chairman's contribution is the only one meriting retention in its entirety.

5.4.4 Experiment 141 P52 and P53

Another LP origin experiment contrasting coastal and inland types. Initiated with an all embracing long term remit: to compare their survival, rate of growth, yield, form, disease resistance an any other differential characteristics.

The three segments of the experiment are dispersed over a relatively wide area. The site preparation was single mouldboard Cuthbertson at 2 m spacing, the ploughing in conjunction with neighbouring experiments. A randomised block design, four replications of 36 plant plots; spacing 1.2 m.

The largest section, two blocks, is on a flushed blanket bog (9b) occupying a local flat whereas the two other one block sections appear to be peaty gleys.

The number of seedlots is somewhat restricted:

P52 50/262 Lulu Island Vancouver, BC - NLP
50/293 Lulu Island Vancouver, BC - NLP
50/292 Western Montana, USA

P53 51/349 Lulu Island
51/348 Salmon Arm (Shuswap Lake) BC

Basal GMP applied at 2 oz per tree

Current State of the Experiment and Conclusions

Unthinned. Foliage tends to be sparse; stem morphology is generally satisfactory. In general the crop can best be described as drawn-up bean poles with generally unsatisfactory crown development. Overall, stocking tends to be patchy, the best growth on the slightly convex slope in block II where one Lulu of sizeable breast

height diameter stands out in marked contrast to all other trees. A variable amount of blow and dieback, generally on a small scale, occur in all blocks, but more so in I and the combined III and IV, the latter straddling the inadequately drained deep peat flat; growth in these three blocks is rather poor.

All origins have grown relatively slowly, but none appears to be the first choice for afforestation on this site type. Site variation and the scattered nature of the experiment detracts from its validity as either a comparison between the various origins or as a subject for demonstration purposes. In summary, a scattered experiment on a variable site type which appears to have outlived its usefulness.

5.4.5 Experiment 149 P58 and P59

An unreplicated LP demonstration, plots of variable size, with a wide range of origins and provenances from the Yukon to California. The 1958 section comprises thirteen seedlots from a collection made by Dr Critchfield augmented by nine others from Britain and Ireland. Eight seedlots were added in 1959, three from Inchnacardoch sources and five imported origins.

The site is far from uniform, both in respect of soil type and topography, largely a high nutrient status flushed blanket bog (9b), some weakly flushed blanket bog (9e) and rock cored ridge and knowe landforms associated with a peaty gley/ranker complex and a podzolic ironpan soil, peaty phase. A hotch potch which was deemed unsuitable for a formal replicated experiment.

As elsewhere on the west Lon Mor the site was ploughed - single mouldboard Cuthbertson at 2 m spacing.

Triple superphosphate @ 14 gm/tree was applied as a basal dressing.

Subsequent Treatments

1959 Beating up with JL 56 (4138)500.

1967 Top dressing with Fisons 48 @ 568 kg/ha to supply 49 kg P and 94 kg K per ha.

The western extremity of this demonstration appears to have had an inadvertent aerial application of PK in 1976 when adjacent Conservancy crops were top dressed.

Current State of the Experiment and Conclusions

The compact group of variably sized, but uniformly small plots (1-13) of Dr Critchfield's collection have been neglected, some plots only identifiable with difficulty and by a process of deduction due to the absence of certain tallies. The demonstration is in a somewhat sorry state, but none the less of interest with an extensive range of origins including representatives from the Yukon, Colorado and California.

Elsewhere windblow is a serious problem in a number of plots, notably in 19-22, various Eire provenances, which have been devastated as a result of, in part at least, inadequate drainage on a high nutrient status blanket bog (9b). The zone of major blow continues on this site type into the five plots fringing the southern perimeter of the Alder, experiment 147 (3.7): albeit here it is much more variable, a ridge land form (podzolic ironpan soil) and Skeena River origins complicating the issue. Stability tends to improve markedly on the ridge, but is generally much superior in two of these five plots, the Kirroughtree provenance, an inland type ex Smithers, and in the Millbuie ex Terrace seedlot which straddles the ridge, but blow occurs adjacent to the Alder in the latter. Instability may have been accentuated by ploughing at approximately right angles to the prevailing wind. In the remaining plots windblow/snap tends to be variable, generally sporadic with few seedlots wholly stable.

Apart from the two relatively windfirm plots already mentioned, the Ladysmith Vancouver Island seedlot (plot 23) on the sheltered flank of the prominent knowe landform and the Hat Creek origin ex Inchnacardoch (plot 30), a distant plot on the western fringe of the

Alder experiment, stand out as notably stable, the latter again on a raised landform.

Potentially an informative trial now unfortunately of limited value. However, it is a further demonstration of the contrast between the vigorous, heavy branched south coastal origins less well suited to these exposed sites and the good stem morphology of the stable Skeena River and Vancouver Island origins.

5.5 Restocking Experiments 1968 - 1976

5.5.1 Experiment 168 P68

A small experiment with two replications, in essence a trial, superimposed on experiment 105 P33, JL and HL, thinned to 247 stems/ha; the larch overstorey removed in 1975.

A relatively sheltered site due to surrounding crops and a ridge landform immediately adjacent to the west. It was thought that Calluna might reinvade, so this inadequately replicated experiment was set up to see how SS, a Calluna sensitive species, might respond in the event of such a development; WH was included as a comparison. Although the site was mapped as a weakly flushed blanket bog (9e), implying only occasional non tussocky Molinia in the original state, it had been transformed to a vigorous, Molinia wholly dominant, sward under the larch crop.

Fencing was necessary and alternate plants were turf and notch planted at 2.1 x 2.1 m spacing in 100 plant (10 x 10) plots laid out amongst the lop and top retained in situ. Four plots in total.

SS 59(7111) QCI 2+2

WH 62(7111)1 Masset QCI 1½+1½+1

A basal application of GMP @ 250 kg/ha provided 30 kg elemental P/ha.

Subsequent Treatments

Beating up in 1969 and 1970, on each occasion SS and WH of similar identity number 62(7111)1, were used.

1971 A PK top dressing @ 575 kg/ha applied to 2 rows of WH, one in each block.

1975 UPR applied to the entire experiment @ 400 kg/ha, supplying 52 kg P. Larch overstorey felled.

1980 Copper sulphate broadcast within the northern halves of all four plots; 50 kg/ha to supply 20 kg elemental Copper.

Current State of the Experiment and Conclusions

Most of the crop has closed canopy although a relatively small pocket of unsatisfactory growth occurs on the western perimeter contiguous with the ridge landform.

On the whole SS leader lengths seem reasonable; likewise needle colour. Nutrient deficiency in a small area of poor checked trees on the western boundary of the experiment is probably aggravated by inadequate drainage.

Multiple stems of generally non commercial morphology are a salient feature of the WH. A deterioration in nutrient status and growth occurs adjacent to similar symptoms in the adjacent SS on the western edge of the experiment; a lack of drainage the underlying cause.

Turf planted trees grew better than those directly notched. Copper seemed to improve the height growth of SS. At fifteen years the provisional yield class of SS ranged between 16 and 18 whereas that of WH was 14.

The experiment no longer has any immediate relevance; its relatively small size, reduced a little further by the area of poor growth, seems to preclude it as a site of further research.

5.5.2 Experiment 177 P74

A rather small SS experiment on the site of an LP stand, 25/59 Mount Ida GYC 8, which was subjected to tree pulling in 1971 - see experiment 47 P28 (5.2.1) - leaving a substantial fringe of pine on the south western end; trees were also left on the southern and eastern edges. A weakly flushed blanket bog (9e).

The area was fenced the following winter to see whether natural regeneration would materialise; in the event this proved to be very limited with only occasional SS and LP although cones collected in 1971 had a 75% percentage germination. Roger Lines thought that serotinous cones, typical of inland origins, had finally developed and hence no natural regeneration was likely without the aid of fire.

The area was previously fertilised in 1959 - see experiment 47 (5.2.1).

Three treatments (control, P and PK) are replicated four times, each plot twelve plants; the SS, 69(41)502 a plus tree mix, were directly planted a week after being dipped in Gammocol.

The basal fertilisers were broadcast at the following rates:
375 kg/ha URP (50 kg P) and 575 kg/ha compound PK (50 kg P and 95 kg K).

Subsequent Treatments

1982 Edge trees on the S and E flanks removed as these were interfering adversely with adjacent SS.

1984 PK applied to the whole area at 575 kg/ha (50 kg P and 95 kg K supplied).

1986 Further remedial felling to remove 3LP and 1 SS encroaching on the experiment.

Current State of the Experiment and Conclusions

A compact thicket, accessible only with difficulty. Growth improves along the major axis from the west, adjacent to the polestage LP, to the more open eastern extremity.

As lop and top were removed during the tree pulling operation the area of replanting was not typical of a normal restock site.
The experiment appears to be too small to retain as a viable entity for further research, but it may be of interest to monitor developments on a "look-see" basis over the next few years.

5.5.3 Experiment 178 P75 and P76

A somewhat involved restocking experiment, SS replacing the SLP (41/7 USA, GYC 8 - 10) in part of experiment 128 P46 - see section 5.1.1 - beyond the original Lon Mor fence. The previous crop had up to 80 kg elemental P/ha in the initial eight years.
The objectives of the experiment were wide ranging and included a comparison between transplants and paperpots, to monitor any benefit from a moderate basal P input on restocking by comparison with a control and to observe any vegetation or natural vegetation colonising a restock site with lop and top remaining in situ.
The previous crop was felled early in 1975 and a temporary deer fence erected immediately afterwards.
There are three replications of four treatments, blocks I and II laid down on an unflushed upland Sphagnum bog (10b) which merges into a peaty gley in block III on the southern edge of the Research enclosure.
The original layout incorporated a control and basal P treatment, each of these plots split between transplants and paperpots planted on the old plough ridge in April and July 1975 respectively. URP was broadcast at 400 kg/ha to provide 52 kg elemental P in the appropriate plots. Both plant types were QCI origin and treated with insecticide, the transplants before planting, paperpots shortly afterwards. Insecticide was applied regularly for the next three years.
Planting was completed in 1976 with QCI transplants and paperpots, the same origins as those used in the previous year.
Plot sizes vary between 1975 and 1976, 48 and 40 plants respectively.

Subsequent Treatments (abbreviated)

1978 UPR broadcast within the P75 controls at 375 kg/ha to provide 48 kg elemental P/ha.

Granulated Muriate of potash broadcast within the P75 phosphate plots at 200 kg/ha giving 100 kg elemental K.

All paperpots removed, hence experiment now essentially concerned with nutrition.

1981 Granulated Muriate of potash broadcast with P76 P50 plots rate as in 1978.

2,4-D Ester applied to the entire experiment.

1986 Urea broadcast within the 76 P50 plots at 350 kg/ha to provide 161 kg elemental N.

thus the revamped treatments can be summarised as follows, based on fertiliser input:

Original O P75 as P

Original P P75 as PK

Original O P76 as O

Original P P76 as NPK

Current State of the Experiment and Conclusions

One of two open experiments on the Lon Mor. Much of its potential value is forfeited because of the dual site type; hence it is difficult to reach a coherent conclusion about the various nutritional prescriptions.

The only really successful treatment, good needle colour and encouraging current annual increments, is that of NPK in block II; by contrast the block I treatment has very yellow foliage and declining increments. The block III treatment is on a peaty gley; hence performance has been rather variable.

The PK treatments continue the theme of inconsistency with variability between plots, in both growth and nutrient status.

There is little to distinguish between O and P treatments, growth and nutrient status rather variable; visually and in terms of mean height there does not appear to be much difference between O, P and

PK treatments. The O and P treatments in block III on a peaty gley are rather poorly stocked.

A nutritionally impoverished peatland on which, even in the restocking phase, an LP/SS mixture would be more appropriate than a pure SS crop.

Despite the variable site type retention until canopy closure of at least the PK and NPK treatments is suggested.

6. Discussion and Conclusions

6.1 The majority of Foresters with a Research background, certainly those with experience in the uplands, would probably return from a visit to the present day Lon Mor with rather mixed feelings. On the one hand there would be a sense of admiration and respect for the dogged perseverance of those early pioneers and their successors who achieved so much on an essentially difficult site, both physically and nutritionally, with far from easy access for men, equipment and materials. On the other hand it is likely that there would be a feeling of neglect verging on embarrassment at the current state of this Research reserve. To be realistic, however, this latter response has to be put into perspective since the emphasis was on successful establishment per se when the various trials and experiments were laid down and, understandably, consideration of the future management implications probably did not loom large in anyone's thoughts.

The Lon Mor has in effect been in limbo for far too long, seemingly rather conveniently low on the list of priorities, if not largely forgotten, by both Research Branch and the Forest Enterprise. One wonders how long this state of affairs will be allowed to continue, particularly in the current climate of economic stringency with the state forest holding under close scrutiny and the distinct possibility of privatisation in some form or other in the near future. The inevitable widening gulf between the Enterprise and Authority will focus attention on Research holdings, especially the larger reserves such as the Lon Mor. It is conceivable, and certainly not beyond the bounds of possibility, that a rent could be levied for the use of these areas by Research. Therefore it would seem both sensible and appropriate for Research Branch to anticipate and possibly pre-empt these potential developments by giving serious consideration as regards the value and viability of retaining large reserves such as the Lon Mor. Consequently the initiative can come from Research, thereby placing the Division in

a stronger bargaining position, with positive proposals for either the continuing management of these holdings or their return to the Enterprise fold.

6.2 Inevitably a number of factors, mostly adverse, have to be borne in mind and given careful consideration when contemplating whether Research Branch ought to maintain a presence on the Lon Mor, either holding on to the entire reserve or retaining certain experiments of particular interest.

Sixty seven years on and access to the reserve remains difficult, albeit the construction of a road terminating a short distance from the north east corner has been a vast improvement. Similarly transportation of men, equipment and materials has only progressed from the pack horse era to that of the all terrain vehicle, hardly a major evolutionary development.

An overall area of 48 ha ensures that the effective management of the reserve is dependent on regular maintenance and the enactment of appropriate silvicultural treatments at the opportune time. When Research manpower was based at Ft Augustus such operations were a feasible proposition to a varying degree; management from distant Newton is another matter altogether. An extension of the road into the reserve appears to offer the only reasonable solution to the problem; however, the likelihood of this development seems remote in the context of the current economic climate and constraints on capital expenditure. A road would open up the prospect of mopping up windblow, clear felling and thinning, the revenue from these activities contributing to the cost of the road. Such operations could be contracted out to the local Forest District as they are obviously beyond the resources of Research.

Some sizeable pockets of windblow occur within the reserve, the approximate boundaries of these areas delineated on the map of Appendix 4. Although there does not appear to have been any significant increase in the amount of blow during the past few years a relatively small annual increase can be expected, with the

distinct possibility of more serious occurrences in the not too distant future, especially in vulnerable LP stands; ineffective and inadequate drainage commonly increases the potential for windblow. Clearance of live trees would provide some return from the crop and greatly facilitate restocking.

Any restocking or new planting would require a deer fence, either confined to the particular area concerned or as a replacement to the entire ring fence, all original fences now hopelessly inadequate for the purpose. The second option would be a prohibitively expensive undertaking, however.

A reluctance to use experimental sites again following clearance has been evident previously because of treatments applied to the preceding experiment.

The Forest Enterprise may be unwilling to accept the return of the Lon Mor in its present state and might impose conditions, for example some remedial work such as the clearance of windblow, before agreeing to taking responsibility for its future management.

6.3 Areas of Homogeneous Soils and Growth where Crops should be Maintained and Monitored

In essence there are two major site types for practical purposes:

1. Peatlands. See section 2 page 9

2. Ridge and hillock landforms, predominately peaty gley and ranker complexes; deep peat and/or podzolic ironpan soil may be present in a subsidiary role.

Pure SS on Peatlands

1. Experiments which appear to be of considerable interest.

10 P25 (5.1.2) page 47 A small self thinning block.

12 P25 (5.1.3) page 49 A small self thinning block.

74 P29 (5.1.12) page 64 A stable pole stage fertiliser stand.

178 P 75 and 76 (5.5.3) page 108 Restocking. Mostly on a discrete area of deep peat; lesser area of peaty gley.

2. Experiments which appear to be of lesser interest

76 P 29 (5.1.13 page 67 A useful demonstration in conjunction with neighbouring experiment 74.

83 P29 (5.1.14) page 69 As above a useful demonstration when viewed alongside neighbouring experiment 74.

135 P47 (5.4.3) page 97 Block I. Pole stage SS, the MP nurse having been cut out.

Each of the above again on deep peat.

The eastern sector of the SS component in experiment **125 P39 (5.1.18) page 73** may be of interest, but the site is relative small and varies between a peaty gley and unflushed blanket bog (9e).

SS in Mixture on Peatlands

1. Experiments which appear to be of considerable interest

55 P30 (4.1.1) page 33 Alternate rows of QSS and Alberta LP.

2. Experiments which appear to be of lesser interest

77 P29 (4.2) Page 39 SS nursed successfully by MP on deep peat. Useful for demonstration purposes in conjunction with 74 and neighbouring experiments.

112 P35 (4.1.2) page 35 The central section only. ALP, not a recommended origin, and QSS.

135 P47 (5.4.3) page 100 Block I, southern section. Relatively small pocket of SS/SP on deep peat.

137 P51 (4.1.3) page 36 A narrow rectangular block on a variable site type which includes peaty gley. Patchy growth.

Other Species Planted Pure

Experiments of lesser interest.

19 P26 (3.2) page 14 SP. Varied site type; discrete areas of peatland and peaty gley.

52 P28 (5.2.2) page 77 Inland LP. Partially devastated by blow. Pure and in mixture with SS and WH. Unflushed peatland.

84 P29 (3.5) page 20 SP. Classic site type, essentially podzolic ironpan soil.

116 P35 (3.6) page 21 Small block of CP on organo-mineral soils.

147 p57 (3.7) page 23 Alder. Interest restricted to that part on flushed peatland. A glutinosa and A incarna the most successful of the three species tried.

Species Trials

1. Experiments which appear to be of considerable interest.

36 P27 (3.3) page 16 Unflushed peatland.

2. Experiments which appear to be of lesser interest

46 P28 (3.4) page 17 Indifferent stocking on unflushed peatland.

18 P53 extension (3.1) page 12 Nine species including SS. Plots too small. Peaty gley/ranker complex.

168 P68 (5.5.1) page 105 WH only. Poor stem morphology a stark contrast to that found in other experiments for example, **138 P51 (4.3) page 41.**

138 P51-53 (4.3) page 41 A widely scattered experiment on a rather variable site type. Extensive blow in the P51 component. Predominantly mixtures. HL, OS and WH of local interest.

6.4 Areas of Homogeneous Soils where Existing Crops are too Varied to Justify Retention and Successor Experiments might be Feasible

48 P28 (5.1.10) page 61 An irregular thicket of variable SS on weakly flushed peatland.

49 P29 (5.1.11) page 63 A variable, generally checked stand of SS on poorly drained flushed peatland.

128 P46 (5.4.1) page 92 SLP with significant pockets of blow on unflushed peatland; block of SS on eastern edge. Exclude the section beyond the original fence.

130 P46 (5.4.2) page 95 Checked thicket of SS/SP on an ill drained unflushed peatland.

135 P47 (5.4.3) page 97 Blocks II, III and IV. Essentially SLP. Careful selection of site type required to differentiate either flushed peatland or peaty gley.

149 P58 and P59 (5.4.5) page 103 Clearance of windblow and clear

fell of standing LP on a high nutrient status blanket bog.

6.5 The Lon Mor alone of the main early pioneering experimental areas in north Scotland which featured, with others, in J W Zehetmayar's classic Bulletin 22 seems to have survived intact; the current state of the Achnashellach and Glenrigh experiments is an unknown quantity, but they do not appear to have stood the test of time so successfully, particularly in the latter forest. The Borgie experiments were obliterated by the extensive fire of 1942. On this historical basis the Lon Mor merits retention. However, maintaining the reserve ought not to be synonymous with preservation. Woodlands are complex and dynamic systems; age and decay are inevitable and cannot be halted.

A mention of the Lon Mor to many foresters evokes a nostalgic response, and rightly so, but this has to be tempered with reality when considering the role, if any, of the reserve in future Research programmes.

A decision on the future of this reserve requires a considered appraisal of R and D policy and the specific aims and objectives of Silv(N). Ultimately the choice of strategy adopted concerning the Lon Mor lies with higher management, this review having set out to provide the foundation and framework from which such a decision can be made. A brief summary and report on the current state of the various experiments and trials has been given in sections 3 to 5, and the factors likely to influence any decision on the future of the reserve are outlined in section 6.2. The options are many and frequently interrelated. At one end of the spectrum there is no doubt that effective management of the entire reserve by Research could result in an ongoing varied programme of experimentation with thinning, felling and any other extensive remedial work contracted out; this is probably not a realistic scenario in the present circumstances, however. At the other end of the spectrum are the negative approaches, either maintain the status quo and continue work at a relatively low level, the reserve effectively in

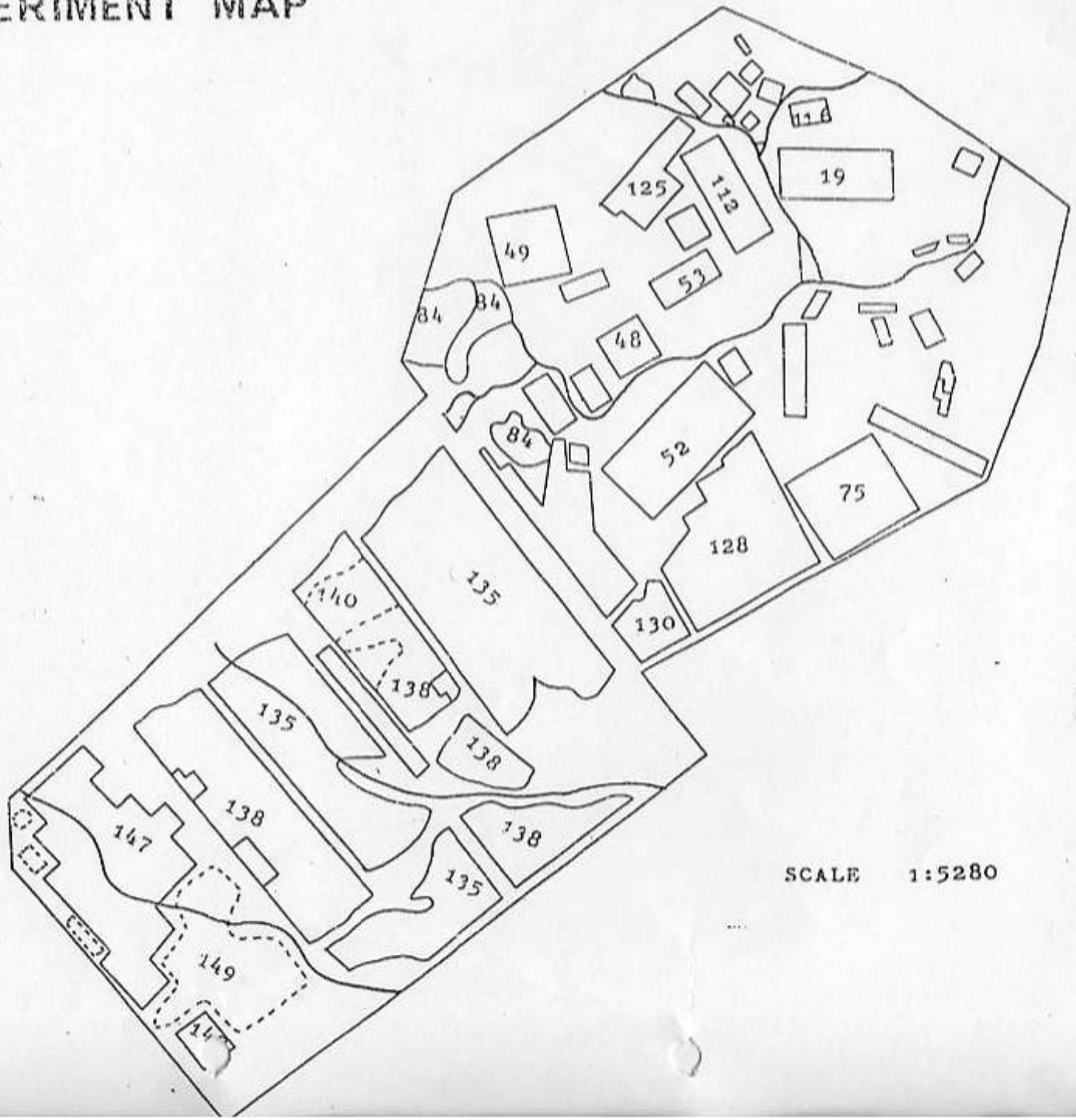
mothballs, or return it in its entirety to the Forest Enterprise having declared an interest in any experiments deemed worthy of retention meantime. I suspect, and hope, that the solution lies between these two end members. One appealing option would seem to be the return of the west Lon Mor to the Enterprise with a declared interest in at least the Alder experiment (147, 3.7 page 23), the original enclosure retained. The West Lon Mor is the more difficult of the two components to manage and arguably of lesser interest than the original enclosure.

That the Lon Mor is of historical interest and still has a potential role in current experimental work is beyond question. It would be a tragedy to abandon it, certainly the original eastern enclosure, to its fate within the Enterprise.

A valuable database has accumulated with ample scope for a wide range of further investigations, for example restocking experiments, further species trials, monitoring of mixtures, root studies and the potential for collaboration with other branches, particularly Wildlife and Conservation, and outside organisations such as MLURI and the Universities.

APPENDIX I

LON MOR EXPERIMENT MAP



N

SCALE 1:5280

LON MOR.

APPENDIX II

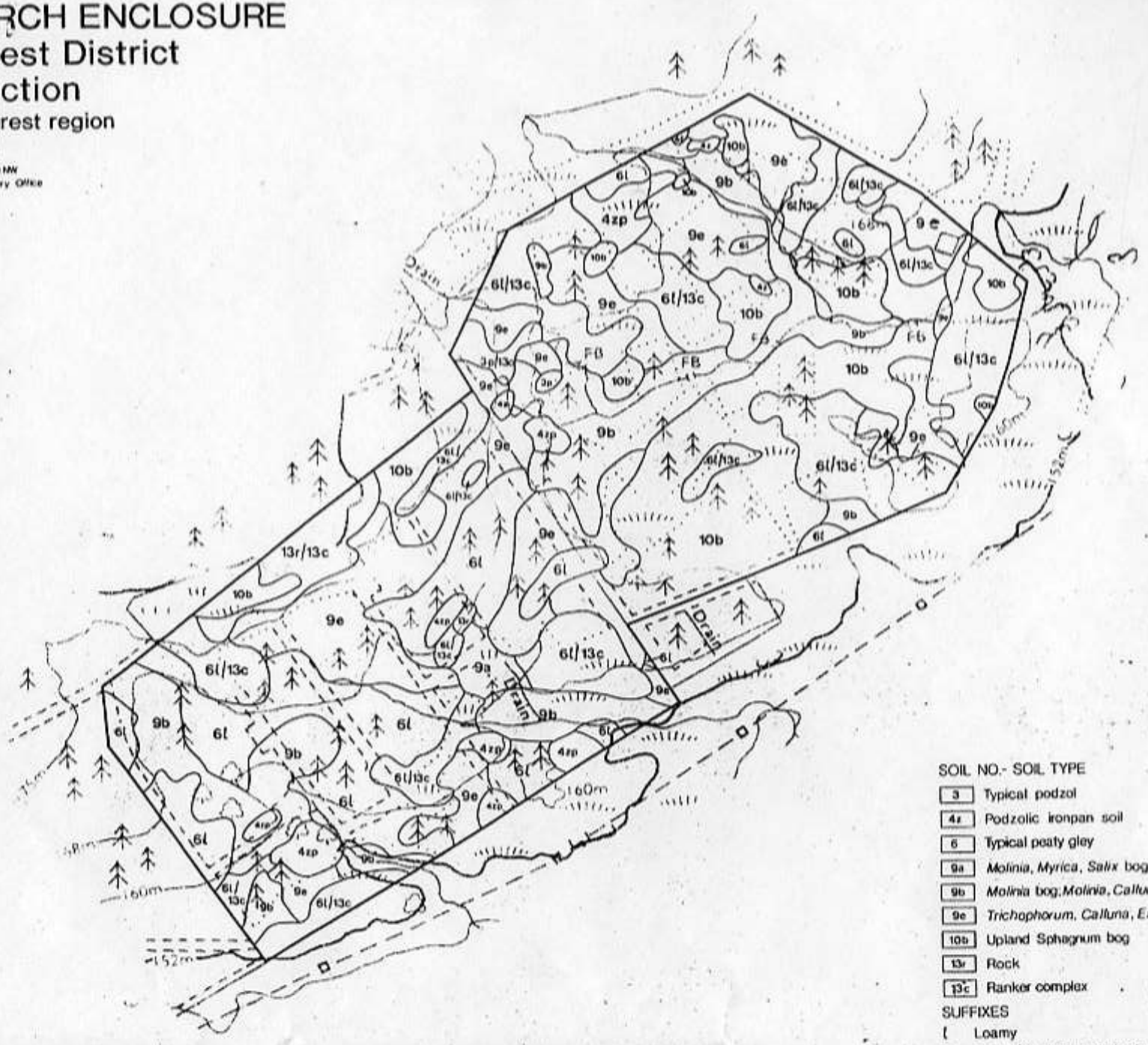
The Original Enclosure

APPENDIX III

LON MOR RESEARCH ENCLOSURE
Fort Augustus Forest District
Inchnacardoch Section
Northern moine highlands forest region

Surveyed by J.S.Innes & J.Davidson 1970

Scale approx 1:4500



SOIL NO.- SOIL TYPE

3	Typical podzol
4r	Podzolic ironpan soil
6	Typical peaty gley
9a	*Molinia, Myrica, Salix* bog
9b	*Molinia* bog;*Molinia, Calluna* bog
9e	*Trichophorum, Calluna, Eriophorum, Molinia* bog
10b	Upland Sphagnum bog
13r	Rock
13c	Ranker complex

SUFFIXES

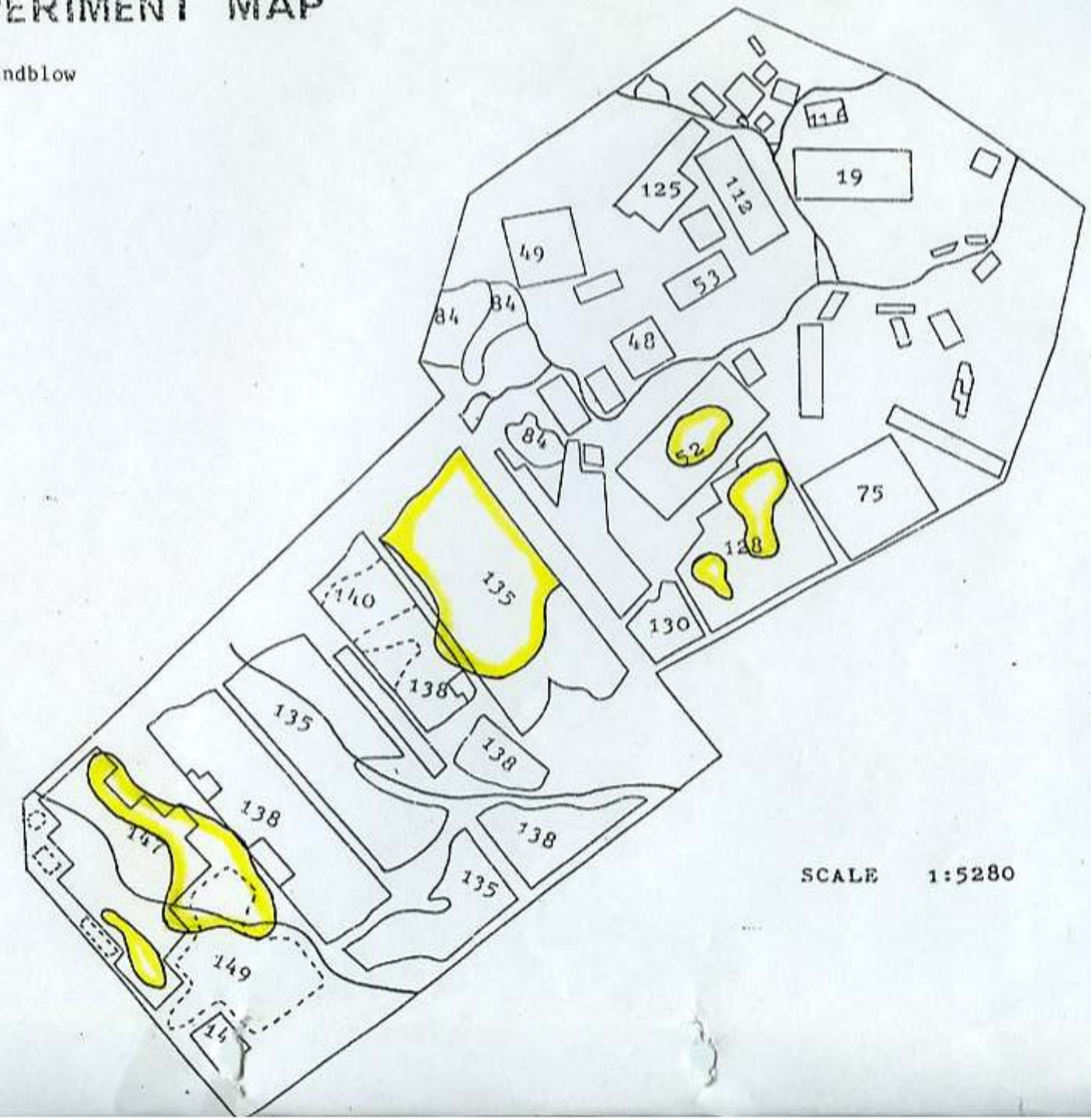
l Loamy

p Peaty (or deeper peat phase) 3p 5–45cm peat
4zp 15–45cm peat

APPENDIX IV

LON MOR EXPERIMENT MAP

Areas of Significant Windblow



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