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No. 28 : 1959

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ACKNOWLEDGMENTS

Thanks are due to the following for providing our photographs:

Mr. John Q. Williamson for Plate 1; Studio 5, Brandon, Suffolk, for Plates 2 and 4; Mr. Marc Sale for Plates 3 and 5; Mr. K. Wilson for Plate 6; the Ministry of Agriculture, Fisheries and Food for Plate 7; the Director General, Ordnance Survey, for Plates 8, 9, 10, and 11; Sir Henry Beresford-Peirse for Plates 12 and 13; Mr. John French for Plate 14; Mr. Anthony A. Vickers for Plates 15 and 16; Mr. Vivian Knowles for Plates 17 and 18; and Mr. I. R. B. Marshall for Plate 19.

All the text figures are based on sketches or photos by the respective authors, except for Fig. 35, which is reproduced by courtesy of the Director General, Ordnance Survey.

EDITORIAL

The Commissioners

The untimely death of Mr. William Hubert Vaughan, C.B.E., J.P., left a vacancy on the Commission which has been filled by the appointment of Alderman E. Gwyn Davies, of Port Talbot, South Wales.

The Commission is now constituted as follows:

The Earl of Radnor, K.G., K.C.V.O. *Chairman*
Major D. C. Bowser, O.B.E.
Lt. Col. Sir Richard Cotterell, Bt., J.P.
Mr. A. P. F. Hamilton, C.I.E., O.B.E., M.C.
Mr. Lloyd O. Owen, J.P.
Major Sir John Stirling, K.T., M.B.E.
Mr. Robert Taylor, J.P.
Mr. Edward Brian Latham
Major F. W. Strang Steel
Alderman E. Gwyn Davies
Mr. H. A. Turner, *Secretary*

Honours

As we go to press we are pleased to record the conferment of the Knighthood of the Garter on our Chairman, the Earl of Radnor.

Others whose services have recently been honoured are Mr. Stanley Longhurst, a former Commissioner, who received the C.B.E.; Mr. G. B. Ryle, Director of Forestry for England, who also received the C.B.E.; Mr. J. P. Mackie Whyte, Conservator for Estates and Acquisitions in our Scottish Directorate, who received the O.B.E.; and Head Forester William Murray, of the Black Isle, North Scotland, who was also awarded the O.B.E.

Promotions and Transfers

At the close of the year our Deputy Director General, Sir Henry Beresford-Peirse, Bt., C.B., was seconded to the Forestry Division of the Food and Agricultural Organisation of the United Nations, with headquarters in Rome. To fill the vacancies that arose in consequence, the following acting promotions have been announced.

Deputy Director General: Mr. James Macdonald, C.B.E.
Director (Headquarters): Mr. J. Q. Williamson, M.B.E.
Conservator (Utilisation) at Headquarters: Mr. E. G. Richards, M.C.

In October, our former Chief Research Officer, Mr. M. V. Laurie, was appointed to the Chair of Forestry at Oxford University. Professor Laurie also becomes head of the Imperial Forestry Institute, and in both these capacities will continue to have many contacts with our work and our staff.

Mr. T. R. Peace, formerly a Divisional Officer, has been promoted to Chief Research Officer, with the rank of Conservator.

Following on the retirement of Mr. E. Wynne Jones, Mr. W. A. Cadman, formerly Divisional Officer at the headquarters of the Welsh Directorate, has been appointed Deputy Surveyor of the New Forest. Mr. R. Drummond, Divisional Officer, has been transferred from South Wales to the Welsh Directorate headquarters at Aberystwyth.

Promotions from District Officer to Divisional Officer during the year were:

Mr. G. D. Holmes, of the Research Branch.

Mr. P. H. Legard, who has moved from the office of Director, Scotland, to South Wales Conservancy.

Mr. K. R. Snook, who has moved from South East England to East England, to take charge of Estates work.

Mr. L. H. Williams, who continues in charge of Estates work in the South Wales Conservancy.

Mr. M. L. David, the Deputy Establishment Officer, left us during the year on transfer to the Ministry of Agriculture, Fisheries and Food. His place has been taken by Mr. N. E. D. Burton.

Mr. A. P. Lenman, Chief Clerk in the Scottish East Conservancy office at Aberdeen, has moved to London on promotion to Chief Executive Officer in the Finance Branch at Headquarters.

Mr. J. Steele, formerly Chief Clerk at Chester, has moved to Aberdeen in the same capacity.

Mr. J. W. Elliott, previously in the South Scotland Conservancy, has been promoted to Senior Executive Officer and appointed Chief Clerk to the North-West England Conservancy, at Chester.

Retirements and Departures

Mr. E. Wynne Jones has retired from the post of Deputy Surveyor of the New Forest, after a ten-year spell of service there which included some notable developments. He was largely responsible for securing agreement on the new "Verderers Enclosures", in which 2,000 acres of heathland will be afforested with particular regard to amenities and the avoidance of accidents to the Commoners' ponies and cattle. He has also carried out much good work in the regeneration of the "Ancient and Ornamental" Woods by means of small temporary enclosures, and he has completed the replanting of all the areas felled during the last war. Mr. Wynne Jones' previous posts included that of Conservator at the headquarters of the English Directorate and that of Chief Acquisitions Officer.

Mr. Eddie Hill has retired from the post of Land Agent in the Forest of Dean after an exceptionally long career, which began forty-eight years previously under the old Office of Woods, Forests, and Land Revenues of the Crown.

We regret to report that Mr. H. Cruickshank, a District Officer in the Research Branch at Alice Holt, who was formerly in charge of the Forester Training School at Faskally in Perthshire, has been obliged by ill-health to retire from the Commission's service.

Mr. A. J. Spencer, a District Officer in South East England, has left us to take up a post with the newly formed Timber Growers Organisation.

Mr. E. C. Shanks, a Senior Chief Executive Officer in Finance Branch at Headquarters, has left us for a post in the General Post Office.

Mr. James Butcher, M.B.E., a popular figure in the Finance Branch at Headquarters, retired during the year, after 38 years service with the Commission.

Four well-known Foresters with remarkably long service who have left us on retirement are Mr. "Tommy" Aston, who had been with us for 41 years, mainly in the South East; Mr. F. W. Everitt who had 37 years service, latterly in the South West; Mr. H. Davies, of Nagshead in the Forest of Dean, who began work under the Office of Woods there, 49 years ago; and Mr. Percy Harrison, Head Forester at Gwydyr, North Wales, who had served in that region for 38 years.

Mr. H. Johnston, a Clerical Officer in the Publications Branch at Headquarters, retired just after the close of the year, having reached an extended age limit of 70 years. During his thirteen years' service with the Commission, he was responsible for sub-editing every issue of this Journal, and this present number, like the others, owes much to his painstaking care.

Obituary

Mr. W. H. Vaughan, who had served as a Forestry Commissioner since 1948, died suddenly on 17th April, 1959. He was widely known for his many public activities in South Wales, and a photograph on our central pages shows him happily concerned with a task dear to his heart—the afforestation of the mining valleys of Glamorgan.

We record with regret the deaths of two well-known serving officers, Mr. D. O. J. Salaman, Higher Executive Officer in the office of Director, Wales, and Head Forester Wilfred Walton, of Thornthwaite Forest, Cumberland.

Among retired officers who passed on during the year, we would mention:

Mr. A. P. Long, formerly Director of Forestry for Wales.

Mr. T. W. Cleland, formerly Secretary.

Mr. James Fraser, formerly Conservator of Forests for North Scotland.

Mr. Frank Smith (aged 88) a former Head Forester, who entered the service of the Office of Woods no less than 70 years ago.

The Hot Dry Summer

The exceptionally long drought of 1959, which extended through an unusually hot summer from April to October, placed a severe strain on our field staff and fire-fighting resources. The number of fires reported and tackled was an all-time record, being 5,600, or roughly twice the previous highest annual figure. On average, each of our 500 forests reported no fewer than 10 fires, while during any average day in the six-month danger season, the Commission as a whole was tackling something like 30 fires.

We are happy to record that despite the long sustained spell of high fire risk, actual damage was slight. Only 5 fires caused damage assessed at over £1,000, or burnt more than 20 acres, while out of a total of 1¼ million acres at risk less than 400 acres were actually destroyed—a proportion of only 0.03%.

The long drought also caused, in some districts, rather heavy planting losses. This, and other effects, such as the "drought crack" of standing trees that occasionally occurs in pole-stage plantations, are now being investigated by the Research Branch.

The New Wing at Alice Holt Research Station

This year has seen the completion of the fine new modern wing at Alice Holt, which cost £134,000, and was opened in July. This is the largest single building constructed by the Commission since its inception forty years ago, for most of our efforts have gone into growing trees, rather than into bricks and mortar. It is also our first substantial building to be planned from the outset for scientific researches, and as such it embodies all the best features of modern design. Each research section now has its own laboratory and associated offices, while the ground floor houses a large refrigerated seed store, associated with the seed-testing laboratory, which holds bulk supplies for general Commission use. A fine new canteen has replaced the old Nissen hut.

These developments have been made without sacrifice to the old Lodge and its park-like surroundings, which everyone agrees have their peculiar charm.

The Sudbrook Pulp Mill

Now that the Sudbrook Pulp Mill, established with the encouragement of the Commission late in 1958, has been in operation for over a year, it is interesting to record its progress. The mill is situated close to the Monmouthshire side of the famous Severn Tunnel, in fact it utilises water pumped from the tunnel itself. It uses hardwoods of low quality for other purposes, drawn from a wide area of southern England and Wales. The pulp produced is not by itself suitable for paper making, but forms a valuable additive to other pulps so used in the various mills of the sponsoring organisation, the Wiggins Teape Group.

During its first year the output of the Mill was 20,000 tons of air-dry pulp, but it is hoped to increase this, possibly to 30,000 tons a year. The green weight of logs required is naturally much greater, and in 1959 it was estimated that the mill took in about 65,000 tons of material, in the form of 5 million separate logs. The specification is for 4-foot lengths, between 3½ and 12 inches in diameter, and no less than thirteen different species can be accepted. The leading species used are: Oak (30%); birch (15%); beech (15%), and ash (10%). The remaining 30% comprises alder, elm, chestnut, lime, willow, poplar, etc. Although the prices paid for the raw material are moderate, the mill provides a very useful outlet for small thinnings and coppice, and also for the produce of scrub clearance jobs.

The peculiar properties of the hardwood pulp produced at Sudbrook, are found to aid the "formation" and the evenness of a surprisingly large range of papers, known in the trade as dry crepe tissue, banks, bonds, writing, greaseproof, glassine, vegetable parchment, and duplicating grades, and this pulp even finds its way into the typist's carbons.

Safety Regulations for Circular Saws

In the interests of avoidance of accidents at work, which can be both painful and costly, we draw the attention of readers to:

Farm Safety Regulations: Explanatory Note

CIRCULAR SAWS

This is a free pamphlet obtainable from the Ministry of Agriculture, Fisheries and Food, Whitehall Place, London, S.W.1., and it explains the provisions of the Agriculture (Circular Saws) Regulations 1959 (S.I. 1959/427) (H.M.S.O. 4d., or 6d. post free). These regulations apply with equal force to forests as well as to farms, and everyone concerned with the operation of a circular saw—whether of the fixed bench or the portable type, should hold a copy of the pamphlet and follow its recommendations.

Heather and Grass Burning

Mr. G. B. Ryle has forwarded us the following correspondence, which we think merits publication in full. Our only comment is that William and Mary appeared much more concerned with the safety of grouse than with that of forests!

Solicitor
E.11/5 LGB/JS

26th January, 1960

Heather and Grass Burning

In an amusing article in the Journal of the Forestry Commission (No. 27: 1958) it is said:

> "A regulation contained in Statutes 4 and 5, William and Mary, C. 23, warns that '. . . to burn on any waste, between Candlemas (February 2nd) and Midsummer, any grig, ling, heath or furze, goss or fern, is punishable with whipping and confinement in the house of correction'."

This I would add would seem to be better as regards both dates and definition of vegetation than those in the Heather and Grass Burning (England and Wales) Regulations 1949 (No. 386), and the punishments too might be more effective! Would you please let me known whether Statutes 4 and 5, William and Mary, C.23 are still on the Statute Book.

Signed, L. G. Barter,

for Director.

FC.6973/HPH
E.11/LGB/JS

Heather and Grass Burning

By 4 and 5, William and Mary, C. 23, Section XI it is provided:

> "that for the better preserving the red and black game of grouse commonly called heath-cocks or heath-poults no person whatsoever on any mountains hills heaths moors forests chases or other wastes shall presume to burn between the second day of February and 24th of June any grig, ling, heath, furze, goss or fern upon pain that the offender or offenders shall be committed to the house of correction for any time not exceeding one month and not less than 10 days there to be whipt and kept to hard labour".

The enactment was repealed by 1 and 2, William IVth, Chapter 32, Section 1.

There is a weekly programme put out by the Independent Television Authority called "Laramie" in which the Indians frequently bite the dust and the cowboys are armed (inter alia) with stock-whips as well as the more conventional six-shooters. I therefore suggest that you might hand over to the Independent Television Authority all the whips which you had purchased in anticipation of enforcing the provisions of the Repealed Act of William and Mary. You must continue to rely I am afraid, on the Heather and Grass Burning (England and Wales) Regulations, 1949.

Signed H. P. HALL

for the Solicitor

4th February, 1960

The Director (England),
Forestry Commission.

Solicitor
E.11/5/LGB/JS 9th February, 1960
F.C.6973/HPH

Heather and Grass Burning

Thank you very much for the advice in your memo of the 4th February, 1960. What you say is particularly interesting as, otherwise, I would have been unaware of the programme to which you refer. It would seem even more absorbing than the exploits of a certain Mr. Charles Drake who I believe can be seen in the same medium.

As it happens I cannot take your advice because I had not put the case to the Treasury for the purchase of the whips—as good clients the Commission were obtaining your advice first.

Signed, L. G. Barter
for Director

Ship Building Stagings

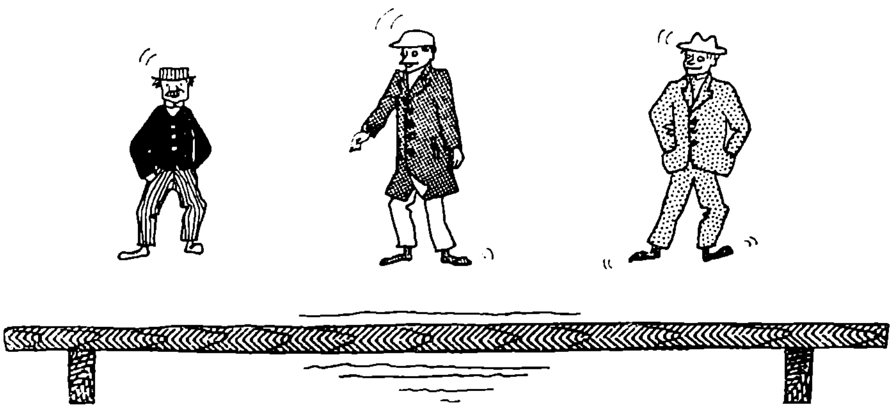
In these days of highly scientific tests and statistical analyses, it is refreshing—at least to some of us—to read of material being tried out in the old hard way.

The following account by Mr. William Gregory, a Director of the well-known timber firm, Denny, Mott and Dickson, is reproduced by kind permission of their house journal, *The Denny Log:*

"Ship building stagings" is a familiar term with those timber importers who cater for ship-building, but what are they?

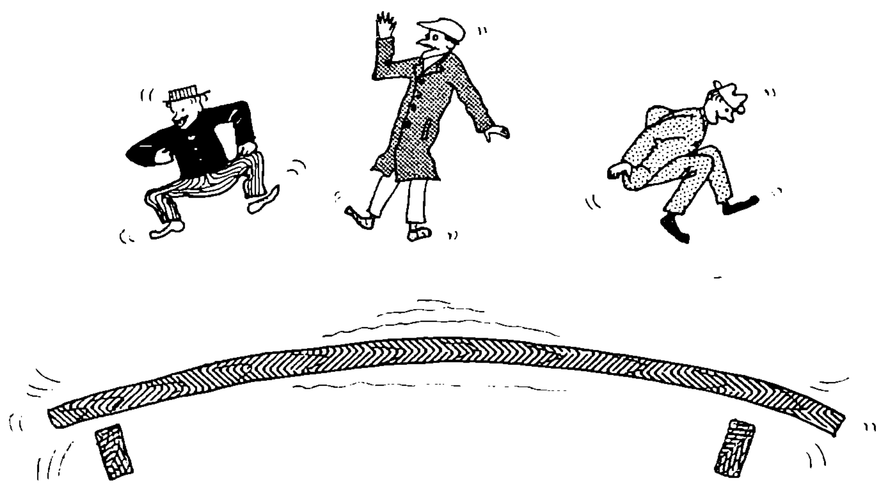
"Stagings" are planks, usually 3 in.×9 in., which are supported by a steel scaffolding round the ship under construction. The staging planks are fixed, usually three together, according to the job concerned, to give a 27 in. width. The distance between the steel uprights is 16 feet, with a minimum overhang of the planks at each end of 1½ feet, thus requiring a minimum over-all length of 19 feet for outside stagings.

In many commodities, including wood, it is fashionable these days to test stresses and strains by scientific methods, but many shipbuilders still prefer to carry out their tests, which for safety's sake must be severe, by the time-honoured practice of mounting staging-planks between two blocks. Three men are then called upon to bounce on the plank in an effort to reproduce, in an exaggerated manner, realistic conditions, until the timber inspectors are completely satisfied. Infrequently a plank will break under the efforts of the 30-odd stone of bouncing humanity, and occasionally a slight cracking noise will indicate a flaw in the plank under test, but as has been indicated, conditions of such severity are hardly likely to arise in the working life of a staging plank.



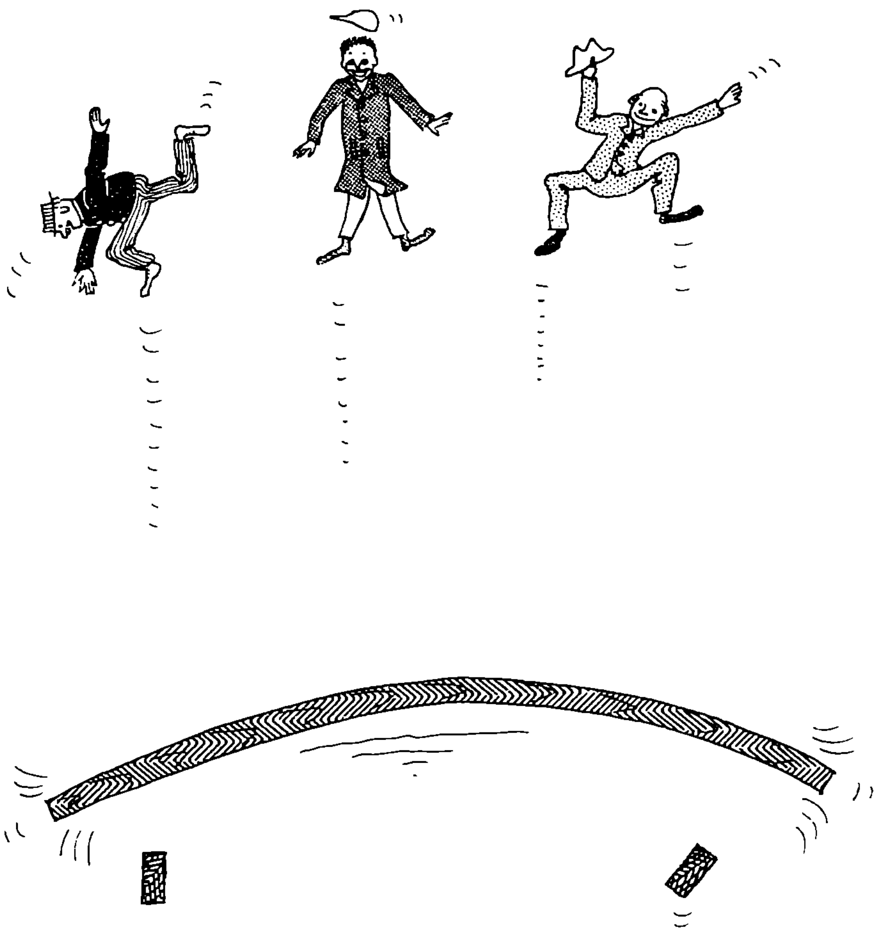
Every time . . . .

Danger money for this work? No—the drop is insignificant. The men enjoy the act, and physical damage, even slight, is almost nil over long periods. Furthermore, the testers know the sounds and are quickly off the plank if they suspect that a break is imminent.



. . . . *She bumps* . . . .

What is the life of a staging plank? In other words, when do the shipbuilders decide that a plank has "had enough"? In the end, even the sturdiest plank must weaken under this usage, and no risk must be taken with the lives of men working from 80 to 90 feet from ground level. It is difficult to pin down this question of "life" with any accuracy. From the keel level of a ship, stagings are assembled progressively to the full height of the hull and so remain until all work up to launching is completed. An average period, dependent upon size, of say 8 to 12 months on the stocks will find a ship ready for launching, after which the stagings are available for a repeat performance on a new ship. Any planks which have become unsound by visual damage are relegated immediately for less-exacting purposes, or cross-cut to provide a shorter plank for "inside stagings" that is, the inside of the hull, where shorter lengths can be used.



She bounces !

After being used for two or three ships as outside stagings, when fair wear and tear will have reduced the efficiency of these planks, they can still fulfil a purpose, being cut up for launchways, general carpentry, etc. Therefore, the average ship-yard life of the original outside staging plank may be anything from 4 to 6 years, which is a very useful performance, but it is all a matter of experience.

It is always an education to accompany a ship-yard timber inspector, wearing the traditional bowler-hat of authority. They sniff out imperfections in a parcel of timber quickly and convincingly, which is so helpful to the importer catering for this highly specialised and interesting industry.

In pre-war days Archangel and Onega whitewood were favourite timbers, light in weight but very strong and resilient; 3 in.×9 in., 3 in.×10 in. and 3 in. ×11 in., containing large percentages of 19 to 24 feet lengths were freely available during the short import season. During and since the war Douglas fir has established a good reputation and latterly Western hemlock has proved to be satisfactory. Eastern Canadian spruce, western white spruce and Swedish whitewood (i.e. Norway spruce) have also been used successfully.

Have you ever looked down to street level from the top of a high building? That is the "stager's" view from his perch high up on the ship's side, working in conditions of discomfort and often with an almost unendurably noisy racket going on around—iron decks clanging into position, riveting outfits with their machine-gun rat-tat-tat. That is why ship-builders are so "choosey" in regard to the species of timber they select for stagings, for in such conditions a man on the staging must feel confident that the breakage hazard is remote, and the ship-builder must maintain his reputation for the care of his men.

A toast then to the man on the staging and to the bouncer!

The Poet and the Axe-Helve

Mr. H. Johnston has brought to our notice a striking passage from the works of Robert Frost, the modern American poet. Describing how a French-Canadian woodsman prepared a new handle for an axe, Frost tells us:

"He liked to have it slender as whipstock,
Free from the least knot, equal to the strain
Of bending like a sword across the knee.
He showed me that the lines of a good helve
Were native to the grain before the knife
Expressed them, and its curves were no false curves
Put on it from without. And there its strength lay
For the hard work . . ."

No doubt our Work Study Section will agree with this specification, but what impresses us most is the beauty that a poet can discover in everyday tasks and ordinary objects.

Our Journal

Following the departure of Sir Henry Beresford-Peirse to Rome, Mr. James Macdonald has become Chairman of the Editorial Committee, and Mr. George Ryle has joined that Committee.

This year we have resumed the old custom of showing, in the Staff List, the honours and decorations held by members of the staff. As our records may not be complete, the Editor would welcome a note of any additions or corrections that should be made. All civil or service awards qualify for mention here, but we do not include academic or professional distinctions.

Contributions

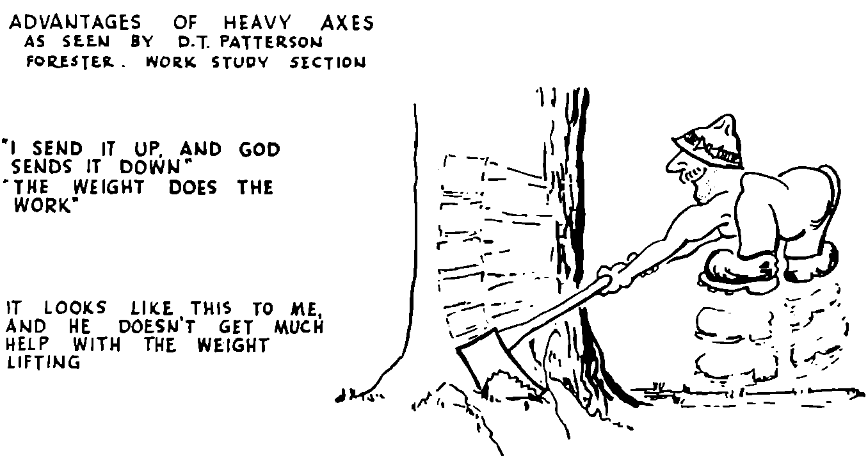
We welcome articles on any subject having a bearing on the Commission's work, from any member of the staff, whatever his rank or profession. Contributions should be forwarded through the usual channels—normally the Conservancy office—to the Editor at Savile Row, and should be accompanied by a note of the author's rank, official station and postal address. They should preferably be typewritten, in double spacing, on one side of foolscap sheets; we can accept a limited number of photographs, and also rough sketches, diagrams, or finished drawings. There are no set limits of length, and brief notes may sometimes be as valuable as full-length reports.

This Journal circulates only among Commission staff, and some intending contributors may feel that their article merits the wider readership of the general forestry profession. In that event they should consult the Editor, who will advise them as to which of the several forestry journals appears appropriate for their particular work.

Erratum

An alert, studious, and careful reader has spotted a slip in "Report on the Forest Worker's Course at Laubau, in Bavaria", an article by C. A. Allison that appeared in the Commission Journal No. 27, 1958. It is pointed out, and the author agrees, that under the *Peeling Spades*, side-heading, the spades referred to are light-weights (almost fly-weights) and not heavy-weights.

On page 66 of the previous Journal therefore, the weight shown in brackets (12 to 24 lb.) should be 10.6 to 21.2 *ounces*. Stated thus correctly in ounces, these are much more workable figures, and spades! Even the toughest forest worker might have found a 24 lb. peeling iron a *trifle* too heavy towards the end of the day's work.



. . . . *Weight-lifting or Axemenship?*

JOURNAL OF THE FORESTRY COMMISSION, No. 28, 1959

NOTES ON A VISIT TO BULGARIAN FORESTS

By SIR HENRY BERESFORD-PEIRSE
Deputy Director General

This visit was made, at the suggestion of H.M. Minister in Sofia, Mr. A. K. Lambert, on my way back to England from Turkey where I had been attending a meeting of F.A.O. Working Parties during the spring of 1959.

Sunday, 3rd May

The journey from Istanbul by the Orient Express to the Bulgarian frontier was uneventful and the country dull. Frontier formalities were easy but prolonged and numerous; customs, police, railway officials, currency, medical (to see vaccination certificate).

Monday, 4th May—Train journey across Bulgaria

The contrast between the Turkish plains and the Bulgarian plain each side of Plovdiv was marked. In Turkey the fragmentation of holdings was obvious with some land well worked, other poorly. In Bulgaria the plain looked fertile, fields larger and well farmed with much evidence of new drainings and irrigation, uprooting of old trees, building of farms and some planting of poplars in rows.

The people are much better dressed and the officials, police and railway, tidier and cleaner. It was misty and raining so it was not easy to get an idea of the mountain which ran steeply to the plain, but from the appearance of the rivers erosion and flooding must be a serious problem, as in Turkey.

The land looked much more lush and the grazing, for instance under orchards, far less heavy than in Turkey. The villages at the bottom of the foothills looked very much like Turkish ones.

About two hours from Sofia we began to climb steeply between wooded hills. The forests looked as if they were managed and growing from degraded scrub to hardwood high forest. There are signs of terracing and planting with conifers.

Monday, 4th May—Afternoon visit to Vitoshe

This is a large, mainly granite, mountain rising steeply to a height of some 7,500 feet south of Sofia. All grazing was stopped on the forest part of the mountain a considerable number of years ago which has allowed the degraded coppice to grow up and the whole area is now in the charge of the Forest Department managed specifically as a national park. Above the coppice, which is largely oak and beech, the usual Norway spruce, silver fir, beech, aspen and towards the top Scots pine are to be found. On the east side fast growing plantations of Scots pine and *Pinus peuce* have been established almost up to the tree limit of 6,000 feet. Roads, restaurants and parking places, have been and are still being built.

Tuesday, 5th May—Visit to Stalin Dam and Borovetz Forest, south of Sofia on the eastern part of the Rila Mountains

The whole of the catchment area of the Isker river, amounting to some 50,000 acres, has been comprehensively treated with the main purpose of providing hydro-electric power. The main dam is the Stalin Dam, which has created an artificial lake some eleven miles long, said to be one of the largest artificial lakes in Europe. There are two smaller dams below it. The Bulgarians are very conscious of the dangers of erosion and consequent silting of the dams, and some six years ago removed all grazing animals from the catchment area, except on a very small scale near villages where the risk of damage was negligible. The catchment area has been, and is being, afforested mainly with pines; Scots pine and *Pinus nigra* var. *austriaca*, sometimes interspersed with *Betula alba*. Almost everywhere, particularly where the slope is moderate to steep, simple but effective terracing is done (see Fig. 1). Degraded coppice is being allowed to grow up, gaps being filled with conifers. The work seems to be thoroughly effective and the whole project well conceived. Wisely, the anti-erosion work has been put in the charge of the Forestry Department.

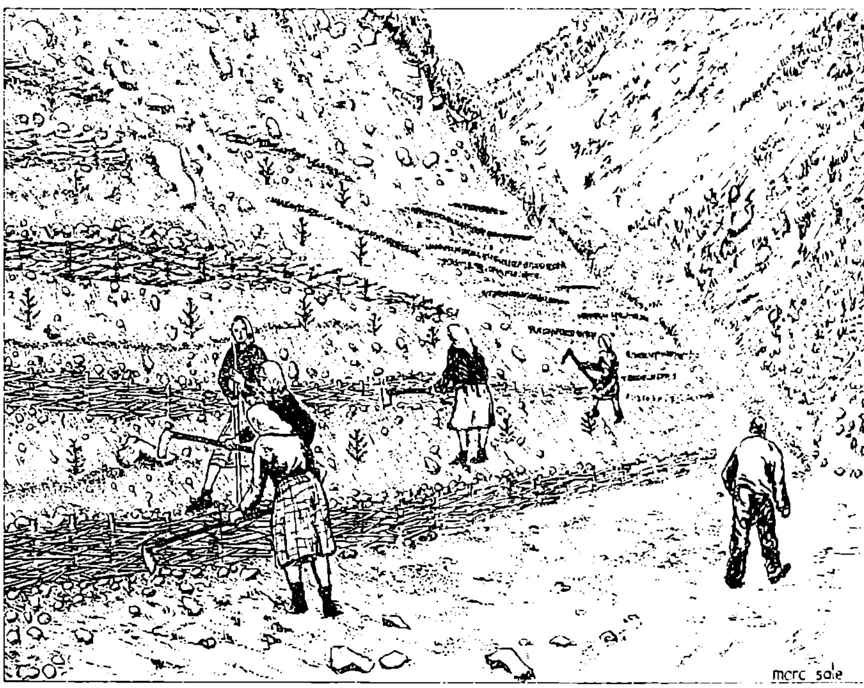


Fig. 1. In the catchment area of the River Isker, Bulgaria. Women workers terracing the eroded hillside, and planting Scots pine.

Above the main catchment area the ground levels off into a small plain, where agricultural improvement has been done on a considerable scale, including clearing of scrub. This again is the proper development where there has been very considerable disturbances elsewhere of the previous grazing regime.

The whole project looks very impressive, but no mention is made, of course, of the inevitable social upheaval caused by the complete removal of grazing over a very large area on which, no doubt, a considerable population depended. Apart from this aspect the treatment of this catchment area seemed to be a model solution of a problem common to so many areas of the Mediterranean basin.

Borovetz Forest. This is a typical natural forest of central Europe, consisting mainly of Norway spruce, common silver fir, with some beech, birch and aspen. It is mainly steepish country where erosion is a danger, and the forest is managed on the traditional selection system. There is probably an over-stocking of the older ages, but this will be corrected. Much of the Norway spruce is badly infected with *Fomes*, but the foresters seem to accept this as normal. Silver fir is little affected. In one excellent stand which we visited the mean annual increment was said to be about 9 cubic metres per hectare (100 hoppus feet per acre). (Judging by the very narrow rings to the inch, I doubt this figure).

A foresters' training school, of which there are several in the country, was visited. It had nothing particular about it, except the rather scruffy and cowed appearance of the students. We were shown over the Sitniakovo Palace, which was one of King Boris's shooting lodges. It is quite simply made, largely of wood and seems to have been left almost exactly as it was twenty years ago. It is now used occasionally as a rest house for writers, painters, etc.

Wednesday, May 6th—Visit to the east side of the Rila mountains

On the way to Rila, which is a spectacular range of mountains rising to 2,925 metres (about 9,000 feet)—the highest mountains in the Balkans—we crossed fertile agricultural land clearly recently collectivised. There had been much planting of peach trees and a considerable use of poplars along river beds and roadsides. The planting stock is rather poor but I was told that the Bulgarians have now the advice of an Italian expert and are beginning to use Euro-American hybrids.

All over the country the very effective use of roadside planting is a feature, poplars, acacias and on a growing scale fruit trees are used. There is as yet little sign of shelter planting other than roadside, though I was told that on the north eastern plains of Bulgaria shelter-belts were being laid down on a considerable scale.

The forest on the west side of the Rila range was of no particular interest except that in travelling eastwards into the mountains there was a good example of rapidly changing types beginning with degraded hardwood, only recently relieved from grazing, changing to high forest, with beech—mainly on the north-facing slope and oak (*Quercus petraea*) on the south-facing slope. Then follows mixed beech, Norway spruce and silver fir, which again changes to Scots pine at the highest level. The forest is managed under a working plan which I saw, in the usual classical form, the valley bottom and lower slopes being treated as productive forest, the extremely steep sides being considered as protection forest only. Little felling and extraction was seen because it was still the season for planting, but one Wyssen cable way was in action. The tendency in the mixed forest is for silver fir to predominate, and management is concerned to keep a high proportion of spruce whose timber is more valuable.

The forest service is responsible for all work up to the point of haulage away from the forest and subsequent conversion; this is the responsibility of a separate ministry. It was emphasised to me, however, that it is strictly the forest service's responsibility to decide what timber is to be felled and when. There is a special working plans branch at headquarters which makes and revises working plans every ten years, though these have to be fitted into the general five-year economic plans of the country.

Thursday, May 7th

It had been planned to pay a two-day visit to the forests in the south-east of Bulgaria, spending a night at Plovdiv, but unfortunately time did not allow for this and instead a visit was made north from Sofia to the Balkan mountains.

On the south side the foothills, which consist largely of limestone and schist, often suffer badly from sheet and gully erosion. It was explained that over the whole of Bulgaria there had been a clear allocation of land between forestry and agriculture, and when I asked if any steps were being taken to prevent any further gully erosion (which I saw) I was told that this was on grazing land and that the first concern of the forest service was to prevent erosion in those catchment areas which are being used for hydro-electric and irrigation work. When these projects are completed, the forest service hopes to tackle the erosion problem on the grazing lands. This seems sound. Rising up to the Petro-Han pass, close to the Yugoslav border, the degraded beech coppice gradually improved until there was reasonably high forest near the summit of 1,430 metres (4,500 feet). Here also was a very satisfactory plantation of Norway spruce, thirty years old, much as one would see in England, of second or third quality class. There were also satisfactory plantations of Scots pine and *Pinus nigra*. The good growth of these trees has led the forest service to decide to introduce conifers by planting, when regenerating lower quality class beech.

Continuing further north on the north side of the mountains, and facing the Danube basin, the beech forest improved, and there were some fine stands with tall straight boles rising to a top height of one hundred feet. Diameters are small, seldom exceeding 15 inches as the stands are dense. We saw an example of their regeneration by "coupe progressive". The beech regeneration was dense and any small gaps had been filled in with Scots pine and Norway spruce. They use far too many plants, to our way of thinking, but are determined to introduce conifers somehow.

A final visit was paid to Varshetz, which is a village with mineral springs which has been developed as a holiday and health resort. Various Trade Unions have rest houses to which they send their members and there is the usual house of culture, mineral baths, recreation gardens and park. There were crowds of gaily dressed, apparently cheerful citizens young and old, and the whole set up was reminiscent, on a very small scale, of the Russian establishments at Sochi on the Black Sea.

The only forestry interest in the park was a fine stand of *Pinus peuce*. I had heard a good deal about the fine forests of this species that they have, but this was my only opportunity of seeing the tree, which was certainly impressive and of a better growth and form than the nearby Scots pine and black pine.

General

My impression of the relatively small amount of forestry that I saw in the country was of work well done and well planned by a keen and efficient service. The head of the forestry division in the Ministry of Agriculture, Mr. Jordan Petkov, who spent two days with me, was a friendly and intelligent man, as was one of his assistants, Mr. Vatchovsky, who took me to the Balkan mountains. The foresters that we met were much like foresters in all countries and seemed to be on friendly and easy terms with their superiors.

I had an hour's conversation at the Ministry of Agriculture with the Deputy Minister, Mr. Mako Dakov, who is responsible for forestry, together with Mr. Jordan Petkov and Mr. Bony Petkov, one of his assistants, on the day of my arrival on May 4th. This was only a general conversation through a very indifferent interpreter, but it was clear that Mr. Dakov was not simply the political head but was himself a professional forester who had a clear grasp of his country's forestry programme. From having read the account of the Russian foresters' visit to Great Britain he had a good idea of our own programme.

Mr. Dakov told me that the forestry development programme was to deal with 175,000 acres a year. This was mainly concerned with restoration of degraded forest but included some new planting. This sounds a very large programme—one of the largest in Europe—but it is impossible to judge its real scale without knowing what work is involved in restoration work. This may consist of no more than the exclusion of grazing animals and the planting of a small number of conifers per acre.

I left some literature and photographs of British-made forestry machines and equipment in which Mr. Dakov said he was very interested, but I had no chance of discussing machinery because the transport and conversion of timber is undertaken by a separate Ministry.

Value of the Visit

It is well to consider what value, if any, comes from a visit of this kind. I am in no doubt of its importance on three main counts.

First, it is policy that contacts should be made with Eastern European countries and a good way of doing this is on a strictly technical level. Politics need not enter into discussions at all and as a result conversation, albeit through an interpreter, can be easy and unstrained. There seemed to be no restriction on travel or photographs. My experience in these respects was the same in Bulgaria as in Russia.

Secondly, it is probably useful to learn something, however superficial, of the scale of work, and administrative and technical efficiency, of one branch of the activities in an Eastern European country.

Thirdly, I found this visit unexpectedly valuable from my own forestry angle. I am frequently concerned with F.A.O.'s "Mediterranean Project"—most recently in Turkey. I saw in Bulgaria the full range of work carried out on a catchment area over a short period of five or six years, which is often described on paper and verbally, but which I had not previously seen put into practice—hydro-electric and irrigation works, removal of grazing, afforestation combined with terracing, improvement of agriculture outside the erosion danger area.

A point of minor interest is that I was able to arrange an exchange of tree seeds—conifers to Bulgaria and birch and beech to Great Britain.

Photographs taken during the visit appear on the centre pages.

ROYAL FORESTRY SOCIETY OF ENGLAND AND WALES SWISS AND GERMAN TOUR, 2nd—12th OCTOBER, 1959

By D. J. MACRAE

Forester, West Scotland Conservancy

Before commencing the diary of the above tour, it might be advisable to give a general description of the forest "set up" in Switzerland.

The 1955 survey of land use, produced the following analysis:

Productive Forest	2,423,070 acres	— 24%
Arable, including vineyards	679,250 ,,	— 6%
Livestock and Dairy Farming	2,030,340 ,,	— 20%
Alpine Pastures and other part-productive areas	2,660,190 ,,	— 26%
Total Productive	7,792,850 acres	— 76%
Total Unproductive	2,405,780 ,,	— 24%
Total Land Area	10,198,630 acres	—100%

Forests are somewhat unevenly distributed, with the principal concentrations in the Jura and the South of Switzerland. By the Middle Ages, forests had been cleared from sites which were reasonably suited to farming. The final ban on further deforestation became effective in the 19th century when the effects of a succession of floods and avalanches, focussed the public attention on the protective powers of forests. Since then, 82% of the existing forest area has been designated protective forest, required by law to be maintained as growing forest in good order. This area, of course, includes low quality woodlands and scrubland areas, listed above as unproductive. In 1956, a total of 1,447,000 acres were being worked in accordance with officially approved working plans and this accounts for about 60% of the total woodland area. Privately owned forests are mostly very small in area and are seldom worked in accordance with a working plan. The same survey showed that 95% of the publicly owned woods were managed as high forests, or were in process of conversion. The Swiss climate is fairly similar to that of England. Rainfall varies a great deal from North to South and, in general is between 20″ in the N.E. and 75″ in the Jura area. An average yearly temperature of 9°—12° C. is found on the South-facing shores of most Swiss lakes and on the South-side foothills of the Alps, while the Jura area has a yearly average of 4°—7°C. The important lowland area has an average of 7°—8° C. The following is a comparison of frost conditions in Zurich and Nottingham.

Days on which frost occur:

	Jan.	Feb.	Mar.	Apr.	May	June
Nottingham	16	16	14	11	4	1
Zurich	25	21	16	3	2	—
	July	Aug.	Sep.	Oct.	Nov.	Dec.
Nottingham	—	—	1	7	14	14
Zurich	—	—	—	2	10	23

It may be noted from the foregoing table that while Nottingham had only two frost-free months, Zurich had no frost during the period June to September, an important factor in the growing of trees.

Switzerland is divided into Cantons or states, of which there are nineteen. The Cantons are permitted a great degree of internal freedom, and for the most part, the woods in each Canton are managed by the Local Government, which resembles somewhat our County Councils. They decide the best methods of forest management and they also decide the size of the "Annual Cut", in order to carry out the policy of sustained yield.

Over the past thirty years, a more or less standard method of forest survey has been developed. The "Method of Control", first used over sixty years ago, has been improved upon and is now more or less universally in use. This method consists of enumeration and callipering at Breast Height of all stems above 6 inches. By similarly measuring all felled stems, a complete picture of the increment during each management period can be obtained. There are many classes of woodland owner within each Canton, but management methods are generally uniform. Broadly speaking, forests belonging to the confederation, the Cantons and communities, can be classed as publicly owned, while woods belonging to particular individuals are private.

It is left to the Cantonal government to decide how to assess co-operatively owned woodlands. Publicly owned woods at present amount to 70% of the whole forest area. The Federal Forest Service is a section of the Ministry of Home Affairs in Berne and is headed by a Chief Inspector of Forests, with a staff of three senior assistants and seven inspectors. The day-to-day management of the forests is in the hands of the central forest administration. All senior forest officers must hold, at least, the forest engineer's diploma of the "E.T.H." forestry school and also a certificate which is issued by the confederation. The time involved in taking these certificates is four years and thirteen months respectively.

Swiss forests are managed on one of two systems, namely, the Femel system whereby attention is paid to groups of trees of varying sizes, or the Plenter system which is the true selection system.

With the Femel system, groups are always fairly small and irregular in shape, with boundaries which are not too sharply defined and such groups may be formed as the result of small clearances in the old stand, regeneration under shade or regeneration under side shade.

They may also be planted, but are most commonly a mixture of both planting and natural regeneration.

With the Plenter system, all age classes are maintained in the most intimate mixture possible. Particular attention is paid to the mixing of sizes, so that live foliage exists from the forest floor level upwards. In this way there is never any break in the sequence and when a Plenter forest is being marked for felling, the one marking must cover every silvicultural operation simultaneously—regeneration, clearing of younger age classes, thinning and final crop felling. It is commonly believed in Switzerland, that forests which can contain a reasonable proportion of silver fir (*Abies alba*) can and must be managed on the Plenter system.

The average labour requirements on properly worked forests, for either system, is said to be one man for 173 acres. The breakdown of a typical time sheet is: Felling and extraction—45—60%. Weeding, Cleaning, etc.—5—20%. Planting—5—15%. Road Making and Repair—5—15%. Holidays, etc.—5—10%. It will be noted that draining, which is one of our bigger items of expenditure, is not considered worthy of mention. The Swiss forest working year amounts to 2,400 hours—almost the same as our own.

Our first visit, on the Saturday afternoon of our arrival in Switzerland, took place to the Berne town forest, which lies on the outskirts of the city and which covers an area of 8,233 acres. Revenues derived from sales of produce, shooting rentals, etc., are devoted to the upkeep of museums, libraries and theatres and for poor relief. Such revenues amount to an annual sum of £4 per acre. The area which we visited, and which is managed on the Femel system, consists of groups of Norway spruce and beech of around 120 ft. in height, adjoining groups of *Abies alba* and Scots and Weymouth pines and groups of younger Norway spruce, Scots pine, and *Abies alba*, varying in size from 2 to 10 ft. The whole area contains a large amount of naturally regenerated beech of varying sizes, which helps to keep down weed growth to a great extent. The sequence of operations in managing the woods is:

Weeding: The cutting back of weed growth and cutting out badly shaped or damaged trees; regulating the mixture by uncovering the desired species and cutting back the edges of groups to avoid abrupt borders.

Cleaning: Cutting out damaged or badly-shaped trees in the upper storey and giving more light to light-demanding species, such as larch, Scots pine and oak.

Selective Thinning: Selecting the healthiest trees at, if possible, regular distances (2/3rds the height of the trees) and marking their respective most acute oppressors, for felling.

Great care is taken to preserve the secondary stand, whose function it is to maintain a relatively moist and windstill interior climate and to provide soil shade, thereby favouring leaf litter decomposition. Thinning operations are carried out every six to fifteen years, depending on age, site, etc. The average growing stock in the stand which we saw, was 3,827 H. ft./acre, composed of 74% conifers and 26% leaf trees. The average annual increment is 67 h. ft./acre, of which 56 h. ft./acre is the allowed annual cut from the main stand and 4 h. ft. is minor produce. Felling is done in winter and extraction is carried out by the use of the "Unimog" tractor.

Although these woods are on the city doorstep as it were, there is a surprisingly small amount of litter to be seen. We saw many parties of picnickers in the woods, who all appeared to be very careful with the disposal of papers, tin cans, etc. It was rather a pleasant change from what one sees in some of our woods which are accessible to the public. The Swiss foresters seemed to think that the reason for this care on the public's part, is due to the fact that the woods are publicly owned. It seems to me, however, that this is due to an inherent sense of cleanliness on the part of the Swiss people. On the other hand, one sees manure heaps within yards of dwelling house doors, but as one member of the party remarked, "At least, the heaps are tidy!"

Sunday, 4th October

A visit to the Schwarzenegg area, where the Plenter system is being practised. The main communally owned woods amount to 2,200 acres, ownership of which is distributed between communities of "Parish Councils". Height above sea level is from 3,000-4,000 ft. The sub-soil is tertiary conglomerate with glacial moraine covering in parts. Soils are deep and fertile, with a high clay content, and liable to water-logging in some places. Average rainfall is 48 ins. on the low ground and nearly 80 ins. at the highest point. Growing tree stocks are between 4,611 h. ft. and 6,564 h. ft. per acre. The annual increment has dropped over the past thirty years, from 123 h. ft. to 83 h. ft. per acre, thought to be due to an excessive growing stock and too high a proportion of large trees. The allowable annual cut is 87½ h. ft., felling being done in winter and extraction, by means of horse sledges on the snow, in the Spring. Produce is valued at £18 per acre, and expenses are £12, leaving a net profit of £6 per acre. The *Abies alba* which we saw in the second wood, are magnificent trees of heights of up to 160 ft. The growing stock here, has been more or less constant over the past thirty years, but the proportion of larger trees has increased. Nevertheless the increment in this particular wood has been maintained. *Abies grandis* were introduced at one time, but they failed at about 50 years of age.

In the afternoon, a visit was paid to a farm belonging to Colonel Charles von Wattenwyl at Ober Diessbach, where various aspects of farming were seen and discussed. One item which intrigued me was the use of dandelion as a silage crop. Colonel von Wattenwyl is a very keen horseman and was in fact, a judge of horse jumping at the Olympic Games in 1959.

Monday, 5th October

Our visit was to the Rapperswil Town Forest which has a total area of 856 acres. The primary aim of this visit, was to see felling operations and the cutting up and grading of produce, for marketing to best advantage. Two workers demonstrated the felling of a very large Scots pine. This tree was measured and logs were graded according to a class scale before being cut into lengths. All measurements were taken under-bark, as all felled conifers in the wood must be de-barked by 1st May. Cost of felling, peeling, extraction to road or rideside, and the cutting of faggots, was 1s. 6d. per cubic foot. The tools which were employed were similar to those used in Great Britain. The power saw was an American "MacCulloch", a very light machine and, I believe, superior to the "Jobu". Fuel wood was cut into lengths by circular saw, at the roadside, and branches were made up into bundles for sale by auction. Wood forms a large part of fuel used for domestic purposes in Switzerland. Most of the houses have large slow combustion stoves which burn faggots. There is surprisingly little waste in the forest; even small branches and twigs are sold to shops for use as decoration and also to garden and nursery owners for use in mulching. Needles and beech leaves are used as compost for nurseries. Telegraph poles were being stacked at the roadside ready for transfer to a processing depot.

The solution, which is salt soluble, is inserted through the end of the pole by a pressure/gravity process. Each pole is placed on a slope below the level of the tank, and a cup is placed over the end of the pole, to which a pipeline leads to the tank. The solution enters the grain and runs, or is forced, along the length of the pole.

Telegraph poles are not peeled until after being treated. The process is based on the idea of displacement of moisture.

Tuesday, 6th October

The party went to the Forestry Research Institute at Birmensdorf. After an introductory address by Dr. Nageli (Head of Section I of the Institute), on the respective climates of England and Switzerland, members were given a choice of subjects to be discussed and visited. I went with a small party to see the Institute Nurseries. There, we saw compost being prepared from leaves and conifer twigs and needles. These are cut up by means of chaff cutters and mixed with ammonium sulphate in the proportion of one, one and two. Compost is treated several times a year and by the end of three years, is ready for use in covering seed beds etc. The subject of "damping off" in seed beds, has been dealt with at this nursery and it has been found that the introduction of a sixty per cent shading of the seed beds by means of slatted covers, has actually, more or less, eliminated the trouble. The addition of leaf/twig compost, as a covering for seed beds, has also helped considerably. Various machines for use in weeding lines were demonstrated, some of which were quite good. A machine which is used extensively for planting trees in rough, stony ground, was also demonstrated. This machine is power driven by a two stroke petrol engine and resembles a hole borer, for use in digging strainer holes for fencing. A very cumbersome affair, which has nothing to recommend it, unless for use where very large trees are to be planted. I think I will still stick to the Schlich spade! Methods of seed/cone collection were demonstrated on trees of 120 to 150 ft., with clean stems. We saw the "tree bicycle" being used very effectively; of course the trees there are ideal for the employment of this machine, which could not be used to any great extent over here.

Tuesday afternoon was a "recreational period" and members of the party were left to their own devices. Most of us went out to spend our travel allowances in one way or another.

Wednesday, 7th October

At 9 a.m. the buses set off for Germany and Salem, the residence of the Margrave of Baden, where we were to remain for two days. The Salem woods cover an area of 10,000 acres and they are under the charge of a head forester, Mr. Rupf, who, incidentally, is the 5th forester to have been in charge since 1803—an average of over 30 years per man. A modified form of Femel system is practised here, with close attention to stand tending and stem improvement in every age class. Regeneration is mostly by strip or group felling. Soil here is loam with a gravelly content. There is very little acid soil and podsols are virtually unknown.

The labour employed at Salem is skilled and the use of power saws for felling has been practised for over 20 years. Saws are loaned out to workers and they are serviced by the Estates branch. We saw some portable huts, which are used as shelters and of which there are over 100 in the forest. These huts can be transported from place to place, as the occasion demands. They are quite light in weight and could prove to be useful, though I should think that with a lot of handling or moving around they would deteriorate very rapidly. Extraction of timber is done by contractors with horse teams and timber is sold at roadside—high quality material to private contractors and firewood by auction. The labour force amounts to 104 permanent workers (men) and 24 permanent workers (women), 112 part time workers (men) (under 150 days per year) and 48 part-time women. Wages are similar to those in Switzerland, i.e. around £9 per week and working hours are also the same. Longer hours are worked in summer than in winter.

The management's aim is to have a mixture of 30% beech, 40% Norway spruce, 14% pine, 4% larch, 5% *Abies alba* and the remainder, of various leaf trees. Uniformity of stocking is not desired as the following are the types aimed at:—

(1) Long rotation type for maximum production of 1st quality saw logs.

(2) Short rotation types for maximum volume production, largely spruce with some beech.

(3) Quality hardwood type—Ash, alder, maple, oak, beech, hornbeam, lime.

Normal average rotations are: Norway spruce 90-100 years, Scots pine/larch—130-150 years, beech/oak—120-140 years.

Several sites were visited during the two days' stay at Salem and the following operations were demonstrated:—

(1) Stand tending in a stand which is approaching maturity and which, we were told, is very near to the estate's ideal.
Age 100-120 years, growing stock—8,617 h. ft. per acre.
Species by volume—35% pine, 30% Norway spruce, 25% beech, 5% *Abies alba* and 5% assorted broad-leaf trees. Tree sizes are (average):

Scots pine	102 ft. × 14.9 in. B.H.Q.G.
Norway spruce	98 ft. × 13.6 in. B.H.Q.G.
Beech	85 ft. × 10 in. B.H.Q.G.
Abies alba	108 ft. × 15.8 in. B.H.Q.G.
Oak	79 ft. × 11.6 in. B.H.Q.G.

(2) An example of increment thinning in conjunction with the development of natural regeneration. The old stand is interspersed with groups of regeneration, some of the *Abies alba* being up to 40 years old. Regeneration includes Norway spruce, *Abies alba*, and pine but the greater part of the groups have been planted. A part of the area has been fenced against deer (which, we were told, are fonder of *Abies*, than any other species). I was particularly impressed by the size of the Scots pine, the average size of which is 105 ft. × 15.4 in. B.H.Q.G. Workers demonstrated the operation of "young growth tending", which is really a case of cutting out any weed growth which may prove injurious to the crop.

(3) Stand tending in a stand, predominantly beech of 90 years old.

(4) The principal feature of this stand is the 160-year-old larch and *Abies alba*, which has been carried over from the previous rotation. Specimen trees are: Larch 157 ft. × 34.6 in. B.H.Q.G., *Abies alba* 144 ft. × 40.5 in. B.H.Q.G.
Volume of the larch is 643 h. ft., and that of the *Abies alba* 740 h. ft.

(5) Another compartment which is approaching maturity, with 65% beech, 20% Norway spruce, 15% Scots pine and some oak, age 100-120 years.

(6) Increment thinning as in (2) above. Beech of 130-140 years old with groups of Scots pine and some very fine specimens of larch. An understorey of 10-12 year old beech. Here there was an interruption in the steady advance of regeneration during the war years, resulting in an undesirable sharp boundary between the old and new regeneration areas. One of the aims of present years has been to bridge this gap and to re-establish continuity in the compartment. A demonstration was given of cleaning and tree pruning in the thicket stage.

(7) An example of the transition from thicket to thinning stage. The potential elite trees had been high pruned and early cleaning operations concerned the negative selection or the removal of undesirable stems, while the later cleaning operations paid even more attention to positive selection, or the furtherance of the growth of the elite trees—a larger number than can actually be kept—as a final crop. Part of the compartment consists of a stand of 80% oak and 20% beech of a smaller size.

(8) Stand tending in middle age.

On Thursday afternoon, the party were shown through Schloss Salem, the Margrave's residence, and in the evening a dinner, in our honour, was given at the Schloss.

Friday, 9th October

At Schaffhausen, where we were met by Dr. Huber, who had spent the previous two days with us in Salem. Dr. Huber is Cantonal Head Forester at Schaffhausen and is believed to be one of the foremost authorities on forestry in Europe. It may be of interest to note that Dr. Huber has given up a very important appointment, with a consequent two-thirds reduction in salary, in order to return to forestry in his native Switzerland. To quote himself, "I felt that I was getting out of touch with the woods".

These forests are also run on the Femel system and we saw a variety of operations being carried out. Formerly, these woods had been managed as coppice woods with standards, the latter being pine, oak and beech. In the course of half a century, they have been converted to High Forest by cutting the coppice in strips for subsequent regeneration. Additional planting has also been done, in groups of varying sizes. Products from selective thinning viz: faggots, fuel wood, fence posts and other poles, wood for parquetry, woodwool, pulpwood in two qualities, saw logs of various sizes and classes, were seen. All grading had been done by the Forester according to the Swiss rules, and the prices determined on the basis of the agreement between the Woodland Owners Association, and the Wood Consumers Association of Schaffhausen.

A demonstration of high pruning was given by a student forester, on a tall tree which had been marked for felling. This is carried out with a view to reducing the area of spread, in the crown, and thereby reducing the risk of damage to adjoining trees, when felling is undertaken. The method of climbing is with safety belt and spikes.

Various methods of protection from deer, of small groups of young trees, were seen, the most effective being hoops of rabbit netting placed around individual trees. A novel idea was the use of dried out spruce points, which were stuck into the ground at each side of the plant. Some trees had been treated with a solution containing cow-dung, chalk, clay and ox-blood, and this, apparently, had proved quite successful. All trees except spruce and oak had been protected in one way or another. Roe deer population in these woods is estimated to be in the region of one to every twenty-five acres; this number is considered to be quite reasonable.

The following are some figures on yields, etc., at Schaffhausen:—

Area of State Forests in 1958	2,134 acres
Growing Stock in 1958	6,230,000 cubic feet
Total Yield in 1958	139,400 cubic feet
Total Financial Yield in 1958	£22,663
Expenses in 1958	£19,588
Profit in 1958	£3,075 or 28s. 6d. per acre

Saturday, 10th October

Our last day of the tour was spent at the forests of Canton Zug, which is the second smallest canton in Switzerland (Geneva is the smallest). The main objectives were the building of forest roads and the extraction of timber by aerial ropeways and by the much talked of "Unimog". The "Unimog" is a German-manufactured machine, which closely resembles a "Jeep" and which has a very powerful winch fitted to the rear. The first demonstration was the hauling of a three-ton oak log up a fairly steep slope. The machine was anchored on the ride and the log was attached to the cable by means of a large "calliper", which tended to tighten on the log as pressure was applied by the winch. A very useful piece of equipment, but one which is more suited to very large logs. The "Unimog" was next shown hauling a large oak log on a sledge, along a forest ride. The sledge was about 4 ft.$\times$5 ft. in size, with the front slightly raised, in order to surmount snags, such as tree stumps, etc. The base of the sledge was made of sheet iron of $\frac{1}{2}$ in. gauge and it was fitted with a small turn-table, on to which the end of the log had been placed. This is quite the best type of sledge I have ever seen and one which could be used effectively for a variety of operations. The aerial ropeways, of which two were on show, were very effective, but rather slow in operation. The first one was seen hauling timber down a steep hill side to a loading base. The winch and equipment cost £1,200 and the cost of extraction by this method was 5d. per cubic foot. The second winch was operating from a road which was well up on a hill-side and it was hauling large logs uphill to a loading bank. The outfit, a "Kupfer", was quite small and costs £700, I liked the simplicity of the ropeways and cradles. The loose cable has a fairly wide "side draw" to the main cable and, I believe, this form of cableway would be ideal for use in open timber, where there are no branches to interfere with the wire ropes. The cost of erecting and dismantling this latter cableway, was quoted as £6, and the whole outfit can be operated by four workers.

After lunch, the party were taken along a forest road to a point where a new road was in course of construction. The Swiss try, if possible, to avoid building roads in valleys or hollows, as they prefer to haul timber uphill than down (they maintain that it is cheaper) and in consequence, quite a number of their forest roads run along ridges, where timber can be drawn in from both sides. The road which we saw, however, was being constructed along a very steep hillside. The digging was being done by a combination dozer/digger and there were five separate layers of material being put on to the road surface and rolled in with a vibration roller. The camber was towards the hillside and that verge of the road had a concrete drain or gutter, which carried water to sumps or culverts at reasonable distances apart. The roads are really of a very high standard and I was very surprised to learn that the cost was in the region of only £3,500 per mile.

The following are some prices, which were quoted, for various grades of timber in Switzerland. Prices are at roadside, such roads to be capable of carrying a 5 ton lorry. Fully peeled Scots pine qualify for an additional 3d. per cubic foot and a charge of 4d.—7d. is made for loading on rail. Saw log grading is: *A.A.*—exceptional. *A.*—above average. *N.*—normal. *F.*—defective, but usable. The permissible defects are always listed and the application of the rules is always arbitrated by the local state forester, whether the forest is privately owned or not.

Long Length Classes—Spruce and Silver fir

Class I.S. Not less than 60 ft. long with a diameter of not less than 15½ ft. at 60 ft. Minimum small end diameter 11.8 in. At least half the length of each piece to be of "A" grade. Price—7/9d. per cubic foot.

Class I. Not less than 60 ft. long with a diameter of not less than 11.8 in. at 60 ft. and a minimum small end diameter of 8.6 in. Price—6s. 9½d. per cubic foot.

Class V. Not less than 33 ft. long with a diameter of not less than 4.7 in. at 33 ft. and a minimum diameter at small end of 3 in. Price—4s. 9d. per cubic foot.

Medium Length Classes—Spruce and Silver fir

Class I.S. Logs not less than 20 ft. long with a mid-diameter of not less than 19½ in.
Price—7/1d. per cubic foot.

Class V. Logs not less than 20 ft. long with a mid-diameter of not less than 7.8 in. Price—4s. 4d. per cubic foot.
Beech, oak, and ash, minimum lengths of 10 ft.

Class I. 23½ in. minimum diameter.

	Beech	*Oak*	*Ash*
Grade:—	"A" — 10s. 8d.	"A" — 15s. 11d.	"A" — 16s. 1½d.
	"N" — 7s. 7½d.	"N" — 11s. 7d.	"N" — 11s. 10d.
	—	"F" — 8s. 8d.	"F" — 7s. 9½d.

Class V. Logs not less than 9½ in. mid-diameter.

Beech	*Oak*	*Ash*
"N" — 3s. 11½d.	"N" — 3s. 8d.	"A" — 6s. 11d.
"F" — 2s. 11½d.	—	"N" — 4s. 9½d.
—	—	"F" — 2s. 10d.

Pulpwood and Woodwool Wood—Healthy, clean and not less than 3.9 in. diameter at small end.

Loaded on rail—Spruce —£16 18s. 8d. per cord.
Silver fir—£16 0s. 10d. per cord.

Firewood—Split pieces £5 12s. 0d. to £11 5s. 0d. per cord according to species.

In conclusion, I should like to say how much I appreciate being given the opportunity of accompanying the Royal Forestry Society party on the Continental trip. It is rather difficult for me to describe how extremely impressed I was by the Swiss and German forests. One feels humble on returning to this country after having seen such wonderful woods, until one remembers that the Swiss are dealing with natural forests, while we at home, are still in the process of creating forests.

ROYAL FORESTRY SOCIETY OF ENGLAND AND WALES EXCURSION TO SWITZERLAND AND SOUTHERN GERMANY, OCTOBER 2nd—11th, 1959

By J. A. WOOD
Forester, North Wales

Town Forest of Berne (October 3rd).

This forest covers 8,223 acres, most of it close to the city. Most of it is communal property and the revenues are devoted to various municipal departments, principally, poor relief, upkeep of museums, libraries, town theatre, etc.

Average growing stock at the last callipering in 1955 was 3,837 hoppus ft. per acre, with an annual increment of 67 cu. ft. only. Annual cut is eleven-twelfths of the increment of which 40% is fuel wood and 8% pulp wood. The rest is saw timber.

The staff is composed of two senior foresters, twenty-five office and supervisory grades, forty-five permanent workers, and approximately sixty seasonal workers. Most of the felling is done in the winter by about twenty-five piecework teams, and extraction is by "Unimog" timber tractor. 200,000 to 300,000 trees are planted out each spring from seed collected in the forest and raised in three nurseries. The 106 miles of hard forest roads are increased annually by an average of two miles.

Annual income is £131,000, running costs £98,000, and profit £33,000 or £4 per acre.

The Bremgartenwald section, which we visited, is the main recreational wood in the vicinity of Berne, and, like most Swiss forests, has a long history. The first restrictions on felling were in 1304, and modern management dates from 1775. The original mixed leaf tree stands were in parts replaced by spruce, Scots and Weymouth pine in the 1850—1890 period.

Elevation is between 1,550 and 1,900 feet, average annual precipitation 38 in. and mean annual temperature 45° F. Soils are in general good brown earths over glacial moraine and gravels.

This wood was managed on the Swiss "Femel" system, which is an irregular group shelter-wood system in which openings in the canopy are made by the felling of single trees and small groups. These groups never exceed an acre, are irregular in outline, and have boundaries which are not too sharply defined. They may be formed as a result of small clearances in the old stand, by regeneration under top shade, or regeneration under side shade. Natural and artificial regeneration methods are both used freely. This system requires highly skilled working staff, and intensive supervision.

Beech is always present in all stages of growth and is recognised as necessary in the maintenance of ideal forest conditions.

Nine per cent by volume of the growing stock was European silver fir, *Abies alba*, but conditions here were not considered optimum for this species. Apparently it grows best only on slopes and at higher altitudes. Sixty per cent by volume of the growing stock was Norway spruce. I saw no Sitka spruce in Switzerland.

No ground preparation for natural regeneration was carried out as the foresters were unwilling to risk damage to the standing crop. The stems of mature conifers were excellent, but many would be considered as over-mature in Britain. The raising of many roots on mature Norway spruce indicated the possible presence of "pumping".

Weeding of regeneration is carried out until the plants are roughly the height of a man, then cleaning, which is a purely negative operation, until one can walk beneath the trees freely. All operations are carefully costed.

A typical small group (approx. ¾ acre) contained beech planted at one foot by one foot with European larch at ten foot spacings. Barbed wire spiral rings encircled the European larch as protection against deer. This area had been planted about twelve months ago, and all plants used were strong and well shaped.

In the small groups of Norway spruce spacing was at 3 ft. by 3 ft., and Weymouth pine, also protected against deer, were interplanted at ten foot spacings.

The object of close spacing was to induce the production of long thin stems.

The future policy for this forest, as quoted to us, was as follows:—

(a) Improve stand tending by selective thinnings.

(b) Regenerate old stands on the "Femel" principle, seeking especially a better mixing of conifer and leaf trees.

(c) Favour the more valuable leaf tree species such as oak, ash, maple, lime and cherry.

(d) Introduce more valuable conifer such as larch, Weymouth and Scots pine.

(e) Build the broad-leaf tree proportion up to a maximum of 30% by volume.

(f) Gradually convert any even-aged stands into mixed stands.

(g) Pay regard to amenity at all times, as the forest has to provide recreation for the citizens of Berne, as well as income.

Visit to the "Plenter" Forest at Schwarzenegg

These forests cover about 2,200 acres, and ownership is distributed between six communities corresponding to our parish councils. Disputes as to ownership resulted in mismanagement during the last fifty years of the nineteenth century, but since 1897, when these disputes were settled, management has been uniform.

This forest is classed as protective, and is, therefore, closely supervised by the Cantonal forest authorities. Eighty-two per cent of the Swiss forest area is classed as protective, and is required by law to be maintained as growing forest in good order. This is to guard against floods and avalanches.

Schwarzenegg is between 3,000 and 4,000 feet above sea level and has an annual rainfall (including snow) of between 48 and 80 inches.

Species are 65% silver fir (*Abies alba*), 33% Norway spruce and 1% broad-leaf trees. In former years beech was ruthlessly removed as a weed, but is now being systematically re-introduced. Although silver fir is a soil improver and is growing here under optimum conditions, it is considered that leaf trees are necessary to maintain a correct forest balance.

The second of the two main Swiss sylvicultural systems is here in operation, and all forests in Switzerland are worked under, or being converted to, one of these two systems.

The "Plenter" system is a single tree selection system. All sylvicultural operations under this system—weeding, cleaning, thinning and felling—are carried out as one 'operation'. If the "Plenter" system is being carried out faithfully a person standing on one spot should be able to see for only a few yards in any direction. There should be visible trees of all ages.

Factors which are necessary to the success of this system are:

(a) Local interest, here fostered by the fact, that all the locals have an interest in the forest. It is their bank.

(b) Skilled workmen. There was a long tradition of skilled workmanship here.

(c) Natural regeneration must be successful. Game here was kept under strict control. This was applicable, also, to mice and voles, for owls, hawks, etc. were not destroyed.

Of the two shade-bearers present here silver fir was the most suitable for this system. Factors contributing to its success were:—

(a) Very strong rooting characteristics made for firm anchorage, and and therefore excellent shelter for the young trees.

(b) Thin branches, were easily "cleaned" naturally.

(c) Silver fir natural regeneration, even if suppressed, came away well when the canopy was opened up.

Norway spruce were considered, to be less steady in their development under shade conditions than were silver fir.

Beech, although shade-bearers, were unsuitable for this system, as their heavy branches did not clean naturally.

Abies grandis had been tried in Lausanne but had died out in the drought years of 1945-49 when 50 years old. There had been extensive beetle damage to silver fir and spruce in other parts of Switzerland during these dry years, but none in these "Plenter" forests. Nevertheless beech were being re-introduced here on health grounds.

Cutting through this forest takes place every six to ten years—ten years in the remote regions—and callipering of all growing stock is carried out every ten years. At each cut about 15% by volume is removed which is equivalent to about 2% per annum. Cutting commences in November and the aim is to complete all felling by Christmas and then to extract all produce by sledge whilst the snow is on the ground. No damage must be caused to standing trees during extraction.

Five people are present at all markings, and the head forester personally approves every tree marked. All trees marked in private forests in this district must have the approval of a state forester, and this is when the subordinate foresters get their training. Care must be taken to avoid opening up the suppressed trees too quickly as this would result in reduced quality of the forest.

To avoid damage to the understorey during felling operations silver fir and spruce (not larch) are pruned to within 12 or 15 feet of the top of the tree. This is a piecework operation and costs from seven to eight shillings per tree. Output is usually about six trees per day.

A good road system is essential in a "Plenter" Forest.

In one part of the forest visited the current annual increment had dropped over the past thirty years from 123 cu. ft. per acre to 83, and this was thought to be the result of too many trees per acre combined with too high a proportion of large diameter stems. Some of the trees are two-hundred years old. In another part of the forest, under the same conditions, current annual increment had been maintained at 127 cu. ft. per acre. The annual cut is 87½ cu. ft. per acre and compartment growing stocks vary from 6,564 cu. ft. per acre to 5,947 cu. ft. per acre.

Rapperswil Town Forest

The emphasis here was on felling and converting. Rapperswil which lies on the lake of Zürich, has, like so many other Swiss towns a long association with Forestry. The town itself completed its transition to communal administration in the fifteenth century, and the first recorded working plan for the town forests was established in 1850. Technical management of the forest has been continuous since 1880.

The forest is just under 1,000 acres in size and the present working plan dates from 1949. It is currently undergoing its ten year revision.

Spruce predominates both numerically, and by volume, followed by silver fir 21%, pines and larches 14½% and leaf trees 18½%. Most of the leaf trees are beech, and these are somewhat younger than are the conifers.

The allowable cut in 62 cu. ft. per acre per annum.

The first demonstration was the felling, cutting up, and classification of a mature beech tree. The preparation of the butt and actual felling was done by a mechancial two-man saw—in this case an American "McCullough". Snedding was done with an axe, but final rounding and division of the butt was carried out with a mechanical one-man saw. American tools are the most widely used foreign tools in Switzerland followed by Swedish and German. Until recently felling and conversion were carried out on a timework basis and with hand tools, but in addition to mechanical tools, piecework has now been introduced. No figures were available.

The beech stem was converted into ten foot (3 metre) lengths with the major defects being cut out for cordwood. For hardwoods there are four quality classes and six size categories.

The quality classes are:—

1. "aa" Specially selected.
2. "a" Above average, no defects, healthy, solid, cylindrical, straight, no spiral growth, no branches, no swellings, even ring widths.
3. "n" Normal healthy growth without appreciable defect or rot.
4. "f" Defective but usable.

The size categories are:—

60	cms.	(24 inches)	or	more	mid	diameter	
50	,,	(20 inches)	,,	,,	,,	,,	
40	,,	(16 inches)	,,	,,	,,	,,	
30	,,	(12 inches)	,,	,,	,,	,,	
25	,,	(10 inches)	,,	,,	,,	,,	
24	,,	(9¾ inches)	or less		,,	,,	

First quality beech and top size category fetched approximately 10/8d. per cu. ft. and lowest quality and size category about 3/- per cu. ft.

All these logs after conversion were callipered under bark and a circle of bark was removed with an axe for this purpose.

Conifers are graded by length, mid-diameter, and small end diameter, and there are five classes. Prices for silver fir and spruce varied from 7/9d. per cu. ft. for quality class I to 4/4d. per cu. ft. for quality class V. Pine and larch varied from 11/10d. per cu. ft. to 2/11½d. per cu. ft.

Spruce and silver fir must be de-barked in the wood (not telephone posts) and all conifers must be de-barked by May 1st each year.

Prices are quoted at roadside, and forest operations are costed on the basis of all work being done up to this point by forest staff.

Telephone poles are not de-barked, and the price is based on length and the diameter at six feet from the butt. All conifers are accepted for this class.

We saw silver fir foliage being cut up for sale as garden manure; later on the branches will be sold for Christmas decorations.

The forest year starts on October 1st, and felling here immediately proceeds. No horses are allowed in the forest for tushing purposes until the frost is in the ground.

Fuel wood is composed mainly of cleft beech pieces about two and a half feet in length. A person purchasing fuel wood is guaranteed a definite heat value per unit of money.

The Swiss Forest Research Institute at Birmensdorf near Zürich

Although these premises were new the Research Institute was founded over one-hundred years ago and was one of the six departments of the Swiss Federal Institute of Technology.

The party was here split into four sections and the party I joined was shown the Research Nursery and a demonstration of cone collecting.

Compost for use in the nursery was being prepared. It was a compost specially suited to heavy soils and was a mixture of one part spruce or silver fir needles and small branches and one part beech leaves with the addition of two kilos of suplhate of ammonia to every cubic metre (32 cu. ft. approx.) of the mixture. The whole was chaffed and stacked in long heaps about six feet wide at the base. Free passage was left between the heaps. Originally the mixture was not chaffed, but with the introduction of chaffing, compost was prepared in four months, instead of three years. Two turnings were necessary, and these were effected when temperatures fell to a certain level—approx. 120° F. More chaffing was done at these stages if necessary.

All seed was sown on a layer of three or four inches—ten inches in research beds—of this compost, and the beds were watered freely.

Particular benefits of this compost were:—

(a) It helped in maintaining the acidity of the soil.

(b) The small chaff of silver fir and spruce branches takes a long time to break down, and so it improves for a long time the physical conditions of the heavy soils for which this compost was designed.

(c) Desirable microflora from the forest soils are introduced into the nursery.

Cultivation of spruce transplants was in progress. All lining-out is at ten inch by five inch spacing, and a small machine cultivator was being used for the inter-lineal cultivation. Sprays were not used, as working of the soil was considered essential for the well-being of the plants. This cultivation was frequent. Lining-out is by hand.

Damping-off experiments were in progress. Specially constructed shelters were used for protection, and these were supported by steel frames, and, set at an angle of sixty degrees, reached to halfway over the seed bed.

Damping-off was considered to take place only when the ground level temperature is at 45° C. (113° F.) and above, and under these shelters the temperature did not exceed 40° C. (104° F.). Horizontal shelters gave too much shade.

Water is considered absolutely essential for a seed bed nursery in Switzerland. It is not necessary for a transplant nursery.

A mechanical hole-digger—something like a road drill—is used to prepare the pits for planting the very fine transplants produced under this system. Both two-man and one-man machines are used. Cultivation, even in rocky ground, is complete and pit planting produces 100% results. Output per man is 230 plants per day, a very low figure by British standards.

A tree bicycle was being used in a nearby plantation to demonstrate the method of cone collection in these tall, rather small crowned, trees. The two "walking pads" were fixed to the knee of the left leg and the foot of the right leg. Seed collection is by volunteers only, and these are recruited from about 2% or 3% of the forest staff. The cost of the tree bicycle is about £35.

In the afternoon we visited the old research nursery at Zürich, and this is now used as a normal supply nursery for the forest.

Five per cent of the space in a comprehensive nursery is sufficient for the production of the required number of seedlings. A four year rotation was favoured—one year conifer seedbeds, one year conifer lines, one year hardwood seed beds, and one year hardwood lines. Conifer seed was drill sown (across the beds) on a three to four inch compost layer, and watered freely with water which had been sun warmed. Germination was rather poor and the seedlings of no great size. The amount of compost applied under this system was about eight cubic metres to a hundred square metres of ground.

Oak and beech were sown in lines as were all hardwoods, and the plants produced—beech, oak, elm, alder, etc.—were very fine. No frost lift occurs to conifer seedlings sown on compost.

Lining-out takes place in the spring, is by hand, with boards to kneel on, and the rate per man at 10 in. × 5 in. spacing is 3,000 per day. The reasons given for this wide spacing were:—

(a) The top of the plant must be strong enough to withstand possible damage by snow.

(b) The root systems of the individual trees must not be damaged in lifting.

Lifting of Norway spruce transplants for planting was taking place. As much soil as possible was left on the roots, and the plants were transported to the planting site unbundled.

Weeding and cultivation of transplant lines was intensive, and weeding carried on until well into the autumn, to prevent as far as possible the development of spring weeds.

Costs? A spruce transplant would sell to the trade at about 5d.

Salem Forests in Bavaria

These forests are about five metres from Oberlingen which is situated on the north shore of Lake Constance. They became the property of the Grand Duchy of Baden in 1803 as a result of an exchange of properties with two monasteries. Between 1803 and 1953, with the exception of two short breaks of a few months each, there have been only five head foresters in charge of these forests.

These forests, extending to nearly ten thousand acres, are situated at an elevation of between 1,400 and 1,650 feet, rising in the north to about 2,700 feet. Rainfall is 20 to 23 in. per annum (10 in. in the summer) and the mean temperature varies between 45° and 65° F.

Soils are fertile and mainly of the brown earth type; most species would grow well there. *Carex* sp. are common in the plant associations.

The aim of forestry here was to make money: these were not, as so many of the Swiss forests were, protective forests.

Normal average full rotation for different species were spruce 90-110 years, pine and larch 130-150 years, beech and oak 120-140 years. Annual increments were spruce 146 cu. ft. p.a., silver fir 166 cu. ft. p.a., pine 113 cu. ft. p.a., and and beech 89 cu. ft. p.a.

As in Switzerland a periodical enumeration of the stems is carried out, the last of these being in 1955. This showed 40% leaf trees (32% beech), 43% spruce, 15% pine and larch, and 2% silver fir (*Abies alba*).

Significantly the long rotation type of forest aiming at the production of high quality saw timber contained 50/60% beech with 30/40% Scots pine and larch and 10/20% spruce, whereas the short rotation type aiming at maximum volume production contained only 15/20% beech with the rest spruce.

One of the most striking features of forestry here is the universal use of beech at all levels. It grows here under optimum conditions, and in a true selection forest system, would probably dominate all other species. It is kept here under strict control, is always encouraged, but is treated as a weed! The mature beech stems in mixture are kept mainly as sources of natural regeneration, and when the mature trees are opened up in the final stages it is this beech regeneration in its earlier stages, which both keeps down weeds and protects the soil and the introduced conifer plants (these are mainly planted) from severe climatic fluctuations. The conifers are weeded simply by freeing them from the small beech plants. This operation requires skilled workmen.

We visited seven different compartments each of which exemplified a different stage in the development of a plantation.

First of all we saw almost the last stage—a stand approaching maturity. The trees were mainly 100-120 years old, and the distribution by volume was 35% pine, 30% spruce, 25% beech, 5% silver fir, and 5% assorted trees (oak, ash, alder and hornbeam).

Average sizes by species were:—

Pine	102 ft. and 14 ft. 9 in.	Breast-height girth
Spruce	98 ft. and 13 ft. 6 in.	,, ,, ,,
Beech	85 ft. and 10 ft. 0 in.	,, ,, ,,
Silver fir	108 ft. and 15 ft. 8 in.	,, ,, ,,
Oak	79 ft. and 11 ft. 6 in.	,, ,, ,,

The pine, spruce and larch were very free from bark beetles, and all felled trees of these species were peeled. Much unpeeled timber was sent away in the immediate post-war years and during this period the mixture of hardwoods and conifers was invaluable in maintaining the health of the forest.

Scots pine growing on this very fertile soil were apt to butt rot.

Beech in this stand were kept solely as stem cleaners and soil improvers and it was emphasised once again that the main object here was the production of quality timber and that natural regeneration was aimed at only when this object had been achieved.

Cutting is restricted by law, and all clear felled areas must be replanted.

At the second site we saw an uneven aged mixed stand, in which increment thinning was taking place in conjunction with natural regeneration.

Of the standing trees—120-135 years old and being used for natural regeneration—55% were beech, 35% pine, and 10% spruce.

Groups of natural regeneration interspersed the stand, which carried 6,000 cu. ft. to the acre, and, in addition to beech, Scots pine and Norway spruce, silver fir were present as natural regeneration. One part of about two square chains containing a high proportion of silver fir had been specially fenced against deer which regard this species as a special delicacy. Silver fir did not grow well here; it was at rather too low an altitude (1,500 ft.), and was liable to attack by the aphid *Adelges nusslini.*

Larch had been introduced as plants, and it had been necessary to protect them from roe deer by spiral wiring.

In another group Norway spruce, silver fir and larch had been introduced by planting (spacing at about three or four feet) after nearly clear felling. Large Scots pine and beech had been left for natural regeneration and beech regeneration had been profuse. It appeared that the conifer plants had been introduced into the beech regeneration by planting after natural regeneration was well established and up to six years old, and that they were protected by beech from the very outset. Tending of this young growth was being carried out at that moment by forest staff using long-handled secateurs. The conifers were being freed from the beech and this operation is carried out every three to five years. I found it difficult to imagine that sone of the conifers would remain unsuppressed for as long as even three years, but apparently in this particular spot, unlike other sites in the forest, beech did not grow faster than Norway spruce.

A mature beech had been felled here in order to demonstrate methods of felling and grading. Saws in use were the "Dolmar" two-man mechanical saw fitted with spring starter and mechanical clutch, and the "Dolmar" one-man mechanical saw.

The stem was marked for grading before conversion. Timber, quality grades 1 and 2 fetch about 7/3d. and 5/6d. per cu. ft. respectively and grade 3 (timber of railway sleeper quality) about 2/9d. per cu. ft. Grade 4 was firewood, and grade 5—branch wood for faggots—was sold by auction in the wood.

The two main diseases attacking beech here were "red heart" and "black heart". Red heart is non-fungal and spreads from the top of the tree down. It would be found in beech of about 140 years with a damaged or forked top and is said to be caused by air entering the fork. Black heart is a fungal disease, and starts from the bottom of the mature tree.

A mature Scots pine, felled, was being peeled by a barking spud in the full length, but, owing to shortage of time no discussion of prices, etc. took place.

The main features of the next site were specimen trees of silver fir and larch about 160 years old. The silver fir was 144 feet high with a volume of 740 cu. ft. and the four larches ranged from a height of 157 ft. with a volume of 643 cu. ft. to a height of 126 feet with a volume of 238 cu. ft.

The stand itself was 70% silver fir and 30% spruce, mostly mature. The silver fir was regenerating naturally but it was considered that there was too little beech present and it will be introduced by planting.

Epicormic growth or "water sprout" caused by the trees having undersized crowns, was present on the silver fir and it was considered that these are better raised under the "Plenter" system.

The next site provided a further example of the use of beech. The stand was predominantly beech (65%) with spruce (20%) and pine (15%), all about 100-120 years old. There was a thick understorey of beech ten to twenty years old and the intention was to thin out this understorey and prepare the stand for natural regeneration. This understorey had been left solely for cleaning the conifer stems and soil improvement. Another reason for visiting this stand was the opportunity afforded of comparing it with an adjacent stand—not the property of Salem. The mixture here was similar, but the stand had been very heavily thinned and grass was in, with resulting deterioration of the soil. Attempts were now being made to re-introduce beech by any means. In the discussion which followed the Margrave and his head forester once more voiced their dislike of pure conifer stands.

Site 5 provided another example of increment thinning and natural regeneration.

Included in the regeneration here were beech, spruce, pine and larch, all about five years old. Most of it appeared to be natural regeneration. A deer repellent had been used on the Norway spruce: composed of a mixture of chalk, blood, clay and urine it is placed on the leading 'shoot' and is good for twelve months protection. Pines and larch were protected by spiral wiring. Shown here was an example of the efforts made to prevent the formation of any sort of a "wall" between adjacent stands. A sharp division of age classes had occurred as a result of war-time fellings, and the outside trees of the older age class were decidedly rough. Isolated in the midst of this young growth were two very tall, thin, and small-crowned Scots pine and the object in leaving them now that natural regeneration was complete was to gather more increment. There seemed to be no risk of wind-throw.

Next was seen thinning and cleaning in the thicket stage. The average age of this stand was thirty years and species included beech (50%), spruce (40%), Scots pine (5%) and larch (5%). Oak, ash and Douglas fir were also present. A positive selective thinning was in progress and all species were being included. Included also was high pruning of the future elite trees up to the green branches and these trees were marked with paint. Although beech comprised 50% of the mixture it was present only for ground improvement and pruning purposes. All cuttings from this operation were sold to the locals who came in to collect. An important function of this operation was the retention and development of the understorey of beech.

Next door was a thirty-three year old stand of oak (80%) and beech (20%). Thinnings in this stand are moderate and aim at improving the best oak and maintaining the understorey of beech. The stand was not expected to produce veneer quality oak as the site was too good and the trees were growing fast. The requirements for veneer quality oak are exacting, one being inability to count the annual rings with the naked eye. It will fetch between £10 and £15 per cu. ft.

Produce from this would be, possibly, fencing materials, but, if not, the thinnings would be left on the ground. Stands of fifteen years and upwards would be expected to pay for all thinning and clearing.

Planting Stock. Some plants are produced in their forest nurseries but Norway spruce are cheaper to buy from the trade than to produce. The reverse is true for larch and all hardwoods, which are very dear to buy. Most planting is done in the spring before mid-April, but if the season is favourable planting might continue until mid-May.

Special summer planting of Norway spruce is carried out in some years, and in fact, has been very successful this year in spite of the droughts. Summer planting would doubtless be favoured by the method of stand tending and regeneration in use.

State Forests of the Third District of the Canton Schaffhausen

Site conditions here were inferior to those obtaining in the Salem forests and consequently the annual increment is about 40% less. The forests are on the Jura formation. Rainfall is about 30-35 inches annually and quickly permeates the limestone. Natural tree species are almost exclusively broad-leaved (oak, and beech predominate), but Scots pine and silver fir—the silver fir on the higher ground—appear to be native. Spruce, silver fir, pine and larch have been introduced in many areas to increase the marketable value of the forest crop.

There has been a gradual conversion of these forests from coppice with standards to high forest, and this conversion is not yet fully complete. The forests are now managed on the group and single tree selection systems. This conversion was previously effected by strip and clear cuts, with subsequent natural regeneration of beech and other hardwoods. Desired conifers were then introduced or came up naturally. This method was abandoned in 1946. Nowadays, the old woods of coppice with standards are preserved until the individual trees reach maturity, and further regeneration is then introduced by careful removal of the mature trees in small openings. The forests therefore, gradually assume the aspect of "Femel Wood".

Here as at Salem, it was emphasised that "walls" between adjacent groups should be avoided. This object has been very skilfully achieved in the instances shown us.

Various methods of protecting individual trees from roe deer damage were shown us. Inverted tops of dead spruce trees were used with larch, and barbed wire in spiral and wire netting circlets were also used.

The cost of protecting each small tree with a netting circlet is ¾d. Deer are now rather a nuisance. Formerly they were kept down by the forest staff, but now the shooting is let to wealthy industrialists who, although valuing the prestige, lack marksmanship.

Another instance of the great value attached to ground cover, even if only temporary, was instanced. A very small bare patch had been planted with four or five grey alder plants as purely temporary cover, and it was intended to remove these as other, and more permanent, cover spread.

Wind-throw in this forest occurred mainly in even-aged stands.

We were shown produce from the selective thinning operations then in progress. This included faggots about two feet long and seven or eight inches in diameter (for kindling and small fuel wood), fuel wood (always stacked to include a minimum of air space), fence posts, poles of varying size classes (rustic poles are half peeled for quicker drying out) and larger pieces. These larger pieces had the large end chamfered to facilitate extraction.

We were shown a mature Scots pine prepared for felling. All side branches had been removed and the top taken off to prevent damage to the underwood. This particular stem had been prepared by an apprentice as part of his two years apprenticeship.

Compost for the nurseries was being prepared in the forest. It was composed of spruce needles (chaffed), beech leaves and dehydrated chalk, in layers. It is turned every year, needs no addition to it, and is ready for use in three years.

Forests of Canton Zug

Canton Zug has only 50,000 inhabitants, and 70% of its nearly 15,000 acres of forests are community owned. Only 500 acres however, are the direct property of the cantonal authorities.

Zug is situated in the zone between the lowlands and the pre-Alps, has an annual rainfall of between 40 and 65 inches and has an altitude which varies between 1,300 and 5,000 feet. Sub-soils are sandstone, impermeable clay strata, and various conglomerates; glacial moraine and gravel coverings are common. The natural forest cover consists of various mixed leaf tree types, beech forests, and also silver fir-beech forests.

The average growing stock is 3,400 cu. ft. per acre (it is intended to increase this to 4,500 cu. ft. per acre) and the average annual cut is 60 cu. ft. per acre. The ratio of 84% conifer and 16% leaf trees is to be changed to 60% conifer and 40% leaf trees.

A work study team of four people were tackling the problems of extraction and this team carried out all practical work personally besides working out all calculations. Slopes were very steep and difficulties were many, and it was therefore rather surprising to hear that extraction uphill was cheaper than extraction downhill. This was one of the reasons why roads were not being built in the bottoms of the valleys, the other being the problem of erosion. A good system of hard roads along the contours was essential.

The wire rope system in use was the "Küpfer" system. When the yarding direction was downhill the timber was felled, prepared and dragged inwards to a position almost directly beneath the cable line where it was fixed to a cradle by hand. It was then raised to the cable line by a winch and released downhill to a produce dump. The cost per cu. ft. for this operation was 8d.

When yarding uphill, in addition to the cable line a single wire rope controlled by a winch was used. This wire rope could draw prepared fellings in sideways towards the line of the cable line from 150 feet away. Hence reduced costs. Costs per cu. ft. were 5d. The maximum limit of sideways movement of the cradle when yarding downhill was only 20 feet.

With the yarding direction uphill the felling area opened up by one cable crane installation would be length 400 feet, width 200 feet and area 1.8 acres. This equipment costs £1,200, and assuming that 1,400 cu. ft. of timber would be removed from that area during operations, the equivalent of ten years increment, the cost per cu. ft. for extraction would be 5d. Four men are needed to operate each system, fifty hours are needed to erect each system, and twenty-five hours are needed for dismantling.

Road making was an operation very thoroughly carried out, the cost quoted to us being in the region of £35,000 per mile! The allowable gradient was 1 in 10, and bridges and culverts were of a very high quality. It should be mentioned that road building in some places was like building a road along the side of a house. A feature of all the roads was a concrete runnel on the inside. Vehicles were expected to keep their nearside wheels on the concrete edge of this runnel as a safety precaution. Stages in the surfacing of these roads were: formation, rough stone filling, soft filling, higher grade stone filling, more soft filling, and finally a high grade metalling. In each of these stages the road was carefully laid, packed, and rolled. Cranes, heavy bulldozers and road rollers were used. All water was run off these roads through a system of carefully constructed culverts with the absolute minimum of erosion to the roads.

A further note about extraction. No figures were given for the area opened up when the yarding direction is downhill, but it appears that the cable way here can be four or five times as long.

REPORT ON A TOUR ORGANISED BY THE FOOD AND AGRICULTURAL ORGANISATION OF THE UNITED NATIONS TO STUDY THE EFFECTS OF MECHANISATION UPON SILVICULTURE IN GERMANY

By R. G. CATHIE

District Officer, East Scotland

The study tour was organised by the Forestry and Forest Products Division of the F.A.O. The tour, which was directed by Dr. M. A. Huberman, Chief of the Silvicultural Section, F.A.O. was held in the German Federal Republic, Land Baden-Württemberg, from the 15th to the 24th September. Representatives from the following countries attended:—Australia, Finland, Holland, Ireland, Italy, Poland, Sweden, Switzerland and the United Kingdom.

The object of the tour was to bring together delegates from participating countries, to discuss and study their experiences in the development of machinery in forestry, to consider how this has affected silvicultural practice, and how the use of machines can be further developed to increase productivity and to make possible the more efficient use of the forest soil and environment. During the tour, many machines usable in forestry operations were displayed and their technical qualifications for the job being done were examined and discussed, but at all times our object, which was to consider the application of the machines to forest operations and not their mechanical technicalities, was repeatedly emphasised by our Director Dr. Huberman.

The tour consisted of daily field excursions, followed in the evenings by the presentation of the statements which had been prepared by national representatives, discussion of these statements and finally the preparation, after discussion, of a joint report. This consisted of a statement of the problems in the field of mechanisation in forestry, and an appreciation of how these problems are being dealt with in the participating countries. As this statement, which was prepared and agreed by all delegates, dealt fully, but in a general way, with the subject of the tour, my report is based on the more specific points of interest which were seen, demonstrated and learned during the tour, not only in mechanisation but in all forest operations, administration and management.

Introduction

Land Baden-Württemberg was formed in 1952 by the union of the old states of Baden and Württemberg.

The forest authority is the Land Minister of Food, Agriculture and Forests whose delegated authority is exercised by four regional directorates—North and South Baden and North and South Württemberg, for which the administrative centres are the towns of Karlsruhe, Freiburg, Stuttgart and Tübingen respectively.

The whole of Baden-Württemberg is divided into about 250 districts or inspectorates, which control an area of slightly more than 3 million acres, that is, 36% of the total area of the State. Of this area, about three-quarters is private and community forest, and the remainder is state owned.

Supervisory staff consists of about 500 officers of the rank District Officer and above, and about 2,300 Foresters. Excluding the timber-using industries, between 50,000 and 55,000 forest workers are employed, of whom slightly less than half are women.

The Black Forest, as well as being the most popularly well-known area of Baden-Württemberg, is also the most densely afforested region in the State, and the town of Freudenstadt, centrally situated in the Black Forest, was the centre of the tour. Most of the excursions were within the Black Forest area, but visits were also made to Karlsruhe in the Rhine Valley and to the University town of Freiburg in Breisgau.

The area of the Black Forest which lies between the Upper Rhine and its tributary the Neckar is a deeply divided plateau with altitudes ranging from 360 ft. in the Rhine Valley to slightly over 4,000 ft. which is the elevation of some of the higher ridges of the central Black Forest.

The principal geological formations are Middle and Upper Red Sandstones with occasional schist, gneiss and limestone intrusive outcrops. These have generally produced fertile soils, which, combined with glaciation and an equable climate, have resulted in deep, steep-sloped valleys in which conditions for tree growth are generally excellent.

The average temperature varies with altitude from 43° to 50° F. and the average annual rainfall is also very variable from 28 in. in the Rhine plains at Karlsruhe to 70 in. in the central mountains, where there is considerable snow-fall during the winter.

1. Machine Operations Demonstrated
Preparation of Ground and Planting

(a) *Preparation of Ground for Planting*

A demonstration of intensive ground preparation prior to planting was given in the Forest District of Karlsruhe Hardt.

This district covers about 10,000 acres of the Rhine Valley. The soil is deep alluvium, the climate is mild, with a long growing season and the original natural forest was deciduous. This has been replaced by a Scots pine (85%) forest, in mixture with oak, beech and hornbeam. The system of regeneration is by felling strips up to 150 yards wide, removing the stumps and brushwood, and intensively cultivating the ground before planting.

Stump removal is either by winching out the stump after felling or by pulling over the standing tree using a wire rope and crawler tractor. Following the stump removal, the ground is completely ploughed to a depth of 15 in. to 18 in. by a single or double plough mounted on a solid four-wheeled frame. On the dry flat ground a 50 H.P. wheeled tractor provides sufficient power for this operation, which is followed by the spreading by machine of manure and anti-cockchafer insecticide. Finally, the ground is disc harrowed or rotovated. This preparatory work, which is done by contract, costs £25 per acre.

(b) *Planting*

The fine loamy soil, having been intensively cultivated by machine, provides an excellent planting medium. Advantage is taken of the flat site to use tractor-drawn planting machines which are adapted agricultural machines. Both the rotating wheel (Robot) and the single furrow type (Akkord) are used. With the latter, the operator works at ground level, and produces a better result.

Great stress is laid upon the exactness of the proportion of broadleaved species used in the mixture and to ensure this, some patches are planted by hand.

The labour cost per acre of planting on this site, using about 4,000 plants per acre, was given as £12. This appeared to be an extremely high cost, particularly bearing in mind the condition of the planting site and the fact that mainly female labour was used for this work.

2. Seed Kiln, Seed Store and Nursery

These were inspected in Forest District Nagold, which lies in the valley of the river from which it takes its name, on the lower eastern slopes of the Black Forest, mid-way between Freudenstadt and Stuttgart.

Altitude is about 1,500 feet, the average rainfall is 30 in. and the average temperature is 47°. At the town of Nagold where the nursery, seed kiln and store are situated, the valley is fairly wide, but frosts, particularly late spring frosts, are frequent.

Seed Kiln

This is a very large, highly mechanised kiln which is used to supply the seed requirements of Land Baden-Württemberg. Output varies between species, but up to 100 lbs. of Norway spruce seed can be produced in a day, and the average annual output of all species is about 20,000 lbs.

Small quantities of cones, generally larch, are treated in a small drum kiln; but the bulk cone collections of Norway spruce, Scots pine and larch are processed in the main kiln which is a large five-storied building. Heating is by steam and all machines are electrically operated. The cones are initially pre-heated in the ground floor boiler-room where, before being conveyed by elevator to the top floor, stones, twigs, needles, &c. are removed by a vibrating riddle. On the top floor of the kiln, a large quantity of cones can be stored for a further period of pre-heating. When required, they are conveyed by elevator into the seed extracting drums, through which dry air is blown by electrically operated fans. A temperature of 105° F. for Norway spruce, and 112° F. for pine and larch, is maintained by thermostat. As the seed is extracted, it is sucked out of the drum and passes on to the riddling, de-winging and cleaning machines. The entire system is based on the downward fall through the floors of the kiln of the cones and seed. When the ground floor is reached, the end products are the cleaned seed and the empty cones and other waste matter.

Silver fir seed is obtained by putting the pre-heated cones into a two-stage threshing mill which breaks up the cones, and the seed is thereafter extracted in a rotating drum. Cleaning &c. is as for all other species.

Before being stored, seed samples are taken to the laboratory, attached to the kiln, where they are tested for germination—both the Jacobsen tank and the Rodenwald system are used—and for purity and moisture content.

The kiln is operated by two men and during the main collecting season, three 8 hour shifts are worked.

(b) *Seed Store*

Up to 40,000 lbs. of seed can be stored in air-tight glass containers in the seed store, where the temperature is automatically controlled at about 25° F. Norway spruce and Douglas fir seeds are preferably stored at a lower temperature of 15° F. Silver fir, oak and beech are stored in bulk on the hard clay floors of underground cellars, where the temperature remains fairly low even during the hottest summer.

A separate seed store is in process of construction for storing silver fir seed at a controlled temperature.

During storage, sample seed lots are tested at 6-monthly intervals for germination, purity and moisture content.

(c) *Nursery*

The Nagold nursery covers an area of 65 acres. About 30 acres are used for agriculture, as the provision of an assured supply of farmyard manure is considered necessary to maintain and improve the nursery soil fertility.

The soil, which has a high clay content, overlies limestone, and had a pH value of 8 when the land was purchased in 1947. The difficulties of making a tree nursery on such a site, that is, frost, heavy soil and high lime content were appreciated, but it was believed that the soil structure and pH could be improved by the introduction of the correct type of humus, and this has been a feature of subsequent manurial treatment.

The compost, which is prepared over a period of 10 months, consists of coniferous forest soil and raw humus, farmyard manure and nursery weeds! The mixing and breakdown of this material is very thoroughly done three times during the preparatory period, using an 8 H.P. machine specially designed for this particular job. Temperatures up to 110° F. are maintained. The compost is applied to the ground allocated for seed sowing at the rate of two cubic yards per hundred square yards.

Although the pH value is still higher than the optimum, the texture, structure and appearance of the soil are considerably better than that of surrounding agricultural ground, and the nursery stock has a very healthy appearance.

Most of the nursery operations at Nagold are partially mechanised by the use of a series of light cultivating machines which are used to prepare the ground for sowing, lining-out and subsequent alley and inter-row cultivations. These machines are all slightly modified agricultural/horticultural machines and tractor mounted equipment had not been tested!

Much of the nursery work is done by experienced female labour, working at piece-work rates, so that despite the lack of more intensive mechanisation, and the lay-out of the nursery in narrow, rather than long working strips, labour costs are fairly low, e.g. lining-out at 5/- per thousand.

The annual production is about 3 million 1+2 or 2+2 transplants and 1 million seedlings.

An interesting feature of the nursery is the maintenance of rainfall and temperature records which, over a period of years, can be related to growth and outturn.

3. Manuring of Plantations

In South Württemberg experiments have been conducted since 1905 to test the effects of the application of artificial fertilizer in the forest.

One of these experiments in which lime and basic slag had been used, was inspected in the Forest District of Obertal. The site is at an altitude of 2,500 ft. and is a broad ridge between two valleys. The annual precipitation is about 65 in. The soil is a typical podsol, gleyed in parts and with a slight iron pan. The surface vegetation is *Vaccinium myrtillus* and *V. vitis-idaea*, *Calluna vulgaris*, *Pteridium* and *Sphagnum* mosses. In 1905 the twenty year old Scots pine crop was reported to be 7 ft. high! Norway spruce and beech were planted through the pine, and the area was divided into three sections which were manured with lime and basic slag in varying proportions. This experiment has shown that lime alone has had little effect, but that the combined lime and basic slag applications have given a volume increase up to 170% greater than the sections treated with lime only. All treatments had included lime so that the effect of basic slag only could not be judged from this experiment. The spruce has shown a much greater response to the manurial treatment than the pine.

A second manuring experiment on a similar site was inspected in the neighbouring district of Klosterreichenbach. This experiment was begun in 1953 on an area of 5 acres which was shallow ploughed and then planted with

Norway spruce mixed with oak, beech and silver fir. In this experiment, great emphasis had been placed on the use of lime despite previous indications that lime had little or no effect! In some of the treatments only lime had been used, but basic slag had not been tried as an individual treatment. Subsequent treatment included the sowing of birch, lupin, wild service and common alder seed, the planting on some sections of Japanese larch, and the application of nitro-chalk in varying quantities. After an initial period of check the sections in which basic slag had been included in the treatment are reported to have shown improvement in 1957. When inspected in 1959, the most satisfactory results appeared to be in the slag treated sections in which birch and self-sown aspen were nursing the spruce out of check.

Based on such experiments the area of plantations in Land Baden-Württemberg being treated with artificial manures has increased from 3,500 acres in 1953 to nearly 10,000 acres in 1957, at a cost of slightly less than £6 per acre. The cost of material is approximately equal to the combined labour and machine costs.

A demonstration of the application of manure by machinery was given in a 35 years old Norway spruce plantation in the Forest District of Hofstett. The area was flat and freely accessible for the Unimog on the platform of which was mounted the Unimog manure spreader known as the 'Super-Molekulator', which can be adapted for a variety of spraying jobs. Power is supplied from a rear power take-off and the range of spread—up to 120 ft.—is readily adjustable by the machine operator.

Where stands are inaccessible to wheeled machines, it is claimed that manure distribution if well organised can be done as cheaply by hand and pack-pumps as by wheeled high-powered machines such as the Unimog.

4. Ground Preparation for Seeding

At the time of the first regeneration felling, on sites where a raw humus has built up, the practice is to prepare a seed bed either by tractor-mounted rotovator, or by self-propelled cultivating machines.

A demonstration of one of these cultivators at work was given in the town Forest of Wildbad. The site is flat, at an elevation of 2,500 ft., but podsolisation under the 200 years old crop of silver fir, beech, spruce and Scots pine, has not been severe. A light first seeding felling had been made about 5 years previously, and the second regeneration felling was in progress. There were dense patches of Norway spruce regeneration.

The machine being used was a 12 H.P. 2-wheeled diesel machine (Agria-type 1900 D), which has a working width of slightly less than 4 feet and a cultivating depth by rotating tines, up to 9 ins., depending upon surface and soil conditions. The total cost of this operation was given as about £5 per acre, but the possibility of breakages was expected to be high. It was considered by the local staff that the existing regeneration was inadequate and that insufficient seeding by the required species would be obtained by the normal regeneration felling.

The 2-wheeled machine demonstrated had a wide range of tool fittings including a nursery plough, water pump, harrows, winch and trailer. Most of these were demonstrated during the tour.

5. Stand Tending

This includes all cultural operations in the stand up to the first thinning stage. This work is carried out intensively throughout this period and includes early inter-row cultivation, weeding, the cutting out of undesirable species/stems at the thicket stage, brashing, pruning and cleaning of pole-stage stands.

In Land Baden-Württemberg in 1957, about 75,000 acres up to the thicket stage were treated at a cost of 50/- per acre, and about 38,000 acres up to the thinning stage were cleared and brashed at a cost of 80/- per acre. This is in relation to an annual planting and regeneration programme which has decreased from 15,000 acres in 1953 to 12,000 acres in 1957.

The machines demonstrated included light inter-row cultivators and harrows, either horse-drawn or self-propelled, and small light-powered circular saws for use in stands in the light-pole stage. In the intermediate formative years of the stand, all weeding/cleaning operations are done by hand tools.

6. Timber Production

The method of preparing the produce for sale is fairly standardised. Virtually all work is done by contract at very closely calculated rates, and the timber is sold in the length, peeled at roadside.

The annual felling programme of the German Federal Republic is about 650 million cu. ft. of which slightly less than 25% is produced in Land Baden-Württemberg. Of the total timber production in Baden-Württemberg 55% is silver fir and Norway spruce saw logs of the highest quality. Timber in this class is being sold at present for prices between 5/- and 6/- per cu. ft. at roadside. Only 20% of the total production is hardwood timber, mainly beech, of which approximately 60% is used for firewood. Even the best quality beech logs are sold for prices much lower than coniferous timber of similar class, the prevailing maximum price at roadside being 4/3 per cu. ft.

Demonstrations of the use of machines in timber felling, extraction and preparation were inspected in the forests of the Murg Floating Co., at Forbach, at the forest workers school of Hollhof near Gengenbach and finally in the Forest District of Schonmunzach. Timber producing operations are generally fully mechanised, and the system of working is stereotyped.

Felling and cross-cutting are mostly by power saw, and extraction is either by wire rope and winch on steep slopes, using sledges and skid-pans, or by four-wheel drive Unimog and trailer on flat ground. The Unimog with winch is also used on steep slopes. and this machine demonstrated its versatility in nearly all forest operations.

The average direct labour and machine costs for preparing timber for sale are 6d. per cu. ft. This extremely low price is due to the following factors—the generally large dimensions of the timber worked, a skilled and permanent labour force, the efficient use of the type of machinery best suited to the job, a first class system of all-weather extraction roads and, of prime importance, a carefully calculated and agreed system of contract or tariff rates based on the time taken to produce the various timber classes. These rates are revised and agreed annually by the Federal State representatives of the Horticultural, Agricultural and Forest Workers Union and the Federal Government Assoication for Tariff Rates.

Other Operations

(a) Inspection of the Town Forests of Freudenstadt and Baden-Baden

(i) *Freudenstadt*

The Town Forest of Freudenstadt covers an area of 6,500 acres. The principal species is Norway spruce (60%) with silver fir (25%) the main subsidiary species mixed with pine and beech.

Freudenstadt is the main holiday town of the central Black Forest, and because of this, the principal object of management is that the Forest should be managed as a selection high forest and that clear fellings should be avoided.

The selection system as practiced on a 4-year felling cycle has resulted in a very heavy stand stocking with a disproportionately high percentage by volume of trees over 70 years of age. It was felt that an extended felling cycle, combined with the more drastic removal of mature stems, would not affect—and might even improve—the amenity, and would eventually result in a higher volume production.

(ii) *Baden-Baden*

The Town Forest of Baden-Baden covers an area of approximately 14,000 acres on the western slopes of the Black Forest, overlooking the valley of the Rhine.

The system of regeneration is by strip felling of the high forest, accepting the natural regeneration when suitable, and replanting where necessary. The normal species of the Black Forest predominate, that is, Norway spruce in mixture with silver fir and beech being dominant at the higher elevations, with the silver fir dominating the spruce and beech on the lower slopes. In the younger, post-war plantations, there has been a considerable introduction of other species generally foreign to the Black Forest. These include European larch, Weymouth pine and Douglas fir.

The difference in the general appearance of the two forests of Freudenstadt and Baden-Baden was very marked, and there could be no doubt that the amenity had been much better preserved at Freudenstadt by the selection system and by the use of the tree species of the area. In addition, the attempt to preserve amenity at Baden-Baden, while still using a strip felling system, had led to extremely unbalanced distribution of the age classes, 40% being in the 120 years and over class.

(b) Crown Blasting

A small demonstration was given in the Forest District of Karlsruhe-Hardt of the blasting of the crowns of mature Scots pine prior to felling.

The object is to remove, by blasting, the crowns of trees left at the final regeneration felling, so that the crown falls at the base of the tree and does not damage the regeneration over a wide ares.

Early trials using borers had been unsuccessful, but the method now used gains satisfactory results. The bark immediately below the break in the crown is smoothed and a band of a Swiss-manufactured plastic explosive is tied round the tree. The charge is detonated either electrically or by safety fuse. The resulting fracture was very clean, there was no splitting of the stem and the crown, which was thrown upwards initially, fell at the base of the standing tree.

The possible practical application of this was felt to be limited.

(c) Forest Worker Schools

In Baden-Württemberg there are four schools or centres which forest workers attend for periods of one to three weeks training. The schools and the work being done at Hollhof and Hinterlangenbach were inspected during the tour.

Annually, about 1,000 forest workers attend these courses, and in addition each year more than 7,000 workers take part in courses and classes organised in the Forest Districts.

The courses are intended to teach the workers the skills of the jobs which they do in the forest and to explain to them the history of the forest, the tariff system for fixing their piece-work rates and the benefits of forest employment.

With the drift of population from forestry work to jobs in the towns, and the subsequent more extensive use of machinery, it is felt that it is increasingly important that the workers be taught how to use and maintain machine tools. Particular importance is attached to attracting young workers and to giving them a sense of pride in their skill and ability.

At the work schools there are three main courses for (1), Learners. (2), Intermediate and (3), Advanced Workers. Workers who have successfully completed these courses receive higher rates of pay.

(d) Visit to Forestry Department University of Freiburg

Freiburg is situated to the immediate south of the Black Forest. The University's Department of Forestry is the oldest in Germany having been founded in 1787 and now comprises eleven sections or institutes. These are—Soil science, forest botany, forest geology, silviculture, management and economics, mensuration and yield, forest history, wood technology and work science, forest policy, a forest research station and the institute of bioclimatic study. The forestry degree or diploma course lasts for 4½ years.

Conclusions

The inspection and discussion of a wide variety of forest operations, seen in a new environment was extremely useful but it is felt that the most lasting benefit of the tour to the representatives of a relatively young forest service was the study of the achievement and working of a long-established and highly organised forest service such as that of Baden-Württemberg.

There can be no doubt that the objects of the Baden-Württemberg Forest Service and the state controlled private forests to maintain and improve the production and natural amenity of their forests are being achieved, and timber of the highest quality is being produced. In addition, the annual budget of the State Forest Service shows a surplus of £4 million over an expenditure of £6.5 million. Nevertheless, the immediate and lasting reaction to what was seen on the tour was that on almost all forest operations and in management, expenditure was excessive.

There was no sign that any of the local supervisory staff considered that the administration and management was top-heavy, nor that any of the forest operations were unnecessary. In fact, the reaction to any questioning of established practice was always defensive and conservative. I consider that it must always be of extreme importance to bear in mind the strict economic justification for each forest operation—unless this is contrary to national policy—and that this must be borne freshly in mind even when a Forest Service moves into the satisfactory position of being an income producing department.

I felt that this attitude of mind and freshness of approach to problems had been lost in Baden-Württemberg.

A further most interesting and valuable feature of the course was the opportunity to see in such a short time the Black Forest, and to be able to discuss with Forest Officers from the participating countries the problems presented, in the light of their experiences in their own countries. It could not but be concluded by the representatives of Ireland, Sweden, Finland and the United Kingdom that the growth capacity of the Black Forest was generally far superior to anything which could be encountered in their own countries, and that the problems of silviculture in their countries bore a much closer relationship to each other than anything being seen in South Germany.

From what was seen on the tour, it is not considered that Britain is backward in the field of machinery used in forestry, and in fact some of the operations inspected, particularly nursery work and the preparation of ground for planting, could have been tackled much more successfully by the machinery in use in this country.

An obvious feature of all demonstrations was the skill and resourcefulness displayed by the forest workers. Many practical lessons were learned from these demonstrations, and it is felt that the basic training of the workers is one of extreme importance, particularly where machinery is being used.

Finally, I would like to express my appreciation of the opportunity which was given to me to attend this tour. The experience of meeting and interchanging ideas with forest officers from the various participating countries was very valuable. I feel sure that the expenditure on a tour of this nature is amply rewarded by the lasting impression and benefit which it leaves with the participants.

In expressing my thanks I would like to record the generous hospitality extended to the members of the tour by the representatives of the German Federal Republic and the Forest Officers of the State of Baden-Württemberg.

REPORT ON ROYAL SCOTTISH FORESTRY SOCIETY EXCURSION TO ARGYLL, MAY, 1959, (PARTY A)

By NORMAN M. BROWN

District Officer, South Scotland

Largie Estate (5th May)

In his introduction, the owner, Mr. J. Maxwell Macdonald, said that silviculture on the Estate was greatly influenced by the exposure of the woodlands to Atlantic gales. The visit was mainly devoted to inspection of the thinning methods adopted by the Estate.

A "crown" thinning pioneer plot in P.35 Sitka spruce was seen and the method explained by the owner. The first step is the selection of 140 to 160 trees of good form and vigour per acre. These are high pruned to 18 or 20 ft. and the best are favoured in thinning and attention is given to pruners. The plot had been thinned twice before and a third thinning was marked. The appearance of the stand suggested that too many selected trees were being favoured but the party appeared generally to favour the method.

Further first and second "crown" thinning markings in Sitka spruce were seen and some criticisms made on the marking. Produce from these stands was inspected, and the relatively large size of the average tree removed in early thinnings noted.

The opposing views on the problem of growing Sitka spruce at Largie were expressed. Some thought it should be grown as a pure crop, left unthinned, and felled for pulp at an early age before windblow occurs. Others thought it should be grown in mixture, thinned early, and the stands gradually converted to irregular structure.

Largie Estate Sawmill

Mr. Macdonald explained that the sawmill was run on commercial lines, and that there was a high demand for fencing stobs in the surrounding countryside, which was remote from other producing centres.

The sawmill had been rebuilt since the war and Stenner Band Saws, saw sharpening equipment and a Cellcure pressure plant installed. An Estate workman had been trained to use the sharpening equipment. Mr. Macdonald said that the percentage conversion loss with the new saws varied from 15 to 22. With the old circular saws it had been 46 per cent.

The Cellcure plant, band saws and sharpening equipment were seen in use and some produce was examined. Many thought that the sawmill was a very efficient unit although a number criticised the lay-out.

Mr. Macdonald kindly provided teas for the party at Tayinloan.

Evening Film Show and Talk—Bowaters (5th May)

In the evening, at Inveraray Cinema, the Bowater Film "Tennessee Project" was shown to a good turn-out of members. The film, in technicolor, dealt with the construction of the mill, its operation and effect on the locality and a little about the source of supply of timber including a glimpse of mechanical planting of loblolly pine. It was well received and followed by a talk by Mr. Shaw of Bowaters.

In his introduction Mr. Shaw gave a brief account of the history of Bowaters and mentioned their present distribution and holdings. He then went on to discuss the supply of home-grown timber for the Ellesmere Port Plant. The more important points he made, referred to:—

1. Quality

(a) *Strength.* Logs of small top diameter from fast-grown timber were sometimes weak and liable to breakage in the peeling drum. They are then useless as subsequent handling is mechanical.

(b) *Taper and straightness.* Logs with basal swellings or bends prevent mechanical feeding of machines.

(c) *Knots.* Badly sned logs, or logs with swollen whorls give trouble in the grinding process.

He thought that the quality of timber required for the Ellesmere Port Mill was similar to that at present acceptable for pit props, and that it might be necessary to raise the minimum acceptable top diameter to over 3 inches.

2. Price

Mr. Shaw thought that the current price was too high. The timber for pulping was purchased by weight, although Bowaters were interested only in the fibre obtained. He said tests had been made and that the results show that home-grown pulp timber contains 55 per cent water and 10 to 13 per cent bark.

A lively discussion followed. Some members felt that Bowaters were trying to make British forestry grow timber to suit machinery designed for Continental or American timber grown under entirely different conditions and circumstances. Mr. Shaw pointed out that the firm's interest was in producing pulp and that their main supply was in imported timber. At present they were simply giving a trial to home-grown timber. If it proved unsuitable the Ellesmere Port plant could readily be supplied with imported material.

Other members were more hopeful and expressed the opinion that, except for some butt cuts and bent logs, home timber would prove quite suitable. Mr. Shaw said that thinnings were not wholly suitable and described them as cast-offs that could demand only cast-off prices. Some members suggested that timber should be grown to a suitable size without thinning and then be clear-felled for pulp. Mr. Shaw thought that this class of timber would be suitable.

Mr. Shaw was asked if there was a possibility of Bowaters setting up a pulp mill in Scotland. He gave no definite reply beyond saying that his last survey of 1948 showed that there was insufficient timber.

The following conclusions might be regarded as general:

(a) A reduction in the price of pulp timber is possible.

(b) Suppliers must pay closer regard to the specifications which are by no means exacting at present and which can be met in most cases without undue waste or loss.

(c) The present attractive pulp prices are likely to result in problems in the silvicultural treatment of spruce stands.

Open Day—Benmore (6th May)

Benmore Forest. The party, conducted by Mr. T. A. Robbie, Divisional Officer, visited a 43 year old stand of Sitka spruce on the lower slopes of a very steep hill, where low and "crown" thinning marking was demonstrated. The best trees, approximately 100 per acre, had been selected for preferential treatment in the crown thinning.

Mr. Robbie said that the "crown" thinning marking was favoured and that the aim would be to encourage the selected trees to reach 12 to 14 inches Q.G.B.H. as soon as possible. He thought that this might be the maximum economical size on this site and that the best trees would attain it in 10 to 15 years. A brief discussion followed on the merits of "crown" thinning with emphasis on the effect on girth development.

Some members argued that Sitka spruce stands should be left unthinned and clear felled for pulp when of a suitable size. Others argued that this might be applicable in particular areas in Argyll where extraction was unusually difficult or expensive.

In reply to a question Mr. Robbie said that it was intended to clear-fell a few groups in 10 or 15 years' time. He thought the groups would each be between 1 and 2 acres and that the size of subsequent group fellings would be modified in the light of experience. The majority of members appeared to approve these proposals.

A fairly open Japanese larch sample plot, part of which had been underplanted in 1926 with *Abies grandis* was then visited. Some considered Japanese larch not worth growing as in their experience the timber was poor quality and not in demand. Several agreed with the view that young Japanese larch stands should be heavily opened up and underplanted with *Abies grandis*, *Tsuga* and *Thuja* and other shade bearers. It was the general opinion that the area underplanted in 1926 should have been opened up much sooner to encourage the undercrop, although a few expressed concern about the danger of heavy damage to the undercrop in felling and removing the larch. It was the experience of several present that, with reasonable care, very little damage to the undercrop resulted from such an operation.

Attention was drawn to the strong growth of grass under the larch not underplanted and everyone agreed that forest land should grow timber and not grass.

In the afternoon machinery exhibits were visited. These included the Jo-Bu clearing saw which was seen in action and thought to be the most useful machine yet produced for clearing scrub. Jo-Bu master light-weight power saw, Rob Roy 24 inch saw bench, Sandvik saws, etc., were all seen in action.

Cowal-Ari-Sawmill (7th May)

The Ari sawmill developed by Swedish specialists to utilise small diameter saw logs was set up at Glenbranter in July 1953. It is jointly owned by Messrs. Adam Wilson & Sons, Ltd., and the Forestry Commission.

The main working floor of the mill, which is highly mechanised, is raised some 12 ft. above ground level. Logs are raised to the first saw by means of a conveyor belt which passes through the centre of the log skids where they are slabbed. Waste slabs are removed by low-level conveyor belt and the remainder of the timber and slabs passed mechanically to the second saw which is operated by one man and has an automatic return. Here deals, 2, 2½ and 3 inches, etc., are sawn and the remainder passed mechanically to pendulum saw for cross-cutting. This saw is operated by a boy who passes the crosscut "slabs" to the last sawbench which is a double adjustable width circular pair.

Sixty per cent of the production is deals and the remainder boarding, strapping, etc. It was noted that interwoven fencing was being manufactured.

The party was plainly impressed by the design, organisation and purpose of the mill. Several criticisms were made. Although the mill was highly mechanised, two men crosscutting logs on the skids were manhandling the crosscut logs to the conveyor belt. It was thought that this latter operation could easily have been mechanised. Three men were employed in crosscutting sawn timber into very short lengths (about 8 inches) and it was felt that, properly organised, the job could quite easily have been done by one man. Some members were surprised to see the methods of stacking boarding. Many lengths were stacked together, with the result that the longer lengths which protruded a long way from the stack drooped very badly. The quality of the sawing and efficiency of the kiln drying were both generally admired.

Argyll Estates (7th May)

The party was led by Mr. A. R. D. Davidson, Head Forester, who explained that forestry had been practised on a fairly large scale on the Estate since the middle of the 17th century, but that the woodlands had been neglected between 1888 and 1951. Since the latter date progress had been made in bringing the woodlands into order. The Estate is now working to an approved plan under the Dedication Scheme.

Amenity is of importance and consequently clear felling in the old mixed woods is not favoured. Group fellings are made at intervals and regenerated naturally or by direct planting. Strong regeneration of *Tsuga*, Sitka spruce with some *Thuja* and Douglas fir, was inspected in a group which had been cleared in 1954. *Tsuja* was very dense and in places it was overwhelming the Sitka spruce. It was agreed by all that here and there *Tsuga* should be cut back to help Sitka spruce.

In Ballantyne Wood, Cpt. 84, some outstanding groups of 71 year old Douglas fir, *Thuja, Tsuga, Abies grandis,* and Sitka spruce were seen. These had been planted for amenity in rich pockets on a very steep south-east facing slope between 150 and 500 feet above sea level. Unfortunately these groups had not been thinned until 1955 when the trees were 67 years old. Despite this, or as some members thought, because of this, the form of most dominants was magnificent. Mr. Davidson had measurements of standing volumes and members were greatly impressed by the figures. Douglas fir 12,000 to 13,000 cu. ft./acre. *Thuja* 9,800 cu. ft./acre. *Tsuga* 12,000 to 13,000 cu. ft./acre. Unfortunately some of the groups were very small—that for *Tsuga* being about 0.2 acres. Nine Plus trees had been selected by the geneticists in this Compt. Members, greatly impressed by the form and volume of the trees, thought they gave a good indication of the performance that could be expected from these species on the better West Coast sites. Some members thought that the groups would have been of even greater interest, had they been mixed, and others made reference to the very high productivity of the site and its suitability for producing short rotation pure Sitka spruce for pulp.

The Estate Sawmill was visited. Mr. Davidson explained that the plant was now considered out of date and inefficient. It was operated by water power and the supply was inadequate with the result that sawing was very slow. A building has been adopted for drying and storing timber, and members thought it very suitable for this purpose.

Luss Estate (8th May)

Highlandman Wood and Drumfad Strip. These woods, orginally planted with spruce about 1880, were blown down in the gale of 1912. Replanting had been done between 1922 and 1930 with Scots pine, European larch, Sitka spruce and Norway spruce, and the first thinnings made in 1956/58.

Several members thought the thinnings had been rather light and that they should be repeated again very soon, in at least part of the crop, and that if the wood were to remain windfirm the drainage system would be improved without delay. Although the woods were situated on the upper slopes of a hill and exposed to the west, most members did not think there was much danger of windblow provided thinning and drainage were given regular and adequate attention.

General

(1) A number of members appeared to be obsessed with the idea of growing timber for pulp. This was unfortunate as it tended, at times, to direct attention away from items of silvicultural interest and importance.

(2) It is a pity that knowledgeable foresters are reluctant to voice their opinions at these excursions.

(3) No unreasonable criticisms of the Forestry Commission were made.

REPORT ON ROYAL SCOTTISH FORESTRY SOCIETY EXCURSION TO ARGYLL, MAY, 1959, (PARTY B)

By W. F. STODDART

Head Forester, North-East England

Inverliever Forest (5th May)

This forest covers 15,192 acres of which 4,365 acres are under plantations. There is a small reserve of plantable land and about 500 acres are scheduled for planting over the next three years.

The southern half of the forest rises steeply from Loch Awe to an exposed plateau just over 900 ft. above sea level. In the northern half the ground falls away out of exposure on more gradual and moderate slopes. Rainfall averages about 85 inches.

The area is sited largely on metamorphic rock of the Dalriadian Series. On the lower slopes of the forest there is an accumulation of wash from above resulting for the most part in deep loamy soils very suitable for tree growth. Further up the slopes the soil becomes shallower with many rocky outcrops. The plateau consists of many peat-filled valleys broken by ridges of outcropping rock which lie roughly parallel to Loch Awe.

Inverliever was acquired by H.M. Office of Woods as a large-scale experiment in the afforestation of difficult ground in the West Highlands of Scotland. It was the first area of State Forest in Scotland on which exotic conifers were extensively planted and it is now providing useful information on the behaviour and development of these species.

Planting was started in 1909. Many different species were tried on a wide range of sites. Norway spruce and Sitka spruce were the main species used along with European larch, Japanese larch, Douglas fir, Scots pine, mountain pine and some *Abies alba.*

It was most unfortunate that Norway spruce was chosen as the working species for the poorest sites, with Sitka spruce for the better sites. The result is that some 900 acres or thereby of Norway spruce are in a very poor state indeed.

The method at present being used by the Macaulay Institute for Soil Research, Aberdeen, to determine whether or not a checked plantation will respond to manuring, is to find the nutrient content of the needles. As a result of this investigation it is hoped that about 300 acres of checked Norway spruce will recover but the remainder will have to be replanted with Sitka spruce, Japanese larch and lodgepole pine.

Thinning began at Inverliever in the late thirties and to date approximately 3 million cubic feet have been felled and extracted. The present annual out-turn is in the neighbourhood of 200,000 to 250,000 cubic feet and almost one-half of this sold as saw logs to the Cowal Ari Sawmilling Company, the remainder going for pitwood, stobs, etc.

When the Office of Woods started operations in 1908 there were approximately 55 people resident in the Inverliever area, by 1912/13 the population had risen to 87 and today it is 318. Perhaps the most encouraging aspect of this is the increased proportion of school children. In 1909 there were only 11, to day there are 127.

Most of the labour are housed at the Forest Village of Dalavich which was started in 1950, the last house being completed in 1955, making a total of 47. There is a school, post office and community centre.

Whilst the setting up of a Forest Village in the centre of the Forest may be ideal from the official point of view I consider that from the point of view of the villagers themselves it can be quite the reverse. In the course of a conversation I had with the proprietor of Portsonachan Hotel I remarked on the neglected state of the village of Kilchrenan which lies 6 miles to the north-east of the Forest Village. The reply I received was that this was the fault of the Forestry Commission for not building the forest village as an addition to the village of Kilchrenan. Having lived in this area for nine years I could appreciate this point of view. I think it is a mistake to expect the Forest villagers to live happily all the year round in a "Forestry Commission atmosphere".

As far as the future is concerned, Inverliever, and its neighbour to the north-east, Inverinan, a forest approximately similar in area but of more recent origin, are being grouped together to form a Working Plan area and survey work is in hand at present. There are certain problems and difficulties which must be considered, and some of the more important are:—

(i) There is a very irregular pattern in the Inverliever constituent of the Working Plan area, and there are numerous small stands needing intensive management. Attempts will probably have to be made towards a slightly more uniform system.

(ii) Windblow will always occur. Heavy rainfall followed by winds gusting up to 100 miles per hour, which occur from time to time, cannot be wholly overcome by wise choice of species and full drainage.

(iii) Red and roe deer are common in the forest and until they can be effectively reduced they tend to make underplanting a complete waste of time.

(iv) The final question is really what class of produce should be produced at Inverliever and to what size should it be grown.

Some discussion on thinning took place on a Management Indicator Plot which, we were informed, was marked for a crown thinning. As there was little evidence of suppressed trees in the Plot, I was of the opinion that it was too late to talk of crown thinning. The plot was at the stage when all that could be done was to select the best stems and then to favour them.

Extraction is done mainly by horse to extraction lanes and thereafter by Fordson Major crawler tractor (Diesel) with Whitmore Sulky.

I was greatly impressed with the use of Fordson Major tractors to which Hiab hoists were fitted, for the loading of lorries. This makes the fullest use of the hoist and is a big advance on the hoists fitted to lorries.

Natural regeneration is possible at Inverliever in the numerous windblow patches but only if these are deer fenced.

In conclusion I would say that Inverliever appeared to me to have been rather neglected as far as thinning was concerned, in some cases the thinning has been delayed and in others the thinning has not been heavy enough and I would say that serious consideration should be given to felling for the pulpwood market.

Bowater Paper Corporation Ltd.

During the evening of 5th May a talk on the "Utilisation of Timber for Pulping" was given by a Mr. Shaw, representing the above-mentioned firm. Mr. Shaw's talk was preceded by a short film showing the process of pulping in a Tennessee mill.

The important points stressed in the talk were:—

(i) To meet the requirements of the industry, timber should have a 12 inch maximum at butt end and 4 inch minimum at small end.

(ii) The taper should be gradual; excessive buttressing causes jamming in automatic machinery; timber must also be round.

(iii) All branches must be trimmed level with the log.

(iv) That Forestry Commission should consider clear felling as a means of producing better quality pulp logs in quantity. This would mean growing our spruces on a shorter rotation.

(v) Home-grown spruce has a lower density and higher moisture content than imported spruce and small diameter home-grown logs, being quicker grown, are weaker and liable to snap.

(vi) Prices should come down in order to compete with imported pulpwood logs.

Mr. Shaw stated that a small pulp mill would only be profitable if the price of pulpwood were reduced and the price of paper raised.

Benmore Forest and Forest Garden (6th May)

This forest extends to 9,584 acres, of which 3,043 acres have been afforested with 300 remaining to be planted. The planting programme is 50 acres per annum, and the work is done by students from the Forester Training School. There is a nursery of 18 acres and the balance of land is used for agricultural purposes.

The thinning of the acquired woods has been in progress for some time but the thinning of Forestry Commission plantations did not begin until 1946.

One of the main interests on Benmore lies in the plantations and specimen trees which were planted on the Estate by the late Mr. Younger and the previous owner Mr. James Duncan. The specimen trees, north-west American species, are scattered throughout the policies and the Arboretum. These were planted during the years 1871 and 1872.

There was little of special interest to be seen in the forest. The present aim is to grow the timber to a B.H.Q.G. of 12 to 14 inches and then clear fell in 2-acre blocks, but this I feel sure would expose the remaining woods to the risk of windblow. On the other hand large-scale clear-felling on the very steep slopes would give rise to soil erosion in such a heavy rainfall area. The question of extraction, too, is quite a problem.

I suggested to the meeting that clear felling might be done in diagonal strips on a very gradual gradient and extraction could be done by timber chute. This I felt would considerably reduce the risk of erosion and to some extent windblow.

After lunch a demonstration of various types of mechanical tools was given by representatives from a number of firms. They were for the most part mechanical saws, peeling machines, portable sawbenches and a variety of hand tools.

A brief unscheduled visit was paid to the Cowal Ari Sawmill which deals with the produce from the surrounding forests. Of the timber taken in to the mill, 95 per cent is from Forestry Commission forests. The produce from the mill consists mainly of deals, battens, box wood, laths and pitwood. There is a modern kiln which deals with two standards per day. Much of the timber is handled mechanically and the men employed work on a bonus system.

Cumlodden Estate (7th May)

The outstanding feature of this estate is the "Quick Growth" factor pertaining on Lochfyneside. An instance of this was the thinning of hybrid larch at 12 years of age, removing 326 stems per acre producing 368 cubic feet, average 1.1 feet per stem.

The owner, Sir George Campbell, does not work to any of the recognised grades of thinning but uses what he chooses to call the "common-sense method".

I was amazed at the early stage at which underplanting has been done in some of the stands visited, e.g. European larch planted 1918, and underplanted in 1943 (at 25 years) with *Cryptomeria*, *Tsuga* and beech, having received four thinnings in the interval, including the removal of 350 cankered stems in 1933. The original spacing was 3 ft.×3 ft. and in January of this year the stocking was 130 stems per acre, standing volume per acre European larch 2,476 hoppus feet, average height to top 68 feet, average volume per stem 19.05 hoppus feet.

Hybrid larch planted in 1926 at 4½ ft.×4½ ft. and underplanted in 1939 (at 13 years) with *Tsuga*; 410 stems were removed in 1936/38 at first thinning. January 1959 shows standing volume hybrid larch as 2,332 hoppus feet per acre, average height to tip 64 feet, average volume per stem 15.55 hoppus feet and stems per acre 150.

Japanese larch planted in 1922 at 5 ft.×5 ft. and underplanted in 1940 (at 18 years) with *Tsuga* after three thinnings. In 1951, as the result of very definite opinions expressed by the Society of Irish Foresters, to the effect that two crops cannot grow satisfactorily on one site, and one must favour the one or the other, the overcrop was drastically reduced to 40 stems per acre. In comparison with the hybrid larch this stand shows, in 1959, standing volume Japanese larch per acre 889 hoppus feet, average height to tip 57 feet, average volume per stem 22.22 hoppus feet.

In my opinion the reason for the extraordinary early age at which underplanting was done, is due to the fact that the death rate was very high and probably no beating-up has been done.

A visit was paid to the Forest Garden at Crarae which was presented to the Commission by Sir George Campbell in 1955. Planting started in 1933 and continued until 1939 by which time 78 plots of varying sizes had been established. Between 1940 and 1948 a further 25 plots were planted. In addition to these 102 plots, there are 48 individual specimen trees or groups of specimen trees. A Working Plan was put into operation in 1957 which among other things recommended that emphasis should be placed on expanding the planting of genera which are at present well represented. These are *Abies*, *Picea*, *Cupressus* and *Tsuga*.

Ardgartan Forest (8th May)

The visit to this forest was disappointing, only eleven excursionists attended. There was some discussion on roadmaking and extraction, and thinning problems.

The planting limit is 800 to 900 feet. The layout system of roads is good but the road surface is poor because of the large size of material used. The decision now is to repair surface with smaller material. Landslides are a bugbear when cutting and many are not yet fixed, so in consequence the minimum roadage is made, the controlling factor being the length of haulage on the very steep slopes.

A VISIT TO GLEN AFFRIC AND GUISACHAN FORESTS

(*Society of Foresters of Great Britain—Annual Excursion*, 1959)

By R. MACDONALD

District Officer, Education Branch

The excursion party was taken by motor coaches to Beauly and along Strath Glass into Glen Affric, thence to Guisachan Forest and down Glen Urquhart to Loch Ness and the main road back to Inverness.

The tour, which was arranged by the North Scotland Conservancy, had two objects of study:—

(1) Management of old natural stands of Scots pine with particular emphasis on amenity.

(2) Comparision of growth of Scots pine with other species.

A large part of Guisachan was acquired before the war, while the remainder and the whole of Glen Affric has been acquired since 1951. A total of 58,898 acres has been acquired of which 11,912 acres are deemed plantable. A noteworthy feature of both forests is one of the last remaining areas of natural pine woods. The pines in general range from 150-250 years of age although the bulk are in the 150-200 year age class. One Head Forester looks after both forests.

Areas and Programmes

	Forest Guis-achan	Forest Glen Affric	Total
Total area acquired (acres)	5,644	53,254	58,898
Area of acquired plantations (acres)	114	1,341	1,455
Area planted by F. C. (acres)	1,919	2,812	4,731
Area remaining to plant (acres)	969	4,757	5,726
Annual planting programme (acres)	150	470	620
Annual timber production programme (000's cu. ft.)	8	150	158
No of Foresters	—	1	1
No of Assistant Foresters	1	1	2
No of employees	6	40	46
No. of houses	3,	24	27
No of Holdings	1	1	2

Climate

The rainfall varies from 50 to 70 inches per annum, Heavy snowfalls are common in winter. The prevailing wind is South-West.

Topography

The area consists of a series of elevated ranges 2,000 to 3,000 feet in height, intersected by a number of rivers—the rivers Glass, Cannich, Affric and Deabhag. The plantable land lies on the lower slopes of the ranges, largely facing north and south. The native pines are mainly on the north-facing slopes while birch has colonised the south and north faces.

Geology and Soils

The solid geology consists of undifferentiated schists and gneisses of the Moine series and the area is comparatively bare of drift which is seldom compacted where found. The higher ground shows a high proportion of bare rock interrupted by patches of *Eriophorum* peat.

The soil types are light stony loam on the birch covered slopes passing abruptly into scirpus peat. The characteristic soil type of the natural pine areas on the northerly aspects is shallow molinia peat, or thin raw humus on the harder sites carrying heather *Vaccinium* vegetation.

Management of Glen Affric

The total plantable area of 8,900 acres has been divided into three working circles as follows:—

(1) Amenity .... 1,900 acres
(2) Semi-amenity .... 2,600 acres
(3) Non-amenity .... 4,400 acres

The prescribed treatment for Area (1) is the removal of 12½%-20% by volume of Scots pine every five years in thinnings and the creation and extension of gaps in the birch. Only Scots pine is to be used for planting up gaps, failing natural regeneration.

The prescribed treatment for Area (2) is the removal of 12½%-20% by volume of Scots pine and the creation of larger gaps in the birch. The forward slopes will be planted with Scots pine only; the backward slopes with Scots pine, European larch or Norway spruce.

Area (3) will receive normal treatment and species used for planting will be according to ground qualities.

At the first and second stops (at Benevean Dam and Dog Falls Bridge) some time was spent in discussing the management of Glen Affric forest, and, as there were no less than three professors of forestry and some very senior Forestry Commission Officers present, the discussion was exceedingly learned and reasonably understandable but was, unfortunately, often inaudible.

The designation of the working circles led to some argument and criticism.

(1) The Amenity Working Circle

This working circle includes roughly the land near to and within sight of the road running up the Glen. Some consideration must therefore be given to amenity. In fact, within this working circle the main object is to preserve the natural Scots pine woodland by regenerating it from natural seeding wherever possible, and by planting stock grown from seed collected on the area where natural regeneration does not occur. It is in fact an ecological experiment designed to study the means whereby an old natural Scots pine woodland can be regenerated; the preservation of amenity is incidental. The introduction of some of the faster-growing conifers on sites not favourable to Scots pine would not detract from the amenity to any extent and would be more profitable.

It is fairly evident that, though all of the area may have been pure Scots pine woodland, many parts of it cannot now be classified as Scots pine sites. There are areas with impeded drainage and a thick layer of raw humus, where the establishment of Scots pine, without fairly drastic interference, may be difficult if not impossible. Drainage, and possibly some form of cultivation, will be necessary, and yet if the "experiment" is going to be ecologically satisfactory the site should be, in theory, interfered with as little as possible.

The birch, which appears to be a natural constituent of the forest, is not being treated as such: it will be gradually cleared over a twenty-five to forty-year period to make way for a pure Scots pine woodland.

While it is admittedly desirable to preserve for the purpose of study any remnants of natural Scots pine forest, conditions have changed here and are not now in its favour. The retention of some of the birch and/or the introduction of other conifers more likely to succeed would not affect the purity of the Scots pine strain.

The main reason for aiming at a pure "natural" Scots pine woodland on this site is, I think, essential, and maybe, even in state forestry there should be some room for sentiment. However it may well be that this "experiment" will show that the re-establishment of a complete pine forest over the whole area is impossible, sentiment or no sentiment, and that other conifers must be introduced, or the birch must be accepted as a crop in some places, or partial stocking only must be accepted.

(2) Semi-amenity Working Circle

While the same criticisms apply to this working circle as to number (1) they apply to a lesser degree. Other conifers are in fact being introduced. Much of the area in this working circle could not be seen and it was therefore only briefly, and I thought somewhat inconclusively, discussed.

(3) Non-amenity Working Circle

The area concerned was completely out of view and therefore only the name of the working circle attracted comment and criticism. Indeed it was suggested by sone that the designation of the working circles was misleading and should be revised. As the third working circle "will receive normal treatment" it could conveniently be called the "Normal Working Circle".

Guisachan Forest

At Guisachan Forest Scots pine natural regeneration in P.39 Norway spruce and Sitka spruce, European larch planted in 1884, P.39 *Tsuga*, and old Scots pine with an understorey of Scots pine, European larch, birch and other species, were inspected for the purpose of comparing the growth of the other trees with that of Scots pine.

It was obvious that on the moister areas the spruces are superior in rate of of growth to Scots pine. Where the Scots pine regenerates naturally it grows well and competes effectively with the spruces, outgrowing them on the drier sites.

The European larch inspected is a small plantation of not much more than an acre in extent. It is fine quality larch close to Q.C. I, having 80 trees/acre, 2,900 H. ft./acre, 37 H. ft./tree, top height 90 ft. Nearby there is a small area of Scots pine of the same age which is Q.C. IV.

It does not follow however that Q.C. I European larch could be grown in place of the Scots pine: there was a difference in site. P.39 *Tsuga* also growing nearby showed a promising rate of growth, considerably superior to that of Scots pine, but with the common fault that the crop contained many trees of poor form.

There was a somewhat prolonged and fruitless discussion about what should be done with the European larch. Timber merchants present agreed that it would fetch a high price for boat buuilding, and as it is now growing extremely slowly the obvious course seems to be to clear-fell it and replant the area; a second crop of larch might be equally profitable.

The old Scots pine with an understorey of Scots pine, European larch, birch and other species, showed that if such plantations are regenerated by natural seeding the resulting crop will be a mixture of available seed trees. Professor Steven pointed out the variations in type among the old Scots pine trees—the horizontally-branched type on the whole most desirable as the branches are usually small and therefore if knots occur in the timber they are small also.

Comments on the Tour

The day's tour suggested that, though we were in natural Scots pine area and it is desirable to grow good quality Scots pine timber, where the Scots pine is not growing well it might be better to grow a good crop of some other species than a poor one of Scots pine; there are sites throughout this area where other species will give a much better return than Scots pine.

Professor Steven argued however that we must preserve the few remnants of natural Scots pine which remain for the purpose of study even if economic crops are not produced by the poorer woods; while scion material has been taken from most of the desirable types it will almost certainly be necessary to go back to the woodlands to check and to study the originals. I am sure he is right. Even if there were no such obvious reasons for preserving them, perhaps we can allow ourselves to be sentimental enough to wish to see some few examples of our natural Scots pine preserved for no other reason than that they are Natural Scots Pine woods.

A DISCUSSION ON SCOTS PINE

(Society of Foresters of Great Britain—Annual Excursion, 1959)

Reported by R. MACDONALD
District Officer, Education Branch

On the evening of 24th September, 1959, a technical discussion was held in Inverness Town Hall. The main speakers were, Prof. H. M. Steven, R. Lines, Major D. J. Brodie and W. J. Riddoch. Synopses of their papers follow:—

(1) The Native Pinewoods and their Management

By Professor H. M. Steven

You have all seen at least one example of a native pinewood and one which exhibits at least some of the problems which such woodlands present. What would your answer be to the question: "How would you manage such native woodlands?" Some professional foresters wish to liquidate such relict woodlands; they feel that they could do much better with the species and techniques at their command. The poor growth of the pine is often commented upon, and it might be argued that the best trees, genetically, have been removed in the past. I shall say something about this last point later. In the meantime I only wish to remind you that as a rule the surviving pinewoods are often on very poor sites, both as regards soil and exposure; on the more reasonable sites the growth is often good. Moreover, land is short for forestry and there is, therefore, pressure to use what is available to the most productive ends. But is land the shortest of our resources and will the destruction or the neglect of such woodlands contribute to forestry from the long-term as well as from the short-term point of view?

I have stated recently* what, in my opinion, is the special significance of these woodlands, and I shall recapitulate briefly;

(a) They are one of the most interesting survivals of our native vegetation and have a distinctive fauna as well as a characteristic flora. Most civilised countries now ensure the perpetuation of such on an adequate scale.

(b) They contain a range of distinctive strains of Scots pine. There are, for example, a number of habit-types as you have seen and the available evidence, while not conclusive, suggests that most are genetically controlled. Some of these morphological variants are obviously desirable sivilculturally, some are not, but the latter may have as yet unrecognised desirable qualities of another kind. The wide range of morphological variations, which may be paralleled by physiological differences, suggests that past destructive exploitation has probably not eliminated the most desirable variants. although it may have altered their proportion. The most important characteristic of these strains, however, is that they have persisted for over nine millenia and today they remain healthy to advanced ages, much beyond that required in normal forest management, and on the poorest sites. Moreover, some of the native pinewoods are in the west and have persisted and are still growing under extreme oceanic climatic conditions where ordinary Scots pine often fails or does very badly. So far as the perpetuation of these strains is concerned, one could argue that if one took an adequate range of scion material and maintained it in tree banks, one could dispense with the native pinewoods. While the taking of scion material has been rightly done already by the Forestry Commission and should be extended, it is almost certain that one will want to go back to the woodlands for material for checking and study.

* H. M. Steven. The Native Pinewoods of Scotland and their significance for current forestry practice. *The Advancement of Science*, XV, No. 59, 1958, p. 340.

(c) Many of these surviving woodlands are growing under adverse conditions, as just mentioned, and thus they provide opportunities for investigation into both the potentialities and limitations of this species. This advantage should not be lightly thrown away.

(d) Particularly in the most westerly of these woodlands, there are both birchwoods and pinewoods, and there are examples of the alternation of such. The influence of these communities on soil condition is a matter of current importance and of controversy, which these woodlands may help to resolve. If one agrees that these woodlands have special significance in these ways, then their management should provide for the following:—

(1) Protection

As they are irreplaceable, there should be special precautions against fire. The areas to be perpetuated should be adequately protected also against grazing damage by domestic and wild animals. The Forestry Commission, the Nature Conservancy, and at least one private owner has already done this.

(2) Maintenance of a Range of Variants of Scots pine

The range of the variants is one of the characteristics of these woods and this should be maintained in regeneration and tending procedures. In normal silviculture one would wish to favour, for example, the habit types considered most desirable in the light of present knowledge, and one may reasonably do so up to a point, because past destructive exploitation has probably reduced their proportion, but one should not go as far in that direction as one would do in commercial woodlands under intensive management.

(3) A corollary of the previous point is that any seeding and planting within a native pinewood should only be with seed collected within it. In my opinion it is an unforgivable sin to bring other strains into it.

(4) Regeneration

The management of these woods must above all else, be directed not only to their perpetuation but as far as possible to their creation into something like their earlier condition before destructive exploitation took its toll. I think I can best convey to you what I consider should be done by quoting a short passage from *The Native Pinewoods of Scotland**; 'The aim should be, say over a century, to build up gradually a reasonable balance of age classes, old and young, so that there will always be a succession of trees of different ages. The structure should be semi-irregular, as it is today in some of the larger and better preserved woodlands, a mosaic of groups and stands of varying extent up to a few acres, each consisting of trees of about the same age and together providing a range in age from the youngest to the oldest, but not necessarily a continuous range of age or any mathematical balance in age or size classes, which is unusual in natural pinewoods as a whole. The other native tree species would, of course, continue to play their role in the woodlands, and regeneration by birches and rowan may later lead to the re-occupation of the ground by pine, as in the past. It is believed that such a forest would also preserve its associated natural non-tree flora and fauna, and come closer to what the natural pinewoods were like some two to three centuries ago before heavy exploitation took place'.

From several different points of view, these woodlands would be better perpetuated by natural regeneration. This has been discussed in some detail in the book just referred to, but we do not yet know how this can be best done.

* By H. M. Steven and A. Carlisle, Oliver & Boyd, Edinburgh and London, 1959. £3 3s.

A new and determined effort should be made to try and solve this problem. It is almost certain, however, that some artificial regeneration will be necessary; past experience suggests that planting rather than seeding will likely be more successful. At least in the most typical parts of the native pinewoods non-indigenous species should not be introduced, because if this was done it would mean that their ecological characteristics were changed.

(5) Tending

While "under" and not "over" stocking is the principal problem in the native pinewoods, there are limited areas where cleaning and thinning are necessary. As in woods generally, the best trees should be favoured, but any examples of the more unusual habit types and other distinctive variants should be retained.

In conclusion, my plea is that because these woodlands are a unique heritage, they should be managed in the special ways I have just outlined to ensure that they will be perpetuated and developed alike for their historical, ecological and practical forestry importance.

The Formation of Scots Pine Plantations with particular reference to Seed Provenance

By R. Lines

Today, at Findon we saw an experiment which indicated that pine from very high or very low latitudes will not survive and grow there; that pine from southern Finland grows slowly and has a nice form with pale-coloured stems and needles; but that the best growth, from an all-round point of view, is that of the native provenances. Between these, at least if the seed is collected from good stands, the differences are not very great. In other experiments, examples of Swedish and Norwegian provenances can be found and like the Finnish ones, are of nice form, but they are slower growing and tend to a yellowing of the needles which makes them look unhealthy.

The conclusion to be drawn from all these experiments, of which the oldest have now reached their 30th year, is that home seed makes the best plantations.

May I also mention very briefly other evidence to the same end:—

John Grigor in 1865 recorded that in the nursery "Seeds of the *Pinus sylvestris* imported from the Continent produced plants of more rapid growth than those raised from the forests of Scotland . . . but the effects of the winter on the second year's growth almost uniformly make them quite brown, and so damaged, that by the month of March they are quite unsaleable . . .".

This was substantiated in the first international Scots pine provenance experiment grown in 1907 at Bangor and at Brodie Castle, but neither experiment survived long enough to prove much.

In the high level experiment (1,300 ft.) in South Laggan forest all Latvian and French provenances died before reaching the age of 30 years, leaving two Scottish provenances of which only one, Beaufort, was promising. The same seed lots planted at a lower elevation (400 ft.) at Teindland, on a good pine site, all succeeded in making crops, though an additional far northerly Finnish provenance failed as at Findon. The best results in both, in height growth and volume, were given by the Beaufort plantation.

Some further examples of the inferiority of foreign provenances will be quoted presently.

Turning now to differences within the range of home collected seed, we saw that as yet there is no significant difference in growth at Findon, but there are signs that the "East England" provenance is drawing ahead in productive capacity and that the Strathconon provenance is gaining superiority in form.

In a small experiment at Roseisle Forest, Darnaway provenance is significantly tallest, but the trees are coarse. Loch Maree and Abernethy trees are intermediate, and a Glen Moriston provenance is the straightest and finest branched. That was the result at the age of eighteen years. In another experiment at the same forest, at thirteen years, Darnaway, Achnashellach and a German provenances were taller than a number of other Scottish plots, but the form of all the trees, which were planted in groups, was bad. (In both these experiments a Norwegian provenance virtually failed).

At Culbin, Cawdor and Darnaway provenances are equal, (and better than an East Prussian lot) in size and quality at twenty-six years of age.

The most detailed comparison of seed from home sources was reported, as far as the nursery stage is concerned, in the Commission's Annual Research Report for 1954. This experiment showed a high correlation between the size of the seedlings and the weight of the seed, and the seed weight was correlated with the elevation of the parent stands, which were all in the East Conservancy of Scotland. After three years in the forest there were no great differences in either survival, height growth or any other characteristic, but these will no doubt begin to develop differently on the three sites where the experiments are planted, now that the plants are well established. Based on experience in other countries, we may expect to find that the provenances which do best are those which are nearest their home, both in a geographical sense and perhaps in respect of environmental conditions, but so far no experiments precise enough to prove this point have been made with our own provenances in Britain.

Next, a few remarks on one particular aspect on this problem, that of Scots pine in the West of Scotland and Northern England. Sir John Milne Home recently lent me a work written in 1808 by the Bishop of Llandaff, who as far as I know was the first to draw attention to the failure of pine in the west because, as he said, of "the height of the situation and the exposure to the west wind . . . and there may be other causes".

Experiments were commenced in 1929 to try and find a race of Scots pine, in the words of Professor Anderson, "suitable for planting on peaty moraines in wet districts". These collections, when planted at Inchnacardoch forest, both on moraines above the Lon Mor and on the riverine deposits in the valley, have tended in general to repeat the results that I have already described, but they also indicate that, among the successful native provenances, differences attributable to that cause are less than those attributable to site differences, because in both cases the experimental plots are situated on variable ground.

The Achnashellach provenance has done well in both Scotland and in Denmark and it has attained some reputation as an outstanding seed source in both places. It may be noted that at Achnashellach itself there is a marked difference in the behaviour of a young crop of this provenance *with and without phosphate*, and one is left wondering to what extent the trouble with West Coast pine is due to inadequate nutrition on leached impoverished soils, under a high rainfall, or the fact that Scots pine is there on the extreme maritime fringe of its natural distribution.

In 1949 to 1952 a set of five experiments was planted in Mull, Loch Fyne, Glentrool and the Lake District on sites similar to those where older crops of pine had failed in the past, with a control in Stirlingshire. Half was ploughed and fertilized and half not. Seed from Altyre in East Scotland, Thetford in East

England, Raasay, Mull and Knapdale in West Scotland as well as Amla and Hedmark in Norway was used. So far the results show that the East Scotland and England provenances have grown best, with the West of Scotland lots not far behind, and the West Norwegian lot the poorest, but the experiments have not yet reached the stage at which previous crops died, and it is too early yet to draw conclusions about the provenances best suited to the West Coast.

Note that these remarks apply mainly to Scotland. As noted by Grigor, and as shown in the modern Thetford provenance experiment, conditions are different in the southerly parts of England.

Finally, may I remind you that this matter has now passed beyond the bounds of a pure provenance question. The quality of individual trees in a stand is taken into account by the Geneticists, and in conjunction with Tree Seed Associations, stands are being classified as "plus", "normal" or "below normal", tended to remove the poorest trees, and registered for seed collection accordingly. Before long it should be possible to ensure that no seed is collected from stands "below normal", and precise comparisons of progenies of the good stands will soon be able to indicate the permissible limits for moving plants from the regions whence the seed was obtained. Until this information is available, we should do all in our power to collect seed from good stands in our own neighbourhood and to use the plants in similar localities.

(3) Management of Scots Pine Plantations

By Major D. J. Brodie

Scots pine can be contrasted with most other conifers which we grow in this country in various respects, and I thought that in the time available to me I might direct attention to four special characteristics and then draw conclusions from them to show how I think they should be allowed to influence the *management* of Scots pine plantations.

The subject of this talk was selected by Mr. Dickson, but apart from that I have been allowed complete latitude in selecting what I have to say. The deductions are entirely my own, but I would like to say at once that I hold them as definite convictions, which I practice. I have no doubt they will prove controversial and will provoke discussion; and that I suppose is why I am here tonight—to provoke discussion.

Now for the four characteristics upon which I wish to focus attention. They are these:—

(1) Scots pine produces less and takes longer to do it than any other of our conifers, with the exception of European larch.

(2) Scots pine is a keen light-demander; again with the exception of larch and possibly Corsican pine, it is probably the greediest light-demander of our conifers.

(3) Timber Merchants who have to deal with Scots pine lay more stress on, and complain more about, *the quality* of the knots than they do about the size or number.

(4) Scots pine is our only truly indigenous conifer, and the only one upon which we have any extensive knowledge of exploitation, and consequently about growing to maturity.

Now for the deductions:—

My first point was about low yield and slow growth. From this we must infer that of all the conifers this is the least profitable to grow. To combat this adversity we must study along four lines:

(a) To keep costs down to a minimum at every stage.

(b) To counter the effect of accruing compound interest by postponing those operations which are not revenue-producing to the latest possible date in the rotation.

(c) To bring our crop to an earning stage as soon as possible.

(d) To manage the crop so that the highest possible proportion of the yield is afforded in sizes and quality easily saleable.

These are my deductions arising from the first characteristic I have mentioned. I regard each of these as a test which we must apply to any procedure we propose. The procedure is only sound if it conforms to these standards.

The next characteristic is the question of light-demand. The deduction to be drawn here is bluntly, that it is a *crime* to overcrowd these trees, so we should practice a *rigorous thinning regime.* Over-thinning is a far less common mistake than under-thinning, in fact it is rare.

In the following remarks I shall be using the expression "heavy thinning" as a relative term, not as specific grade of thinning.

It is dangerous to introduce heavy thinning practice into a stand which has previously been lightly or under-thinned, owing to the danger of windthrow. Therefore we must practice heavy thinning from the outset.

Heavy thinning produces wider annual growths. But the actual width of the ring is less important than the fact they they must be regular; therefore having once adopted a heavy thinning regime we must practice it throughout the whole rotation.

Now to apply the tests.

The size-class structure of a stand is influenced by the thinning regime. So from the economic angle it is desirable to start thinning early, for early returns; thin severely to get desirable-sized mill timber quickly and to get as high a proportion as possible of our total yield into this desirable-size category.

For reasons of profitability and of light requirements therefore, I maintain we should start with a severe thinning regime, early, and continue it throughout the rotation.

My next point is about knots.

Heavy stocking is recognised as having the beneficial result of branch suppression. But I would ask you to note that it is the quality of the knots which matter more than their actual size or frequency. Bad quality knots are of course loose or "encased" knots, or black knots otherwise termed "powder knots". All of these come about by the incorporation of unsound, or rotten, dead branches into the main trunk of the tree.

Obviously therefore it is no good suppressing or killing-off the side branches if we are thereafter to allow them to be incorporated in the millable timber as faulty knots. We must get rid of our dead branches before that happens.

Unfortunately though we can achieve branch-suppression through heavy-stocking and competition, natural pruning is rare in this country; for this it appears that we need certain climatic conditions which occur for our purpose too infrequently.

From the point of view of high-timber quality, of course, early, and if necessary live, pruning is the optimum. But that adds to the expense of production, which we must aim to avoid. Moreover though it produces the highest-quality timber—"clears"—there is not a large demand for "clears". We must be careful not to go to unnecessary expense to produce a more high-quality supply than that necessary to meet the sufficient demand.

I submit therefore that we should beware of practicing artificial pruning in the strict and accepted sense of the word, because it involves incurring perhaps unnecessary expenditure, and unnecessarily early expenditure, to produce an expensive supply for which there is not really a big demand. Early live pruning is a procedure which does not pass the test of profitability which I have described.

I submit also that we should beware of devoting too much attention to early branch suppression, because it may involve heavy stocking which conflicts with our deductions about the need for intensive early thinnings. Instead we should recognize that small live knots are acceptable in our timber and *above all* recognise that as soon as we decide to suppress side-branches, by killing them, they become a potential liability because we must then incur the expense of removing them before they become incorporated as unsound knots. Again our tests of profitability apply.

Now I come to my last point; the vast inheritance of information about cultivating Scots pine, which should be ours. Emerging clearly, and to my mind head and shoulders above all other points, is this feature of black or loose knots—call them what you like. Where we do not encounter these unsound knots it seems to be mainly attributable to either of two factors:—Either the trees are of appropriate strain and have grown in a locality where climatic conditions prevail which are favourable to natural cleaning of the branches once they are dead and potentially unsound; or the trees have been grown with great care under a regime which has produced long clean boles essentially associated with narrow ring widths, which is to say they have been grown in conditions of relatively intense competition, and (if they are of any appreciable size in girth) on a long rotation. We no longer need to grow tall trees, there is not a big demand for long timber these days. Long timber and narrow ring-widths involve a procedure which is incompatible with one of our deductions about profitability, because Scots pine is a slow grower anyway,

A number of magnificent-looking logs are relatively valueless because buried deep inside them are black knots, which were incorporated long years ago when the trees were younger and which have since been healed over so that they are scarcely able to be detected. The wary merchant has a sixth sense.

So my points are these:—

It is a mistake to retard the growth of the trees in girth by over-crowding them. They are light demanders and respond well to appropriate treatment. We should revise our ideas about pruning, avoiding waste by doing it too early but also avoiding the mistake of allowing dead branches to be incorporated in otherwise valuable mill-wood. We should revise our ideas about rotation; we ought to concentrate on rotations measured in terms of girth, realising that long rotations are less profitable and tall trees are no longer required. We should clear up our ideas about the desirability of growing narrow rings, and realise that regular ring-width is more important.

The question of disposing of our small-sized thinnings is highly topical and very difficult. We should be bold and make an early and vigorous start in eliminating them. In that way we shall the more quickly rid ourselves of this size-category throughout the stand. All these points are, I recognise, departures from traditional practice; that being the case I see no reason to adhere to tradition. In regard to this last deduction I am really quite emphatic, even perhaps agressively dogmatic.

In conclusion I would like to draw attention to two things:—

First:—the published results of the Forestry Commission experiments in thinning in Bowmont Forest. Though these are in Norway spruce, they undoubtedly apply to Scots pine. The lessons I want to point out are these:—

The thinning regime—

does not affect the height-growth
it does influence the size-class structure of the stand and its yield.
but it does not affect the volume of the total yield to the end of the rotation.

Second:—The South African methods of cultivating pine. They are not all applicable to our case; there there is a very different climate and very different rates of growth, but they do merit careful and thoughtful study, particularly in regard to ideas about size-class structure of the stand.

Finally before I finish I would like to justify any apparent mistakes and omissions by emphasising that I have been talking about managing Scots pine when it is *growing in "captivity"*. It is most important to remember that by the time we have made a plantation of it we are treating it as a domestic crop, and we must therefore manage it in that light.

(4) The Utilisation of Scots Pine

By W. J. Riddoch

In considering the utilisation of Scots pine, notice has to be taken of the faults as well as of the good qualities of the timber. Let me describe the faults first:—Unless this timber is grown on typical Scots pine soil and is of a good strain, the stems often fail to be as straight as they should be. The young tree if grown too fast is liable to be bent at the butt end of the stem by snow damage or by heavy weeds. This is often seen when Scots pine has been planted on spruce ground. Even when the trees are too big for snow or weed damage, they do not grow as straight as they should. They are very liable to damage by Pine Shoot Beetle with subsequent defects in the straightness of stem.

This forces us to crosscut the stems to short lengths which reduces value a lot.

Scots pine sometimes tends to have large knots and what is worse, the knots frequently are loose and rotten. We usually call these black knots.

Any forester who can tell us how to grow Scots pine with only a few black knots, as they do in Northern Europe, will deserve the highest honour that this Society can give.

This tree is the only common conifer in this country which is damaged by red squirrels if these animals are too numerous. If the squirrel scrapes off the young bark a wound is made which never disappears even when there is little outward sign of the trouble. For the last 40 years red squirrels have been few in number and no damage has been done. Their numbers however have been increasing over the last few years and care will have to be taken that we do not again suffer a plague similar to what we had at the end of last century and during the first twenty years of this one. The trouble was especially severe throughout northern Scotland where so much Scots pine is grown.

Scots pine is easily affected by blue stain, especially when the weather is warm and damp. If we are to avoid this defect it must be put under cover as soon as it is dry. Sometimes this is necessary before it is dry. The wetter weather of our west coast makes proper seasoning difficult. Kiln drying does not always overcome the trouble, as it is sometimes difficult to avoid the resinous knots becoming unsightly by weeping.

Owing to the resinous nature of the wood it is not so popular as spruce where manufacturing processes necessitate mechanical grinding.

To summarise the faults, these are:—

Short lengths through bent stems, large or black knots, squirrel bites, and discolouration.

Now for the good points:—

It is easily grown and therefore cheap. It is strong and tough and holds nails well. It is light and does not warp easily. Its sapwood absorbs preservative better than any other common softwood and it can, therefore, be made more lasting in use than most timbers at small expense. Owing to the habit in some strains of dropping branches it can develop a stem of which the outside wood can be completely free from knots. If enough of this clean timber can be collected it can be sold in the same market as Parana pine or other similar cheap, clean wood.

The uses to which Scots pine is usually put in this country are as follows:—

Young trees or the tops of older trees—Mining Timber and fabricated board.

Medium-sized trees—boxes, crates, fencing and telegraph and transmission poles (if preserved).

Heavier trees—railway sleepers and wagon wood and building timber.

The short lengths and wide widths which are required for railway sleepers and wagon bottoms along with the capacity to absorb preservative, make Scots pine eminently suitable for railway work. I am sorry to say that the introduction of steel wagons and proposed changes in methods of laying and types of rails seem to indicate a serious lessening in the use of short-length broad timbers. This will mean that more Scots pine must be used in general building where short lengths are not popular.

In order to assist those responsible for the proper manufacture and marketing of Scots pine in this country, may I ask as earnestly as I can that Foresters grow this excellent timber as straight as possible and with as few large and black loose knots as possible. If this can be done Scots pine may well regain the popularity which is presently being lost to Norway spruce.

No additional points came out in the discussion on each paper. On the whole there was agreement with the speakers.

OUR NATIVE SCOTS PINE

By H. A. MAXWELL
Conservator, Director Scotland's Office
and H. L. EDLIN
Publications Officer, Headquarters

Cruaidh mar am fraoch,
buan mar an giuthas—

Hard as the heather,
lasting as the pine

Forestry, whether it be carried out by private landowners or the Forestry Commission, now holds a firm place in the Scottish economy, and there are few people who are not familiar with the new forests that now clothe many northern hillsides. In Scotland it is generally accepted that most of the new plantations must be coniferous, for conifers alone can thrive as timber trees under its northern climate and on the kind of land that can be spared from farming use. Moreover, it is nowadays their softwood timber that is in demand for industry, and the hardwood timber that the broadleaved trees produce—more slowly and only on land of better quality—has become difficult to market.

Foresters, therefore, commonly choose a conifer for planting, and they have all those of the temperate world to choose from. Many of the conifers from overseas can show, under the right conditions, faster rates of growth than our only native kind, the hardy Scots pine, and their timbers are equally valuable for most purposes. Why then, do foresters devote so much thought to this tree, and why did the Forestry Commission alone plant 5½ thousand Scottish acres with it last year? Is it mere sentiment, or have we here a real economic asset?

Scots pine, or to use its botanical name, *Pinus sylvestris*, has the widest world distribution of any timber-producing tree. You may find it growing wild right across Europe and Asia, from the Atlantic to the Pacific Ocean. It ranges from the cold of the Arctic Circle to the warmth of the Mediterranean seaboard, while it grows both at sea level and high up the mountain ranges. Our native pinewoods lie at the western extreme of this vast range, and may well include strains of pines that have become adapted to our peculiar maritime climate. In times long past, this tree grew wild over most of the British Isles, but within historic times few woods survived south of the Forth and Clyde valleys. North of the Highland Line, the pine remained a leading timber tree, and many place names incorporating its Gaelic name of *giuthas* record its abundance.

Largely because they lay remote from any useful means of transport, these large natural pinewoods remained reasonably intact until the end of the sixteenth century. Then the increasing call for softwood, both in the Lowlands and further south in England, made their commercial exploitation worthwhile. Companies were formed to buy up the majestic forests of Rothiemurchus and Rannoch, and rafts of logs floating downstream became a familiar sight along the Spey, the Tay and the Dee.

The destruction of our native pinewoods continued through the seventeenth and eighteenth centuries, and probably reached its peak at the middle of the nineteenth century; even the few surviving woods suffered yet again during the two world wars of this present era. Under good forest management, the clearings could have been so planned that natural seedlings filled most of the gaps left, and young trees would soon have grown up to replace those felled. But the time of the greatest exploitation of the natural woodlands coincided with the development of great sheep farms and vast deer forests. The searching muzzles of the sheep and deer made it impossible for anything but a handful of seedling pines to survive. The few that did escape from browsing generally fell victims to the muirburn fires lit deliberately to improve the hillsides as ranges for sheep, deer, or red grouse.

Happily the history of forestry in Scotland is not entirely one of destruction, and from the seventeenth century onwards many far-sighted lairds made praiseworthy efforts to replace the ruined natural forests by extensive tree planting. Even at that time the value of the natural Scots pine was appreciated, and it is recorded that in the seventeenth and eighteenth centuries there was a regular trade in indigenous Scots pine seed from the Highlands to the Lowlands, and even to England. As early as 1582 Sir Duncan Campbell was raising and planting Scots pine on Drummond Hill in Perthshire, while about 1640 his successor, Sir Colin Campbell, sent seed to the leading English forester of the day, John Evelyn, who raised the resulting trees at Wootton in Surrey. English tree planters were quick to appreciate the virtues of this Scottish stock, and today claim a Highland origin for the finest pinewoods of the New Forest, the great Hurtwood in Surrey, and Thetford Chase in East Anglia. Many of the foresters on the big English estates were Scotsmen who naturally sent home for their seed supplies.

Unfortunately, with the passing of the years many planters in Scotland itself became less discriminating. A striking characteristic of Scots pine is that it will grow, or at least start off well, over a wide range of different sorts of land, including poor acid peats. Because it grew anywhere, the belief spread that any sort of Scots pine would do. During the nineteenth century, the sensible practice of using only native pine seed gave way to the unwise one of importing pine seed from Europe. Much of this came immediately from Germany, but it is more than likely that the German seed merchants in turn bought their supplies from those countries where collection was cheapest, anywhere from Russia to Spain. Further, much foreign pine came in as planting stock, for there was a period before the present quarantine control when shiploads of trees were sent from Hamburg to Aberdeen! The result was that considerable pine forests of various unknown foreign origins grew up all over Scotland. Not all these foreign strains, or "provenances" as the forester terms them, were bad. But experiments carried out by the Forestry Commission Research Branch since 1920 have failed to find any that do better, under Scottish conditions, than our best native ones. In contrast, strains from Finland grow much slower than ours, while some from Spain and Russia have failed entirely.

The practice of indiscriminate importing, or indeed of importing at all, was viewed with suspicion by some Scottish foresters of the old school, but it was not until the present century that interest in our native Scots pine revived. When, around 1910, the late Sir Arthur Tansley began his famous ecological studies, the remnants of the true native forests were few and were limited to the steeper and remote parts of the Highlands. More recently, since 1950, Professor H. M. Steven and Dr. A. Carlisle, working from the Forestry Department of Aberdeen University, have carried out a comprehensive survey of all the surviving stands they could find, and published their results in a fine monograph entitled *The Native Pinewoods of Scotland* (Oliver and Boyd, Edinburgh, 1959). They have identified 35 undoubted native stands, 25 of which are in private ownership, while 9 are held by the Forestry Commission and one by the Nature Conservancy. The most southerly is in Glen Falloch, the most easterly on Deeside and the most northerly at Glen Einig in Wester Ross.

From its early days the Forestry Commission has recognised the importance of our true native Scots pine, and has taken steps to conserve those ancient pinewoods that, from time to time, came under its control. By the early 1930's investigations had been started at Glenmore in the Cairngorms, Glengarry and Glenloy Forests in the Great Glen, and in the Black Wood of Rannoch, to find the best methods of treating the native stands to ensure that they would be perpetuated. These researches still go on, and in addition steps have been taken to form special reserves at Glen Affric and also at Rannoch, where the Commission holds large stretches of natural pinewoods. No "outside" strains of pine, even if they come from another part of Scotland, will be allowed in these reserves. Only natural seedlings, or planted trees raised from certified Glen Affric or Rannoch seed, as the case may be, will be permitted to grow.

Such measures are aimed to ensure the continuance of valued stocks of native pine, over a total extent of 18,000 acres, free from all possible contamination with foreign strains.

Now we come to the reasons behind this care devoted to these natural pinewoods. Although other trees from overseas admittedly do better than the Scots pine on some kinds of land, there is a broad belt of the eastern Highlands, from Sutherland right down to Perth, where this native pine remains a leading tree. Research in tree breeding and the selection of the best individuals or stands for seed collection, has shown that we can often profit from the natural variation that exists in any untouched stand of a wild tree. Some of the strains present should be ideally suited to Scottish conditions, since they have evolved here over thousands of years. Others may prove to be good material for the tree breeder, showing hybrid vigour when crossed with allied races. We cannot afford to lose this irreplaceable reservoir of foundation stocks. Even if its preservation and regeneration is liable to prove a long, slow business it well merits the attention it is now receiving from the research workers of the Nature Conservancy and the Forestry Commission.

Besides their economic worth to the forester, these old pinewoods have priceless scientific value for all students of plant and animal life. They hold their own distinctive flora of juniper and crowberry, along with beautiful little rarities like the chickweed-wintergreen and the *Linnaea borealis*. They are the haunt of red deer and roe, crested tit, crossbill and capercailzie. In every sense they are important national monuments, and their disappearance would be a national tragedy. Even the layman, when he pauses to "take in the rich greenery and warm heath of the forest", and to admire the warm red boles and lustrous blue-green foliage of the mighty pines, feels that he is in the presence of one of the grandest manifestations of wild nature—the native pinewood set so fittingly in the frame of the great Scottish hills.

A VISIT TO A FOREST TREE BREEDING STATION IN EAST GERMANY

By A. S. GARDINER

Assistant Forester, Research Branch

General

During the summer of 1958 I had the good fortune to visit the Forest Tree Breeding Station at Waldsieversdorf in East Germany. The station, which is pleasantly situated in an area of small villages and inland lakes, is about 15 miles east of Berlin. It is post-war in origin, is well-equipped and employs a staff of more than one-hundred people. All the buildings, with the exception of the main laboratories and offices, are of recent construction. The work, including the house building, has been largely done by the staff themselves. The objective of the work done at Waldsieversdorf is the genetical improvement of the forests of the northern half of East Germany. This work is the responsibility of Dr. O. Schroeck, who as well as being in charge, is also the station's founder.

The species which are included in the breeding programme are Scots and Weymouth pine, Norway spruce, Douglas fir, European and several North American silver firs, oak, beech, ash, birch, *Robinia* and various poplars.

Birch Breeding

This subject formed the main purpose of my visit, with special regard to plywood birch, and the recognition, in the forest, of birch with figured grain through the examination of external bark characteristics. It included an excursion to the Schorfheide, a natural forest area north-east of Berlin, which contains several birches selected for breeding purposes and some birch provenance trials.

German interest in birch has until recently been mainly centred on the production of timber for the plywood industry. The bulk of this type of timber was produced in what is now East Germany, in the Mark Brandenburg and in that part of Poland which was formerly East Prussia. The type of tree which is sought, is essentially smooth-barked to the base; it has been found in Germany that under rough bark the timber-fibres are liable to be irregular in pattern. *B. verrucosa* is the main producer of this timber. Large numbers of the best stems were felled both before and during the war for the aeroplane industry and were known in forestry circles as 'Fliegerbirken' or 'Aeroplane birches'. This term has now generally been dropped in favour of 'Schaelbirke' or 'Peeler birch'. Timber merchants used bark colour and texture in addition to smoothness of bark when selecting plywood stems. Those which were grey or greyish-white in colour and whose outer layers of bark were easily peeled off by hand, were given preference over others. Due to large-scale fellings of the best material Herr Scholz, the birch breeder, is now faced with the necessity of building up a stock mainly from 'second string' trees, a situation common to many European countries. A comparison with British material would show, I believe, that although the best of our plus trees are somewhat smaller in height and girth (they are also younger) than those in East Germany, they are equally good in growth habit.

In addition to plywood birch, Scholz has also examined the possibility of obtaining decorative veneers from home-grown trees. Decorative veneers have until recently been mainly imported from Scandinavia. The two best-known types are 'Flamy' and 'Brown curly' grain. In the former case Scholz has been very successful indeed. Flamy birch is associated with rough bark and is thereby generally always of the species *B. verrucosa.* After examining several hundred stems Scholz was able to correlate certain peculiarities in the form of the rough bark with flamy grain. This greatly simplifies the work of the tree breeder and forester respectively, enabling both to spot the required type within the stand and to ensure their survival during thinning operations. The grain is characterised by flamy markings, often highly colourful, which show up best of all on the tangential surface.

In contrast, 'brown curly' or 'brown maser' birch, which is very much rarer, is characterised by brown curled areas in the timber which are very decorative. External bark characteristics are somewhat different from those of flamy birch, stems usually having bumps or rolls in areas where the timber is thus affected. On the better-formed stems however the only external signs of curly grain are small crescent-shaped fissures. Until recently it was generally believed that this type of birch was confined in its distribution to Scandinavia and Finland. However, as a result of a prize of 1,000 marks being offered to the discoverer of the first brown maser birch in East Germany, two trees of this nature have been identified which gives hope that others may turn up in future. Several specimens have been found recently in Czechoslovakia. Prior to these discoveries, Scholz had been working with curly birch material imported from Sweden. He suspects that there is a close correlation between branch angle and the amount of maser tissue. He has observed that curly birches with horizontal branches have more strongly developed curly grain than others with narrower branch angles. This may help towards selection for this grain in early years.

For genetical and silvicultural observations of birch, the open-pollinated progenies of sixty-two mother trees of both common species were planted out on the Schorfheide in 1934. They represent provenances ranging from the north of Finland to the south of Austria. Considerable variation was observed in such characteristics as branch form, branch angle, natural pruning ability, crown shape and bark features; in certain instances the variation was extensive between individuals with a common mother. A certain amount of natural regeneration had taken place within gaps in certain groups, and the chain of inheritance of such bad features as stem bends was noticeable between mother trees and progeny. A small number of individuals exhibited rather peculiar bark features of a type not generally described in literature. Scholz has named this type 'Lockenbirke', which can be translated as curly-barked birch. The bark is generally smooth and peels off in very tough rolls which curl up like coiled springs, often 16 inches in length. This type is also occasionally found elsewhere in East Germany. Associated with this unusual feature are fine branches and excellent timber quality.

The cytological background of birch is being studied by Fräulein Dr. Eifler. Up to the nineteen-thirties, many botanists were of the opinion that the wide range of variation found in the two common European birches, *B. verrucosa* and *B. pubescens* (=*B. pendula*), was due to a large extent to hybridization between them. However, with the advent of more intensive cytological work on birch, this theory has been generally discarded. It has been found, that *B. verrucosa* is a diploid species with two sets of chromosomes and *B. pubescens* is a tetraploid with four chromosome sets. Attempts experimentally to cross the two species by German and Swedish workers have met with very limited success, and individuals exhibiting the triploid condition have been difficult to obtain.

However, Dr. Eifler has taken this a stage further and found, that a very limited number of individuals of both species will intercross more readily than others under experimental conditions. These crosses produce substantial numbers of triploid progeny. In addition Dr. Eifler has found a specimen, which shows all the characteristics associated with *B. verrucosa*, with four sets of chromosomes. The value of triploids, which are generally sterile, is difficult to forecast. If their chromosome sets can be doubled, they may be of value in permitting cross-breeding with exotic birches which have higher chromosome numbers. The general picture at present seems to be, that though occasional hybridization does take place between the two commoner European birches, the progeny are usually sterile, and the two species can therefore exist side by side in a stand and preserve their identity.

Other Projects

Dr. Schroeck, in addition to his work of running the station, is also personally responsible for the early determination (as far as possible) of the genotypes or hereditary make-up of the "Auslesebaeume" or selected trees (the term "plus tree" is no longer used in East Germany). This is done by studying the correlations obtained from data on such factors as seed weight, seedling growth under special laboratory conditions, the growth of open and controlled pollinated progeny, and eventually the stem analysis of the selected trees.

Herr Hoffmann, who looks after the establishment and lay-out of seed orchards, has been experimenting very successfully with outdoor summer grafting. Scots pine has yielded from 60 to 70% usable grafts, the work being done from June to the beginning of August. Norway spruce can also be grafted during this period up to the middle of August.

Unfortunately through lack of time I was unable to see much more of the station's work. My main impression, apart from the extreme thoroughness with which the assessments, etc. are carried out, is of the steps being taken to help the forester gain some knowledge of the timber qualities of his trees by examining such characteristics as bark features. Birch species by nature of their bark variance lend themselves very well to such a study, however attention in Germany is now being paid to more important species such as oak, and information in this direction, when it becomes available, should be of great value to the British forester.

In concluding I would like to acknowledge the warm welcome which I was given in East Germany and especially the hospitality extended to me by Dr. and Frau Schroeck and Herr and Frau Scholz.

ELECTRICAL WEED CONTROL

By J. R. ALDHOUS

District Officer, Research Branch

A report of work carried out by the Electrical Research Station on control of small plants by electricity was seen and the Station contacted. An apparatus developed originally for thinning of sugar beet was then obtained on loan for trial at Alice Holt. The object was to try out the apparatus and decide whether it would be suitable as a means of killing nursery weeds which survive treatment by oil sprays.

Description

The apparatus was housed in a wooden box approximately $16 \times 6 \times 8$ inches, from which emerged an insulated cable leading to a short copper probe, and an uninsulated earth wire leading to an earthing rod.

The apparatus consisted of six two-volt accumulators, a transformer, two rectifiers, two condensors and a non-synchronous vibrator.

When switched on, the transformer in conjunction with the vibrator converts the low tension D.C. supply up to 1,200 volts A.C. The A.C. current is rectified by a full-wave rectifier. On load, the output is 850 volts at 10 mA.

Trials

Trials were carried out on weeds in foot-square plots in the garden at Alice Holt. Trials were on a small scale and the results are not capable of statistical analysis.

The method of testing was to touch the plant for a period of one to five seconds with the probe. The effect of touching two positions on the plant with the probe were compared: the extremities of the plant, and the centre or heart of the plant.

The following species occurred in the trials:—

Senecio vulgaris	Groundsel
Sonchus spp.	Sowthistle
Capsella bursa-pastoris	Shepherd's Purse
Stellaria media	Chickweed
Veronica spp.	Speedwell
Urtica dioica	Nettle
Plantago major	Plantain
Chenopodium album	Fathen
Poa annua	A grass
Anagallis arvensis	Scarlet pimpernel

Results

(i) Plant tissues were killed wherever current passed through them. However in larger plants, the current passed through only part of the plant tissue and the remainder recovered (e.g. large specimens of *Senecio vulgaris*). Similarly in grasses, all stems of large plants had to be touched; those that were missed usually survived.

(ii) Touching the extremities of plants was more effective than touching the heart. In the latter case, the probe occasionally passed through the plant and entered the soil, in which condition it was ineffective.

Extension of Trial

While using the instrument it was noted that worms in the area in which the instrument was working came to the surface and were remarkably active. This effect had been noticed by other workers using similar instruments.

At Kennington Nursery, Oxford, cutworms (larvae of Noctuid moths—*Agrotis segetum* Schiff. and allied spp.) have been active and have caused considerable damage in experimental plots. The possibility of cutworms reacting in a similar manner to earthworms was considered and as a result a trial was carried out by the staff of the Entomological Section, Imperial Forestry Institute, Oxford. In this trial, the apparatus was used to pass a current through the soil in a similar manner to that occurring when weeds are killed.

Results of this trial were completely negative. No cutworms appeared above the surface of the soil.

Danger of Electrocution

The apparatus was tested by the Clarendon Laboratory, Oxford and was reported to be capable of giving a lethal shock to human beings. Insulation, where present, was adequate.

Discussion

Using the apparatus it became apparent that while small weeds were killed instantaneously, these same weeds would have been killed by standard applications of weed killer oils. Larger weeds were not necessarily killed unless an appreciable time was spent touching leaves on all sides. This took longer than would be taken by a very careful hand weeding. In view of this and of the danger of electrocution no further work with this apparatus is proposed. Contact will however be maintained with E.R.A. and any apparatus subsequently developed will be tested.

ONE-MAN LINING-OUT BOARD

By W. F. STODDART

Head Forester, North-East England

I was recently faced with the task of organising the lining-out of a considerable quantity of seedlings with a squad of men who were quite inexperienced in nursery work of this kind.

Work commenced with the normal type of lining-out board in use today for strip lining-out. Progress was very slow indeed and the unit cost was abnormally high. The men were unused to turning over the soil against the lining-out board and levelling, and the results were rather discouraging.

It then occurred to me that if the digging-over of the soil could be dispensed with (the ground had already been ploughed and cultivated) and each man were to work on his own, progress would be speeded up. I therefore devised the lining-out board illustrated in Figures 2 to 4. I later discovered that it was somewhat similar to a type of board used in Sweden and described in an article by Mr. M. E. S. Dickenson in the Journal of the Forestry Commission No. 26–1957.

In an established nursery where the soil has been well-worked a man should be able to line-out a minimum of 8,000 seedlings per day. The method of working is to set out guide lines at intervals of 7 feet 6 inches, which allows for an eighteen-inch alleyway between strips, then proceed as follows:—

(1) Cut a notch the width of the strip (6 ft.) and deep enough to receive the seedling roots.

(2) Place board at right-angles to guide line with notched side coinciding with the top of spade notch in soil.

(3) With forefinger and thumb place a seedling in each notch (see Fig. 4), a very slight downward pull being given to the plant once it is placed in the notch to ensure correct 'hang'.

(4) Cover roots by scuffing the soil back in to the notch, level off with the spade.

(5) Lift the board off with a forward and upward sweeping motion, the purpose of the drill hole at the back of the notch is to allow the board to be cleared freely from the plants.

(6) Place the board up against the last line of plants, the width of the board being the desired distance between lines, and cut the notch with the spade, one foot being placed on the board in doing so, the pressure thus exerted firms the soil on the last line of plants, and so on.

The advantages of this type of lining-out board are:—

(1) It is cheap to make and notches can be cut to whatever spacing is desired.

(2) The two side boards on the Swedish method are replaced with one guide line.

(3) The use of trestles and screen are dispensed with.

(4) There is a minimum of delay between the filling of the board and the covering of roots (each worker has a bucket to puddle plants in).

(5) Each worker works independently.

(6) Lining-out is simplified and the task can be performed by men, women, or boys.

(7) It costs much less to equip a large lining-out squad with the necessary equipment.

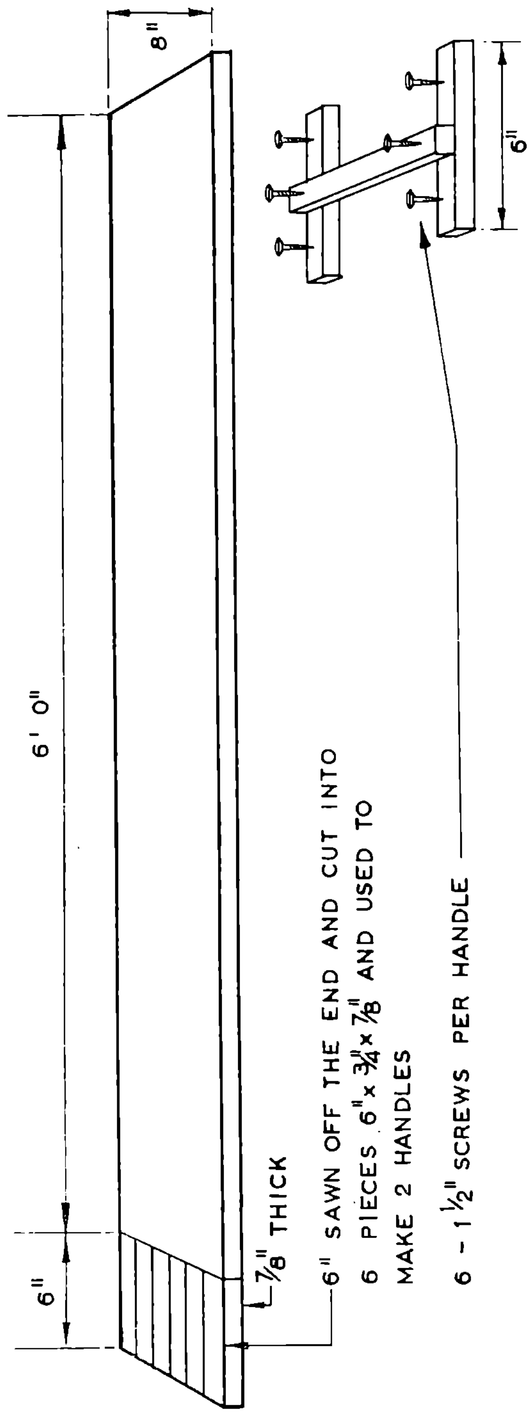


Fig. 2. Materials required to make the One-Man Lining-out Board.

(8) Replacement boards are inexpensive to make, the cost being in the region of 10/- per board, or less, depending on the source of material and the skill of the maker.

In conclusion I hope that readers with a nursery will be sufficiently interested to give the board a trial and I feel sure they will be satisfied with the results.

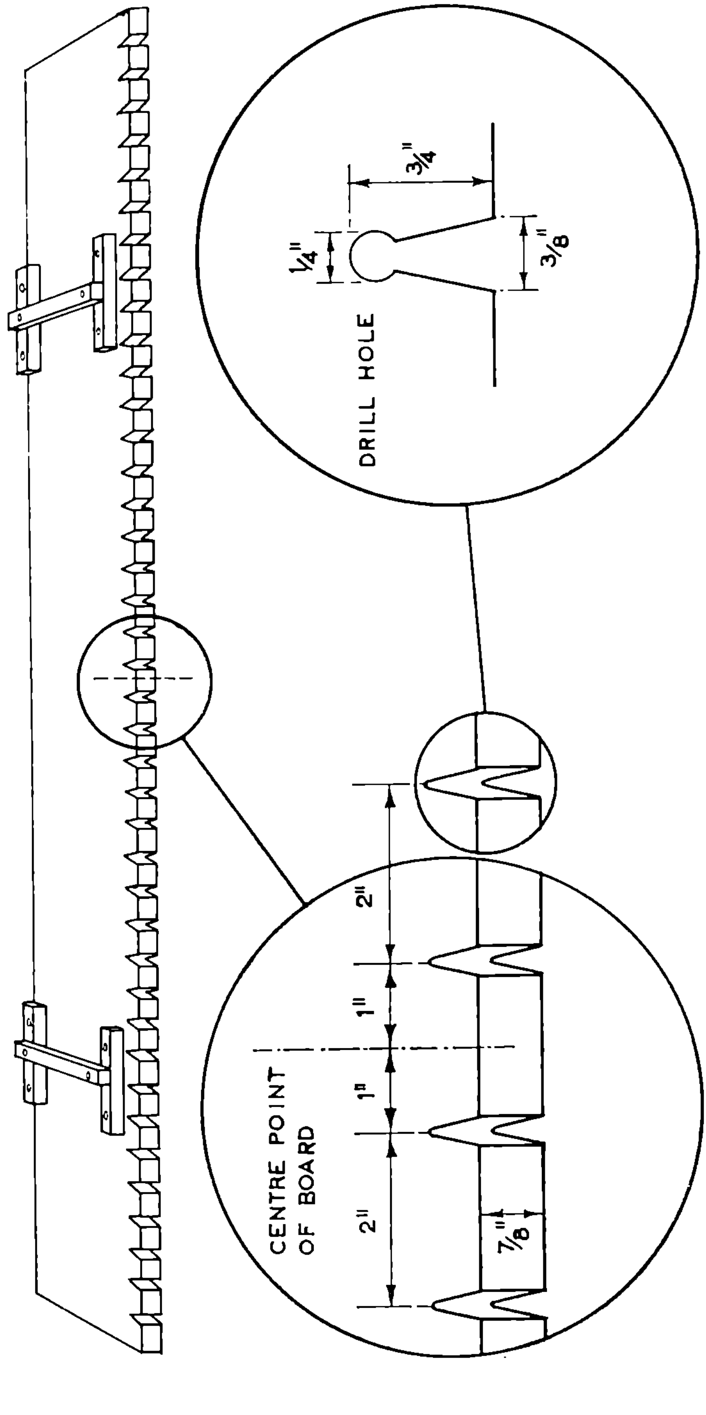


Fig. 3. Details of Construction of the One-Man Lining-out Board.

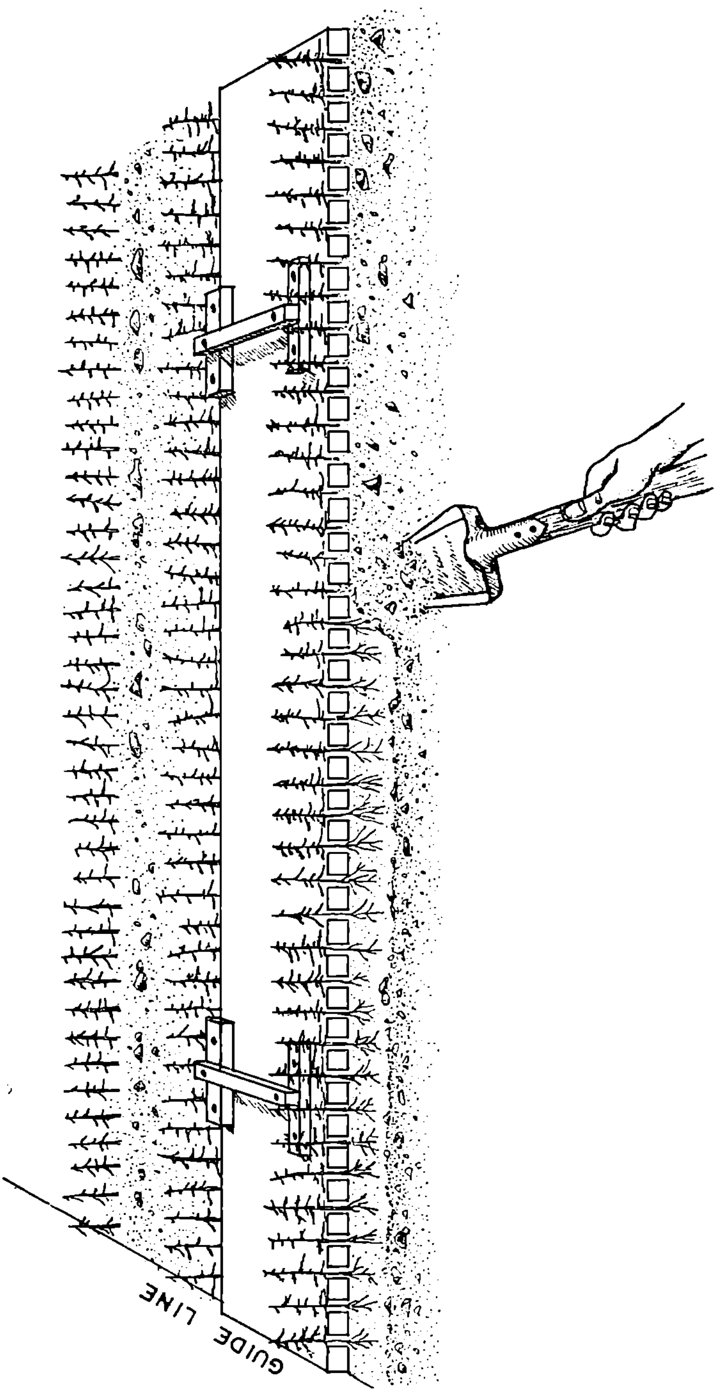


Fig. 4. The Board in Use.

AFFORESTATION ON THE CHALK WOLDS OF EAST RIDING OF YORKSHIRE

By I. R. MARSHALL

District Officer, East England

This article records investigations comparing conditions on the Yorkshire Wolds with the Chalk Downlands of south east England. The importance of soil, aspect and vegetation is defined, and recommendations given for cultivation treatment and choice of species. Data have been obtained from Scardale and Londesborough Forests in Yorkshire and from private estates as well as from several Forests in Sussex.

Comparison with Sussex Downs

The general topography of the Yorkshire Wolds with their small dales and plateaux is similar to the Sussex Downs. There is a more or less well defined escarpment, the highest point, at 808 feet, being similar to the highest part of the Downs; this escarpment, continues the trend of the Lincoln Wolds, running firstly due north from the River Humber, then curving round in a quarter-circle to the coast at Flamborough. The chalk declines gently to the Holderness Plain on the south-east, which is an area of Boulder Clay overlying the chalk. The extent of chalk having less than two feet of soil above it, extends from 4 to 12 miles from the escarpment. The remainder of the chalk, lying towards the Yorkshire coast, is well below the Boulder Clay.

The winter or dormant season in the East Riding is several weeks longer than on the Downs, and the Wolds are subject to cold east winds. This may be the reason for the small variety of vegetation on the Wolds, particularly of shrubs and underwood as compared with the rich flora on the Downs. Shrubs, apart from ash and sycamore coppice, consist almost entirely of elder and hawthorn. Rainfall at 30 inches a year is similar.

Clay-with-flints soils, associated with southern chalk areas, are non-existent in the East Riding; also the chalk is very hard and leaves only a faint mark when rubbed. There is a deficiency of potash on the Yorkshire Wolds, not apparent on the Downs. A remarkable feature is that European larch—apparently a failure in the South—is an important economic crop on the Yorkshire chalk.

Geology and Soil

The chalk was deposited during the Upper Cretaceous period, which in the East Riding formed beds about 1,400 feet thick. Of this about 1,050 feet is referred to as the "Upper Chalk", which is poor in fossils. It has been pointed out by Wilson (1) that in passing northwards from the southern counties the general aspect of the fauna of the chalk changes, becoming in the north more akin to that of the Chalk of North West Germany. This is with reference to fossils of ammonites and sea urchins. It is possible, but doubtful, that this might indicate a soil difference.

The Middle Chalk is about 260 feet in depth, and the Lower Chalk 60 to 120 feet. At the surface there appear to be roughly equal amounts of "Upper Chalk without flints" and "Middle Chalk with flints". There is no apparent silvicultural difference between the two.

The Chalk was laid down in a sea following a general land subsidence. There was a great accumulation of calcareous ooze which is mainly organic and not terrigenous in origin. That is to say, there is very little material in chalk which has resulted from being washed off the land and carried down rivers and deposited. Microscopically it is composed of fine particles, foraminifera, minute spheroidal bodies and small fragments of shells. The almost complete absence of foreign bodies in the original chalk is the main reason for the relatively thin layer of soil over chalk, as this soil is derived largely from these foreign bodies left behind after the chalk has been dissolved out.

The soil then consists of a fine-textured sand with some silt and clay, light brown but sometimes yellowish in colour, in which are scattered lumps of chalk and sometimes flint. The proportion of chalk to soil increases rapidly with depth until solid chalk parent material occurs. If this solid chalk comes at a depth greater than 24 inches, it does not give rise to such an extreme soil type and is outside the scope of this article. Chalk subsoil is highly consolidated, and where it is not ploughed or under existing woodland this compaction extends to the surface.

The critical depth of fine soil, or fine soil with chalk fragments, is 6 inches. Soils shallower than this should be considered with care, especially on south-facing aspects. Very poor soils, as indicated by the vegetation, may be deficient in nutrients of which potash seems to be everywhere in short supply. There may also be deficiencies in phosphate and nitrogen, and a leaf analysis of larch at Scardale as compared with a sample from a more normal site is given below.

Larch Foliage

	Scardale Forest	*Normal*
Nitrogen	1.54%	2.07%
Potash	0.10%	0.60%

Grass Wolds like the Downs create a highly calcareous rendzina soil which is not a good medium for tree growth. On the other hand, after a considerable period under a tree crop, this soil, by developing through intermediate stages, becomes a leached Brown Earth which is not calcareous and is much more fertile. Steep slopes will probably not attain the status of a Brown Earth, because of the adverse effects of erosion.

The soil analysis figures suggest that the addition of one or more of the nutrients in short supply, particularly phosphate and potash, should result in improved growth. It has been argued that because of high alkalinity the excess of calcium causes an "induced deficiency", and that therefore the addition of fertilizers is wasted. As against this it is observed that farmers use large quantities of fertilizer on the chalk, which is considered to be a valuable grain-producing area.

Experiments over several years with the addition of fertilizers have given negative results, but in spite of this it is felt that the basic infertility of chalk rendzinas is such that it is logical to expect a response from fertilizers if correctly applied, and these experiments are being continued.

Vegetation

A feature of most of the West Sussex Downs is the presence of the fescues, *Festuca ovina* and *F. rubra.* These are short fine-leaved grasses occurring in a dense mat. Unless eliminated by ploughing, they are a formidable problem in establishment of trees. In East Sussex at Friston Forest, the vegetation is of coarser, taller grasses that do not form such a thick carpet as the fescues. These species include *Avena pratensis*, *Trisetum flavescens*, *Bromus erectus*, *Arrhenatherum elatius*, *Brachypodium pinnatum.*

The Friston vegetation is generally very similar to that of the East Riding, but a direct comparison in other respects is slightly clouded by the fact that Friston, lying on the coast, has some problems with salt. Cocksfoot (*Dactylis glomerata*) and False Brome Grass (*Brachypodium pinnatum*) are common on the Wolds with False Oat Grass (*Arrhenatherum elatices*) coming in on more fertile sites.

Brief reference has been made of the poor variety in shrubs. On the chalk one expects to see juniper, wayfaring tree, dogwood, guelder rose, field maple, holly, etc. All these species are missing on the Wolds and it is a debatable point whether this is because conditions are not suitable for their propagation or because the seed has never reached the area. The latter theory becomes less valid when it is found that most if not all of these shrubs occur on the nearby Hambleton Hills.

Shrub species are restricted broadly to two—hawthorn on grass dales and elder in association with woodland and generally in profusion with willow herb. Briars and brambles occur locally in old woodlands.

Cultivation

The study of cultivation and methods of planting is most interesting. Due to the highly compact nature of chalk on grass dales, it is not disputed that cultivation is necessary—it is almost axiomatic for all types of afforestation. In more recent years a great deal of work has been done throughout the country with the "R.L.R." plough and generally speaking this has been successful on chalk.

Crops can be seen at Scardale Forest where beech has grown 3 times as fast after "R.L.R." ploughing as compared with "no cultivation", and it is found that pines grow twice as fast.

On the fertile sites it is evident that partial ploughing, i.e. spacing furrows at 5 feet apart, is not always the best solution, one reason being the amount of weed growth, generally grasses, which is encouraged. Sometimes this weed growth can be prolific. Complete cultivation, although expensive, is therefore being practised more; but there may be a difference regarding the optimum depth of ploughing as between the southern chalk and that in Yorkshire. Troup (2) in the south, prefers fairly shallow ploughing so as not to bury the top soil too much. In the north it is becoming evident that deep ploughing, say 12 to 15 inches, is more successful than shallow ploughing, although this in turn is a great deal better than no cultivation at all.

The greater success of complete cultivation as against partial ploughing is probably more related to water status than to more effective weed suppression. The limiting factor on chalk sites is generally recognised to be shortage of water. Chalk is a permeable rock, and when surrounded by impermeable rocks, e.g. clay, it will hold water up to saturation point in the natural state. This source of water has been tapped for water supplies in chalk strata, so that it has dropped to below sea level in many cases.

Water is absorbed by the chalk, although the moisture content is less at the surface than lower down. The problem is to get tree roots in direct contact with moisture-laden chalk.

To take the three planting points available on five-foot ploughing, the one nearest the water supply is at the bottom of the furrow. Here the tree is likely to be enveloped by invigorated weed growth sprouting from the sides of the ridge, and in any case it is growing in uncultivated, hence consolidated, ground. Planting at the top of the ridge, while minimising competition from weeds, puts the tree further away from moisture. If the tree is put halfway down the ridge on a small platform, one is incurring the defect of the first position by planting it in an uncultivated portion of ground, unless the roots grow upwards into the ridge, when little benefit will result since the water is underneath. With complete cultivation, one will have water at a constant depth and all the soil will be freely rooting. It is of interest to point out here that at Friston, a great deal of which has been partially ploughed, a ½-acre plot of "complete R.L.R." ploughing shows better growth than five-foot ploughing adjacent.

The R.L.R. plough is however obsolete and expensive to keep running. An alternative implement which is in common use in agriculture is the "Rooter". This is a set of heavy-duty vertical tines towed by a large crawler tractor. During reclamation of woodland sites this is the first implement to be used for cultivation after removal of the largest stumps. It has a span of eight feet and will cultivate up to five acres a day with a D.7 tractor, whereas the "R.L.R.", assuming it does not break down, will plough only one acre.

A great deal of the land becoming available for afforestation on the chalk is too steep to plough, and such land is treated in a similar way on both Wolds and Downs. As with all grass areas, it is necessary to screef off a patch of grass, and if the turf will remain intact, to hinge it back to form a mulch on one side of the tree. Subsoiling with a pick mattock is important to ensure survival of the tree, and the speed with which the mattock blade wears out is an indication of the compaction of the soil. It is usually worthwhile to have the job of screefing/subsoiling carried out in advance of planting, in order to speed up the planting operation.

Tools for planting vary from a garden spade, Mansfield spade and mattock to the garden fork as used at Friston. There seems a great deal to be said for the fork, because of the additional cultivation it provides in the process of planting.

Even after planting, it is possible to achieve a degree of cultivation by "screef weeding". This is screefing off a patch of grass from around the tree with a mattock, preferably in the spring. This is not so expensive as it sounds, because in doing this work, one normally avoids summer weeding.

Choice of Species and Silviculture

There is again much common ground between the Downs and the Wolds in the choice of species. In the first place beech is the principal tree to be depended upon to reach saw timber size, because of its tolerance of alkaline soil conditions. Sycamore shows much promise as a secondary species.

Beech is not of much value below saw timber size, so it has become customary to plant it in mixture with a nurse crop or catch crop of conifers. 'Catch crop' is used here deliberately because on cultivated ground in Yorkshire, beech grows every bit as fast as the conifer, sometimes overtaking it. On uncultivated land it falls far behind the conifer. Soil differences are masked by cultivation, so much so that cultivation has a greater significance than minor changes in soil.

As regards the conifer component of these mixtures, the Wolds differ in two important respects from the Downs. Firstly European larch is the most valuable conifer and has become traditional on private estates because of its usefulness for estate work. This species will only grow on the better sites on the Downs and generally speaking is absent. Both Scots and Corsican pine will grow on the Wolds for a longer period than on the Downs, before becoming chlorotic, a disease resulting from high soil alkalinity.

The pines will survive until well over 30 years, being outlasted by larch. Larch will indeed live 80 years or more, but the chances are that it will be "pumped" or rotten; whatever conifer is used as a nurse it should be removed early, so that by the time the crop is say 30 years old there will only be a scattering of conifers.

A row-by-row mixture, as opposed to bands, is preferred because in addition to improving the amenity it acts as a safeguard if either the conifer becomes chlorotic or the beech fails. Note that beech is extremely sensitive to attack from vermin, namely rabbits, hares and voles. Some beech crops seem to have been produced from bad strains, and in that case it is as well to revert to a conifer crop and to underplant with a good strain of beech later.

Pine is not altogether a desirable nurse tree, although it has been commonly used, as it develops its branches where there is most light, leading to a considerable risk of bad rubbing. European larch branches do not grow so strongly towards light, so they interfere with the beech crop to a lesser degree than does pine.

As regards other species available for mixing with beech, experience appears to be the same in the Downs and in the Wolds. Austrain pine is suitable with *Thuja plicata* and Lawson cypress for underplanting. Norway spruce grows on better soils, and on the Wolds *Picea omorika* looks extremely promising after three years' growth. It has withstood drought when other species failed.

There is some controversy as to whether it is not better to grow pure conifer in afforestation on the chalk because of its higher yield, in spite of the risk of chlorosis, and to introduce beech as an understorey. On the whole the writer recommends against this because it has been found that chalk remains quite consolidated under a conifer crop but under a hardwood canopy the soil becomes more easily workable. On the whole, hardwood roots are tougher than conifer, as is well known by those who have carried out destumping of old woodland. It does in fact seem to be more appropriate to produce a first crop of beech from the chalk in order to ameliorate the conditions, in fact to produce a Brown Earth or an intermediate form of Brown Earth, and to turn to conifer during the second rotation. This process can be seen at Arundel Forest in Sussex where in established woodlands, Corsican pine, Japanese larch and Douglas fir are put into the deeper soils, and Lawson cypress and *Thuja plicata* in shallower soils, the trees being planted under light scrub which is taken out soon after planting.

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AFFORESTATION OF A FORMER OPENCAST COAL SITE IN COED MORGANNWG, SOUTH WALES

By JOHN WHITE
District Officer, South Wales

Introduction

The working of coal seams by the opencast system in this country seems to have developed during the war years 1939-45 and by the end of the war had become established as a more economic system than the orthodox underground mining. So successful is it, in fact, that it has proved a paying proposition to remove overburden hundreds of feet thick in some cases.

As is well known, operations of this kind produce a vast disturbance to the surface of the soil, and to restore this to its original contours and replace the topsoil costs a very considerable sum. While a case for this heavy expenditure might be made in areas where amenities or agricultural land have been destroyed, there can be little justification in spending several times the value of the land itself in restoring it if it were formerly only rough mountain grazing.

In 1953 the late Mr. W. D. Russell (then Conservator) gave a considerable amount of thought to the problem. A fair amount of Forestry Commission property in South Wales, particularly in Coed Morgannwg, was under requisition for opencast working and he felt that, in the national interest, it should be possible to bring former opencast sites in poor mountain grazing areas back into production as forests, with a minimum of restoration work.

The restoration specification considered acceptable for afforestation was the rough "hill and dale" configuration resulting from dragline working subject to the following conditions:—

(1) No "hill" slopes to be left steeper than 1 (vertical) in 2 (horizontal).
(2) No slope to exceed 200 ft. in length without terracing. Such terraces or level strips to be not less than 14 ft. wide on gradients not steeper than 1 vertical in 7 horizontal to provide suitable formation for forest roads.
(3) The base of two adjacent slopes, i.e. the "dale" to be graded level to a width of not less than 14 ft. and not steeper than 1 in 7 throughout its length.
(4) The layout of these potential forest roads to be planned by the National Coal Board and approved by the Forestry Commission.
(5) The main "coaling" roads and any subsidiary roads to be incorporated into the road plan and left in good condition.
(6) The area to be drained to avoid all ponding.
(7) Channels of suitable width, side slope and bed gradient to be provided to control all surface drainage and avoid erosion, pollution, flooding or silting of channels or water courses on or off the site.
(8) Surface erosion, ponding, flooding and silting of water channels and water courses to be avoided during the progress of the work.
(9) Surface compaction to be the minimum to permit the above restoration work to be done.
(10) The "high wall" to be left as excavated for the last cut if desirable subject to adequate drainage being provided and to adjacent slopes conforming to paras. (1) and (2) above.
(11) As far as practicable, drainage channels to be made alongside roads or projected roads. On the terraces (para. 2) and in the dales (para. 3) the channels to be at the sides, leaving approximately 10 ft. of consolidated ground for the formation of an extraction road.

History

A small opencast site known as the Aberpergwm site near Glynneath in the Vale of Neath and forming compartment 297 of Rheola Forest (now incorporated in Coed Morgannwg) was worked for coal between 1948 and 1953 and was derequisitioned on 1st January, 1954. and restored according to the specification set out above. It is some 25 acres in extent and it was decided to use it as a pilot scheme to gain experience in dealing with future opencast sites as they became worked out and were derequisitioned. For lay-out see Fig. 5.

Previous experience in the Vale of Neath had shown that Corsican pine was a reliable species for planting on colliery waste heaps which of course are similar in composition to worked, un-restored sites. In this pilot scheme it was decided to make trials of all the common species likely to succeed, but as an insurance against failure to plant pure plots of each species and plots which consisted of a 2-row : 3-row mixture of each species and Corsican pine. The list of species used in P.54 was:—

Scots pine	*Abies nobilis*	Birch
Corsican pine	*Tsuga heterophylla*	Common Alder
Lodgepole pine	*Thuja plicata*	Grey alder
Japanese larch	Lawson cypress	*Robinia pseudoacacia*
Norway spruce	Red oak	Rowan
Sitka spruce	Sycamore	

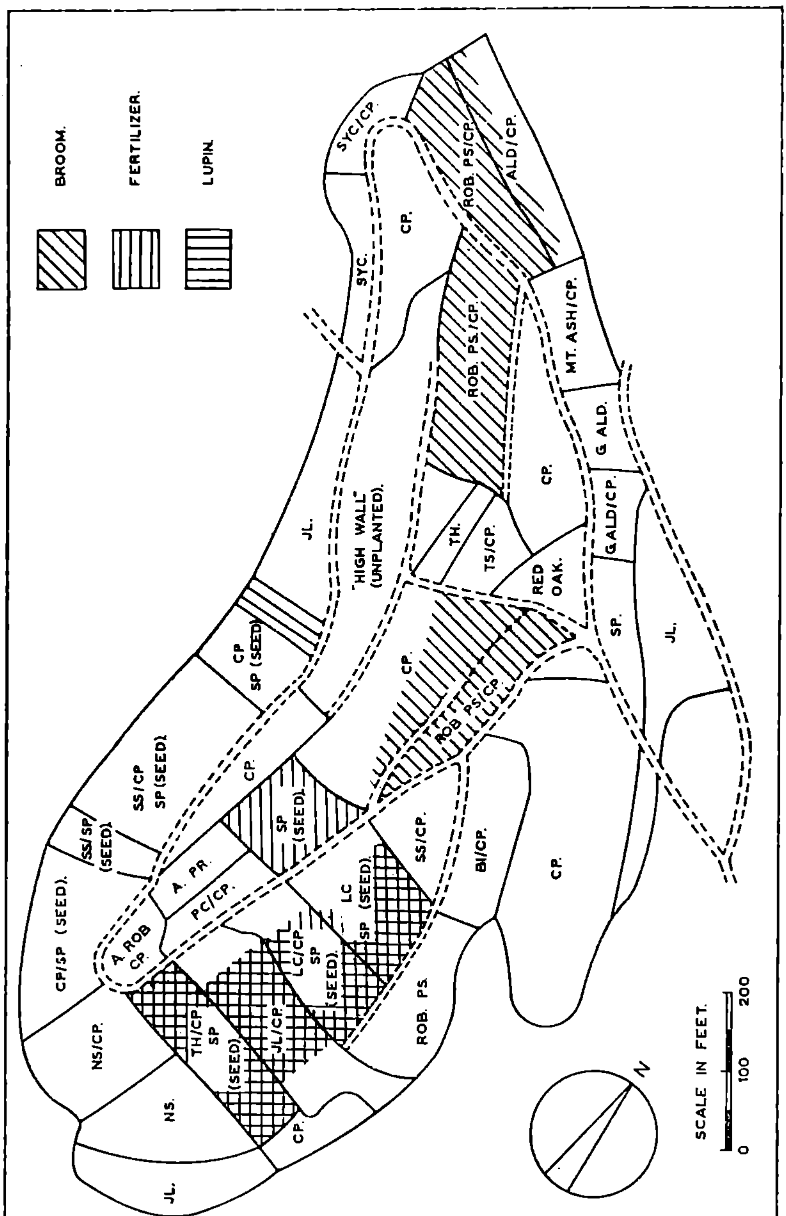

Fig. 5. Plan of the Aberpergwm Opencast Site at Coed Morgannwg showing species planted, areas sown with broom and lupin and areas treated with fertilizer.

In addition to tree species agricultural lupin and broom were sown in some places with the object of increasing the nitrogen content of the soil. Part of the area was also treated with potassic superphosphate at the rate of 2 oz. per tree.

Most of the planting and sowing (25.2 acres) was done in 1954, although a very small amount of broom seed was sown in 1953. A further 1.8 acres was planted in 1955 and the P.54 area was beaten up. In order to obtain as quick a closure of canopy as possible a spacing of 4 ft.×4 ft. was adopted throughout.

The results obtained have been most encouraging, but are a little difficult to interpret and only rather broad inferences can be made which may have to be greatly modified by future experience both on this particular site and elsewhere.

A brief survey of progress to date follows; see centre pages for photos.

The lupin produced a heavy crop in the first year, but then faded out. The sites of the drills in which it was sown were indicated a year or two later by lines of weeds and grasses, but whether this was due to the enrichment of the nitrogen in the soil or to the slight cultivation in covering the seed is doubtful.

The broom has done remarkably well and by 1958 produced a heavy growth which has to be cut back to avoid competition with the trees.

As regards the tree species the percentage of deaths after the first season was as follows:—

Scots pine	25%	Sitka spruce	8%	Birch	16%
Corsican pine	42%	*Abies nobilis*	29%	*Robinia pseudoacacia*	28%
Lodgepole pine	18%	*Thuja plicata*	64%	Grey alder	13%
Japanese larch	6%	Lawson cypress	29%	Rowan	4%
Norway spruce	3%	Red oak	25%		

The whole area was fully beaten up in 1955 and in making an appreciation in October, 1959 (i.e. after six growing seasons) the following points appeared to be noteworthy.

The area is now, in general, fully stocked with trees, and ground vegetation is colonizing the area at a very satisfactory rate. It is fairly certain than in another year or two the bare earth scar of this site will have been covered over and will present a much more natural appearance.

Tree growth has, as might be expected, been somewhat variable, reflecting variations in the soil. Some patches are, no doubt, accumulations of former surface soil which, being more fertile, have produced better growth. Other patches are definite subsoil and on the steepest slopes are still weathering, and are not yet stable enough for the trees to obtain a foothold. Immediately before afforestation began, a fair proportion of the area consisted of large slabs and lumps of fairly hard shale, but this has now weathered rapidly to a fine gravelly mud. Even the "high wall" has lost its perpendicular form, and in the course of time may settle down to an angle which may become plantable.

One point which is now obvious is that tree growth is much poorer on the level areas than on the slopes. No doubt the passage of vehicles and machinery has caused considerable consolidation in such areas, but it may also be the case that water tends to lodge and reduce soil aeration as well.

The exceptionally hot dry summer of 1959 does not seem to have had any very bad effect on the trees. The Norway spruce is perhaps rather yellower and definitely appears to be unhappy. Scots pine has produced leaders only half the length of the previous year although the other pines have kept the same rate of growth. On the other hand *Robinia pseudoacacia* has shown remarkable growth and could almost be described as being in the thicket stage. Even on the difficult flats growth of this species in this exceptional summer has been very striking, the effect being of plants coming out check and doubling their height in a single growing season. The grey and common alders are the leading species as regards height growth and are quite remarkable, but as mentioned above this may very well be due to an accidental accumulation of good soil.

Some indication of the difference in growth is given by the following tables. The figures are not mathematical averages, but indicate more or less representative samples judged by eye and when more than one set of figures is given, this is due to variations in different parts of the area.

	Good Sites (usually slopes)			*Poor Sites (usually "flats")*		
Species	*Total Height (6 years)*	*Length of Leader F.Y.58*	*Length of Leader F.Y.59*	*Total Height (6 years)*	*Length of Leader F.Y.58*	*Length of Leader F.Y.59*
Scots pine	40″–45″	12″	9″	30″–36″	9″–12″	6″
Scots pine	—	—	—	22″	8″	4″
Scots pine (seed)	42″	12″	7″	22″	6″	4″
Corsican pine	56″	12″–15″	14″	39″	9″	9″
Corsican pine	50″	12″	14″	18″–24″	5″	6″
Lodgepole pine	54″	9″	12″	20″–24″	4″–6″	5″
Japanese larch	78″	13″	18″	36″	3″	4″
Norway spruce	—	—	—	18″–22″	2″–3″	4″
Sitka spruce	46″	9″	10″	22″	4″	4″
Abies nobilis	20″	3″	5″	—	—	—
Tsuga	—	—	10″	—	—	—
Thuja plicata	66″	—	—	24″–30″	6″–7″	6″
Lawson cypress	66″–78″	18″	18″	12″–18″	6″	6″
Red oak	24″–36″	—	12″	12″–18″	—	Bushy
Sycamore	Dying back	—	—	—	—	—
Birch	96″	—	—	36″	—	—
Alder	Up to 240″	—	—	Up to 120″	—	—
Grey alder	Up to 240″	—	—	—	—	—
Robinia ps.	Up to 240″	—	—	24″–48″	—	—
Rowan	Dying back	—	—	—	—	—

Conclusions

This trial must be regarded as merely a tentative beginning, and its chief use will be to provide evidence of the behaviour of the species tried and should be a help as a starting point for further more detailed experiments. It can hardly be over-emphasised that soil variation on such a small site as this is a factor which must not be overlooked. The real problem is the afforestation of the unmixed subsoil which will form the bulk of the surface on the larger opencast sites that will have to be tackled in the future. The remarkable success of the hardwoods (Common alder, grey alder and *Robinia pseudoacacia*) must therefore be accepted with reserve. It may very well be that in this trial they are in very favourable pockets of top soil. They are certainly in well-sheltered positions on the lower parts of the area, which may also mean an abundant water supply.

The indications are that quite a number of economic conifer species may be expected to do well. The original view that Corsican pine was a reliable species, is supported by results. There is still the same difficulty (found everywhere with Corsican pine) of initial failure, but once over this stage the species has done well up to the present. There is, of course, a lot of scepticism about the future of Corsican pine in South Wales generally, but there seems little doubt that as a pioneer, or a pitwood rotation crop, Corsican pine can be regarded as a staple species for these sites in this part of the world, provided the elevation above sea level is not excessive.

Perhaps the most striking of the other conifers tried is Lawson cypress. This has exhibited all its pioneering qualities and, although its habit will not give such a rapid closure of canopy as Corsican pine, it has nevertheless shown a very heartening vigour.

Scots pine and lodgepole pine could probably be used more extensively. In this particular experiment the Scots pine are mainly on the flatter places and might have given a better showing if they had been planted on the slopes. It is perhaps noteworthy that the lodgepole pine are already attempting to produce cones.

Japanese larch shows a great variation and no doubt the best trees (up to 10 feet high) merely indicate pockets of top soil. The species was not tried on the typical slopes and the poorest trees are on the "flats".

Abies nobilis, which has been tried with little success on limiting sites in South Wales, has surprisingly done very well in this experiment, but here again it may be due to the fortuitous collection of top soil.

Thuja plicata and *Tsuga* have been used in very small numbers, but show adequate vigour.

No doubt time will alter the appreciation, but as a guide for afforestation of similar sites in the near future, it seems that pines (particularly Corsican pine) are probably the most useful species and have the merit of being readily available.

Lawson cypress and possibly *Tsuga* and *Thuja plicata* seem to merit extended trials. The use of broom and lupin as soil improvers is also worth while, but there does not seem to be any necessity to apply artificial fertilizers or manures.

The restoration specification originally framed appears to need some slight amendment. A maximum slope of 1 : 3 (rather than 1 : 2) seems advisable and possibly some kind of cultivation of consolidated flats. It could be that both purposes would be served by one process, namely a certain amount of spreading out of the spoil heaps.

COURSE ON MANAGEMENT AND METHODS KLAGSTORP, SWEDEN

15th—19th June, 1959

By C. E. ALLISON

Assistant Forester, New Forest

The Course was held at an Agricultural School in South Sweden for the benefit of Swedish Woodland Owners. The aim is to give the private individual a good general picture of Swedish forestry and the part it plays in the national economy.

Emphasis is stressed on the part the private owner plays in this vast national enterprise, and the best methods to follow to ensure maximum efficiency, thus benefiting himself and his country.

Time was divided about 40 per cent lectures and 60 per cent discussion in the field.

History of Swedish Forests

For a long time Sweden has made use of its forests. In the 17th century large quantities of wood were consumed in the flourishing iron industry. After the invention of the steam engine the forests became really valuable. The first steam power sawmills were built in the middle of the 19th century industrialisation spread, and sawn goods became a sought-after commodity on the European market.

Virgin forests, particularly in north Sweden, were increasingly taxed. Rivers were converted to means of transportation for logs. Forests in the south were utilised as well. Vast areas were denuded without thought of how new stands were to arise. Unemployment followed, with consequent emigration.

At the end of the 19th century sustained yield forestry was practiced only in State forests and by certain large forest companies. The red light was seen in time and in 1903 a Forestry Act was passed to ensure regrowth after felling operations. The Act applied to private forests only. State Forests were governed by a regulation of 1894 based on the sustained yield principle.

In 1923 a new Forestry Act was enforced, making the landowner and not the felling operator responsible for regeneration. It was decreed that young stands could not be harvested other than by thinning adapted to promote growth.

The Forestry Act in force today was passed in 1948. It is an improvement on the 1923 Act, with the addition that the principle of sustained yield forestry, should apply also to private forests. This was tempered by a recognition of the landowners desire of some financial return.

Soils and Climate

Cold temperate climate with moderate precipitation. Despite the high latitude (55°-69° north), only at high altitudes and in the extreme north is forest growth severely limited. Compared to growth in the British Isles the rate is, of course, slow in Sweden.

Forest soils consist mainly of stony yet mineralogically rather rich moraines and sediments. Weathering and leaching have, only to a limited extent, affected the soils which contain large supplies of latent nutrients. A sandy soil in Sweden is usually poor in quartz but rich in phosphate and potash.

The water table is often high since ground water rests or moves upon the smooth surface of the bedrock which usually consists of granite or gneiss as a parent material.

Generally speaking, in south Sweden brown earth with mull is common and in north Sweden iron podsol with raw humus.

The southern soils are mostly found in the original deciduous forests which once covered southern Sweden and are favourable for growing spruce. This converting of original deciduous forests to conifers has the effect of causing the brown earth to degenerate into podsol with raw humus, and some attention must be paid to this soil problem.

The podsol types of the north vary in productive capacity depending on differences in moisture conditions and mineralogical composition of the soils.

General Outline of Swedish Forestry Today

Forest Area

Total area of Sweden 109 million acres
Agricultural land 11 million acres
Unproductive bogs, rock outcrops
Mountains and Lakes } 41.25 million acres
Remainder productive forest land 56.75 million acres
This remainder constitutes 52% of the total land area (Compare 7% Great Britain).

Ownership of Forest Land

Private Individuals	50%
Forestry Companies	25%
State	18%
Church and Local Government	7%

However, when yield is considered the distribution is quite different. State forests are situated mainly in the northern part of the country where yield capacity is lower than in the south. It is estimated that the State's share amounts to about 10% of the total yield.

The companies who own forest land are also, generally, the owners of important wood industries. These industries supplement their raw material by purchasing timber from the State and from private forest owners. The latter constituting the largest suppliers.

Rate of Increment

The first National Forest Survey was carried out 1923-29. The second in 1938-52.

According to the 1st National Forest Survey the total growing stock was: 60,733 million cubic feet.

2nd Survey showed: 67,654 million cubic feet.

The latest information from 1953-54 indicates a total of 75,634 million cubic feet.

This shows an increase of 12% over an average period of 10 years.

So we see felling operations in Sweden of late have not been excessive.

Annual increment is 2,450 million cubic feet. The average growing season can be considered to be between June and August. The annual increment per acre is greatest in Southern Sweden, e.g., in the province of Malmöhus 70 cubic feet per acre per annum. Whereas in Norrbotten in the north the figures are 18 cubic feet.

Reasons Why Increment Exceeds Annual Felling are as Follows:—

1. In central and southern Sweden certain difficulties have been experienced in finding markets. An expansion of the wood industry in these parts is necessary. Certain plans are proceeding including construction of sulphate plants. Demand for sulphate pulp is expected to grow steadily on account of the rising consumption of paper throughout the world.
2. Heavy taxation and current inflation particularly in the case of private forests in south and central Sweden, act as deterrents to felling. Many forest owners think it wiser to leave the trees in the forest and wait for better conditions.

Distribution by Species

	State	Others
Pine	40%	46%
Spruce	44%	37%
Broadleaves (mostly birch)	16%	17%

Distribution by Age Classes

	5.2%	BARE LAND
Age 1-20	12.8%	CLASS I
Age 21-40	21.0%	CLASS II
Age 41-60	27.3%	CLASS III
Age 61-80	20.2%	CLASS IV
Age 81+	13.4%	CLASS V

Ideal Distribution

	3.5%	BARE LAND
Age 1-20	22.0%	CLASS I
Age 21-40	22.0%	CLASS II
Age 41-60	22.0%	CLASS III
Age 61-80	22.0%	CLASS IV
Age 81+	8.5%	CLASS V

Distribution of Forests

Most timber is in the north but adverse climatic factors prevent maximum production there. Most of the pulp mills lie along the east coast of the northern region.

Forestry and the Economy of Sweden

In the past 50 or 60 years the character of Swedish forestry has changed from large-scale exploitation to a producing activity.

Almost half of Sweden's exports are derived from the forests. Sweden has nearly 4,000 sawmills, 118 pulp mills, 72 paper mills and 36 factories for the production of wallboard and veneer.

Methods of Reproduction—Silvicultural Systems Employed

(a) Natural regeneration under shelterwood or seed tree method wherever conditions are favourable.

(b) Natural regeneration from perimeters when a small felling area is made.

On most forests we saw (and we had the good fortune to visit many further north after the course) natural regeneration is hoped for, and seed trees are left. After one year, if the regeneration appears to be incomplete, beating up (enriching) by patch sowing or planting is carried out.

There is usually no profuse weed growth such as we in South Britain encounter and no preparatory cuttings are usually necessary.

Seed trees are removed after 10 years.

Preparation of Ground

(1) Scarification by hand or machine is widely used, especially in the south. This greatly assists in ensuring a well-stocked regeneration.

(2) In the north, burning the slash is the normal preparation to facilitate regeneration. This method is not so successful as scarification and particular care must be taken to stack brush around the seed trees or they may be badly burned.

We witnessed one such site, near Lake Siljan, where the slash burning had been uncontrolled, with the result that the seed trees were very seriously burned indeed.

Methods of Scarifying

Where scarifying is done, usually 10% of the ground is screefed in patches but where much grass is in evidence, a much greater percentage may be scarified by machine.

Hand Scarifying

Screefs are usually made about 1 metre long with a screefing mattock, getting down to the mineral soil.

Machine Scarifying

The Kulla Cultivator is a very useful machine for this operation. It is coupled to an ordinary agricultural tractor. During transport it hangs lifted-up in the hydraulic arms. The mechanism of release is coupled to the 'power take off' shaft of the tractor. The distance between the screefs is regulated automatically.

Normally the screefs are 60 centimetres square (about 1 ft. 9 in.) and about 5 feet apart.

The cultivator is self-cleansing of sods, branches, etc. so there is no need for branch clearing.

Cost	1,150 Swedish Kr.=£80.
Cost of Hire	5 Kr.+12 Kr. for Fordson=7/-+16/6d. for Fordson per hour.
Cost to use	80/100 Kr./hectare=£2 4 0/£2 15 0 per acre.

It would be interesting to compare the above cost of £2 4 0/£2 15 0 per acre with the cost of preparing for regeneration at the Windsor Crown Estates, where "blading" with the bulldozer, is the standard method of regeneration.

I feel that sufficient regeneration would occur, within the screefs, with this obviously much cheaper bulldozer preparation.

In Sweden, in the event of poor regeneration occurring, patch sowing is often carried out as described later.

Sowing

Sowing is sometimes carried out because of the high cost of transplants, but more often on poor soils which are weed-free, or on stony soils where it is difficult to plant.

Never sow on clay soils because of frost lift.

Scarifying as previously described is carried out before sowing. Seeds are sown around the edge of the screef so that they obtain the maximum degree of shade from the sun. 1 cm. of the fine mineral soil has proved to be the best covering.

Cost of scarifying	(10% area) 100 Kr./hectare or £*2 15s.* per acre	*By Machine*
,, ,, ,,	150 Kr. per hectare or £*4 2 6d.* per acre	*By Hand.*

Seed Costs

Pine	£2 15s. per pound
Spruce	£1 5s. per pound

A mixture of pine and spruce is not normally sown, as pine outgrows the spruce initially.

Time to Sow

Just after the snow has gone in April, when the ground is moist. The next best time is just before midsummer, after the usual spring drought, when rain can be anticipated again.

Planting Stock Used

Spruce 2+2 home-produced transplants
2+1 German or Danish imported transplants.

Spruce is very susceptible to frost when young. Experiments with different provenances from the Arctic Circle to Southern Europe are now under way. No results are yet available.

A certain amount of birch on a planting area is useful as a nurse on pure spruce plantations.

Costs of Transplants

Spruce	2+2 transplants:	£5	3	0	per 1,000
	2+1 transplants:	£3	8	9	per 1,000
Pine	2+0 seedlings:	£1	7	6	per 1,000
	2+1 transplants:	£2	15	0	per 1,000

Time to Plant

Again April is best, as soon as the soil is warm enough. Planting is normally carried out from April to June. Great care must be taken in planting because of drought conditions, and the distance transplants have to be carried to the site, especially in the case of German-imported transplants.

Weevil Protection

Plants are usually dipped in D.D.T. solution for half-a-minute, as areas to be planted are usually infested with weevils. Thus, there is no delay in waiting to plant. Some weevil trapping is also done on the felling area.

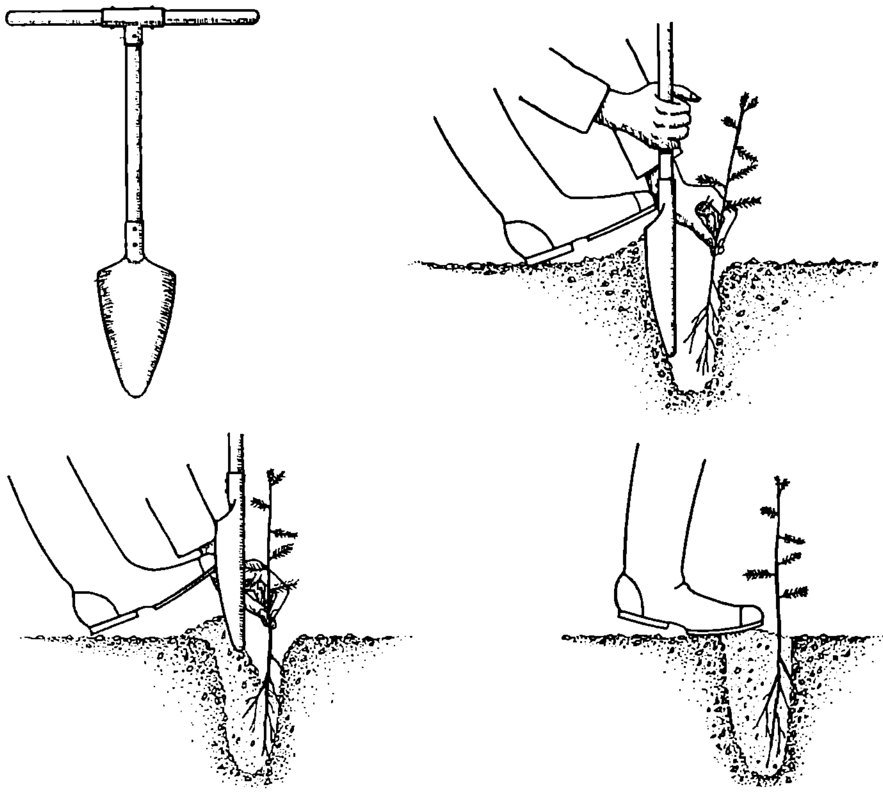

Fig. 6. Planting with a semicircular spade used where vegetation is sparse and the ground i not too stony.
(1) The tool itself.
(2) Inserting the tree, with earth held within blade.
(3) Withdrawing blade and releasing earth.
(4) Stamping firm. Note position of plant at edge of hole.

Methods of Planting

A visit was made to a planting site where several different planting methods were seen. (See Figs. 6, 7 and 8).

The vegetation was predominantly heather with a layer of raw humus. The mineral soil underneath was sandy.

A brief talk was given on the source of supplies of seedlings and transplants, together with examples of good and bad planting stock. Owners, in general, are not sufficiently firm and should refuse to accept plants of inferior quality.

There are very few nurseries in Sweden because of the short season available for nursery work and the spring drought which means constant watering, consequently added costs.

These factors add greatly to the expense of producing planting stock. Heathland nurseries cannot be established, as in our country, because of the lack of water—no rain until after midsummer.

For these reasons many transplants are imported from Germany and Denmark.

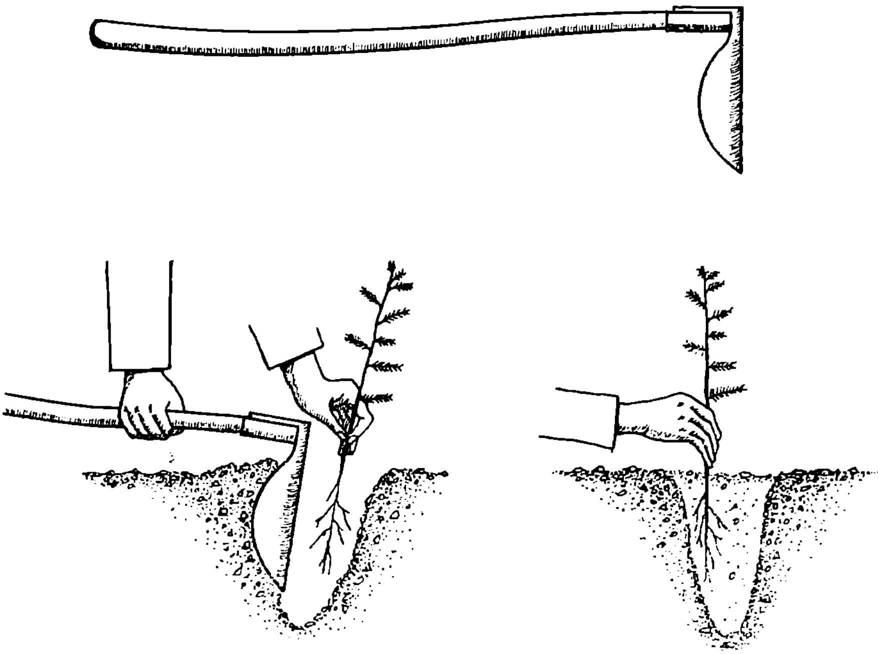

Fig. 7. Planting with the Swedish Bodenhacka screefing and planting tool.
(1) The tool itself.
(2) Inserting the plant in the ground.
(3) Setting plant against edge of hole to get maximum moisture.

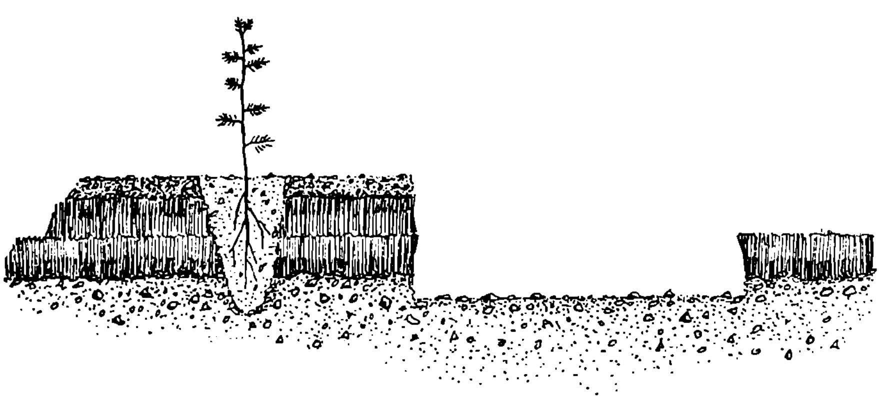

Fig. 8. Turf or Mound planting on low lying ground to get plants out of water: Inverted turf method: Note how roots penetrate below original soil level.

Handling of Plants

Exceptional care must be taken in handling plants, and in the methods of planting, because of the above adverse conditions and the distances which plants are transported to the planting site, often 1 to 2 days by lorry from Germany and then heeled-in on the planting site.

Interest was shown in the use of our polythene bags for plant transportation.

First Method of Planting Seen

Semi-circular borer—similar to our own. Suitable only on bare ground, not stony. (See Fig. 6).

Second Method of Planting Seen

The "Bodenhacka"—a very light screefing tool. Screef off the surface vegetation down to the mineral soil so that any water can quickly reach the plant.

Then drive the screefer into the ground and insert the plant behind it. The plant is up against a solid wall of earth on one side (as in method one), consequently full advantage can be taken of all available moisture. (See Figure 7).

Third Method of Planting Seen

An old agricultural grassland field visited had been machine-planted. Alternative methods are ploughing. Position of plant is in the furrow bottom so as to obtain maximum moisture. The exception to this rule is, of course, in very low-lying areas, when the plant is put on the out-turned spoil.

Fourth Method of Planting Seen

Mound planting on low-lying swampy ground. (See Figure 8). In all methods particular care is taken to ensure that the plant is planted to the same depth as it was in the nursery. Life is difficult enough in the early stages for the young transplants, without it having to grow another root system.

Weeding

From what we saw on different estates, very little appears to be done. This may be all right on the relatively weed-free *Calluna-Vaccinium* sites and where regeneration is prolific. However, a bracken site was visited one morning where bracken had fallen over the small spruce plants in autumn. Then came the weight of snow with the result that the spruce were badly smothered and bent over. Some weeding would be beneficial on these areas of heavy bracken.

Cleaning

This can be divided into 2 classes:—

(a) The elimination of undesirable species such as scrub birch and other broadleaves along with any wolf trees.

(b) A "young plant thinning" when the trees are about 1 metre high.

Let us look firstly at (b).

Reasons for the "Young Plant Thinning"

(1) The aim is to produce wood fit for pulpwood in a comparatively short time. The market for small wood has slumped. Such wood is now only used as firewood. By means of early plant thinning, the volume of worthless small wood will be considerably reduced when the stand has reached the stage when the first profit is obtained in a thinning operation.

(2) To give desirable mixture of species.

(3) Better quality for the stand.

(4) To give even spacing to eliminate root competition.

(5) To strengthen plants to withstand snow break. It is important to do the operation in time. If done too late there is less advantage. If done under 1 metre (3 feet) high you get more natural regeneration from the sides, and another "plant thinning" is called for later.

The tools used are shown in Figure 9.

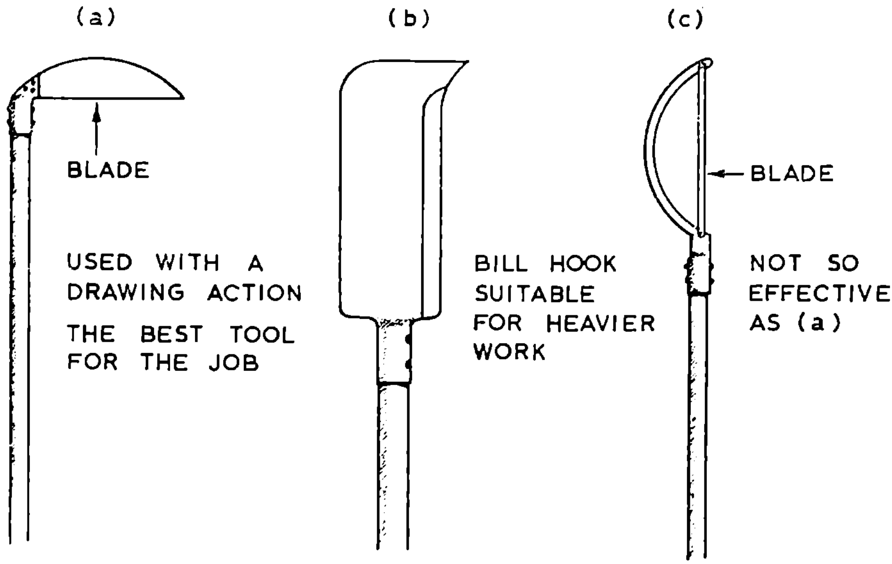

Fig. 9. Tools used for thinning.

How to Ascertain Degree of "Plant Thinning"

Great importance is based in Sweden on Soil (Site) Quality Class and many excellent tables can be referred to. The Quality Class figure is arrived at by taking the average production capacity *per year per hectare* over a *100 year rotation*.

Thus when we refer to the Soil Quality Class as 5.4 m^3 (which is about the average for Skovde county), we mean that the site is capable of a Mean Annual Increment of 5.4 m^3 per hectare (60 hoppus feet per acre) over a 100 year rotation.

The average for the country as a whole is as low as 3.5 m^3 (about 39 hoppus feet).

Plant Thinning in the Field

We did a small practical exercise in the field.

The site was carrying a pure pine crop just over 1 metre average height, which had been originally patch sown. The Quality Class was 5.4 m^3. From the tables we saw that after cleaning, 4,600 trees per hectare should remain (approx.). This is equivalent to 1,860 per acre.

By means of a 4 metre stick, taken around in a circle to give a rough sample plot of 50 square metres, we were able to check the result of our efforts.

The lower the Quality Class the less plants should be left per hectare.

Normal Cleaning

The ideal is to cut out the birch in a plantation long before the final cut, so that the birch may be killed out under the canopy, thus saving much money spent in cutting-back birch coppice, or ring barking in the newly-established plantation.

However, one must bear in mind that the birch does act as a soil improver and a certain amount should be left.

Chemical Spraying

A demonstration of chemical spraying of birch was seen using Phillips Brush Killer 165, Esteron Extra and Kalmapan.

This demonstration included:—

(1) Spraying the undesirable coppice regrowth.
Cost 270/350 Kr./hectare. £7 8 6/£8 5 0 per acre.

(2) Wounding and spraying into the wound, for heavier scrub. (See Figure 10).
Cost 250 Kr./hectare. £6 17 6 per acre.

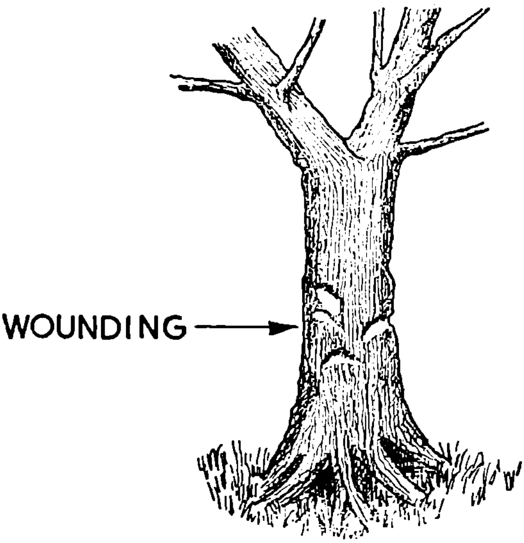

Fig. 10. Wounding Birch before spraying chemical poisons.

(3) Spraying the cut over tree stump, 800 Kr./hectare. £22 0 0 per acre.

Comparison with Manual Cleaning

Looking back at these costs, and comparing them with the average manual cleaning costs, 55/67 Kr./hectare=£1 10s./£1 17s. per acre, it is clearly seen that spraying does not appear to be a practical solution owing to the prohibitive cost. One can afford to cut over an area 5 times manually for the equivalent spraying cost, by which time, in many cases, the young plants are out of danger.

However onc must bear in mind the slow rate of conifer growth, also the fact that the chemical kills the tree once and for all.

As will be noted from the costs the amount of scrub growth is negligible compared to what we are used to having to encounter in Southern England.

Pre-Thinning

This is only done for firewood in a stand where no "plant thinning" has been done. There is no profit in a pre-thinning as there is no market for these small-dimension poles.

Thinning

Usually carried out in stands 30 to 100 years old, the thinning cycle varies from 5 to 15 years depending on the rate of growth.

Types of Thinning:

(1) Low Thinning.

(2) Crown Thinning.

(3) Free Thinning. This latter is a combination of Low and Crown thinning, aiming to keep about "10 to 20 years ahead of nature".

Low thinning is the most common in use, possibly the only type used by private owners. Thinnings generally are of a moderately heavy grade.

Conditions to Bear in Mind when Thinning

(1) Site Quality Class. A good quality class site can carry more trees per hectare.

(2) Age and height.

(3) Cycle.

(4) Rotation—In South and Central Sweden the rotation for spruce is 80 to 90 years, for Scots pine 100 years.
In North Sweden the rotation is from 120 to 150 years.

(5) *Mixture of Species:* Spruce and pine with their different rooting levels lend themselves to mixture on good soils. Maximum volume production can be attained.
On an average soil, take out the spruce after 80 years for pulpwood and let the pine grow on to bigger dimensions—100 years.
On a good soil spruce and pine can be cut together at 90 years.
On a poor soil pine will predominate in any case.

(6) *Owners Policy and Requirements influence thinning and rotation.*

Visits to Various Stands to Compare Thinnings

First Visit

Pine 30 years old. Patch sown originally and neglected. The owner had taken a very light thinning-out for firewood recently.

The stand can easily be imagined and care must be taken to thin annually, gradually reducing the stocking and making the remaining trees strong enough to resist snow-break and windblow.

Second Visit

By complete contrast a magnificent 30 year old stand of spruce. Quality Class 7½ m^3.

One thinning, a moderately heavy low thinning, had just been completed and rackways for extraction had been cut.

I was greatly impressed by the form, straightness and fine branching of these trees. It was quite the best stand I have seen in Sweden or anywhere else.

The site was a good one and had been ploughed prior to planting, the furrows being still visible. The plants had been planted in the bottom of the furrow.

Third Visit

Finally a good stand of 60-year-old pine was visited growing on a 7½ m^3 quality class site.

Number of stems per hectare: 740 =296 per acre.
Mean height: 20 metres =67 feet.
Volume per hectare: 275 m^3 =3,000 hoppus feet per acre.
Total yield to date: 460 m^3/hectare=5,060 hoppus feet per acre.

The "interest %" was computed over the last 14 years, since the last thinning, and proved to be 3.1%.

N.B. Under Swedish Forest Law, woods over "3% interest" may be thinned but not felled.

$$\textit{Interest:} = \text{Current Annual Increment } \% + \left(\frac{\text{current basal area } \%}{2}\right) + \text{financial } \%$$

Final Cutting

Final felling should be applied when it is more profitable to harvest than to leave the stand. This occurs when the stand no longer yields a reasonable return on the value of the timber and the site.

Seed trees are usually left, but many estates still do a complete clear felling. Natural regeneration may come in from the sides and the stocking is completed by patch sowing or planting.

In limited areas of Southern Sweden a Selection system is used; thus the soil is not exposed at any time.

Much of the felling is done by power saw. Bushman saws do most of the converting in the wood. Dimensions of timber are not large.

Produce

Very good prices can be obtained for good larger dimension pine timber for veneers, timber and telephone poles.

Spruce is used mostly for pulpwood and some sawn timber. There are two qualities of pulpwood: Prime and Second. Prime is cut into 2 to 3 metre lengths not below 3 in diameter.

Pitwood is cut into feet units. There is a slightly higher price paid for pitwood than for pulpwood but the demand is not so regular.

At the turn of the century sawn goods dominated Sweden's forest produce, but the development has subsequently shown a steady decline for these products, whereas the quantity of pulp and paper products has increased sharply.

Management Plans

The two main divisions of the Plan are:

1. *Measurement.* 2. *Advice for management.*

(A) *Begin with a Map of the Area showing:—*

1. Felling areas (less than 3/10 area carrying tree growth).
2. "Plant Thinning" woods.
3. Woods in the thinning stage.
4. Woods with too low a rate of growing interest (3% is the minimum—fellings only to take place when less than 3%).

(B) *Divide into Compartments:—*

1. Area of each.
2. Growing stock.
3. Soil Quality Class.
4. Composition of Species expressed by volume (pine, spruce and broadleaves).
5. Age class.
6. Density of stocking.
7. Remarks.

Example of Compartment Record Compiled During a Field Exercise

Compt. No.	*Area*				*Growing Stock*		*Soil Class*	*Composit of Species By Vol. (Spruce, Pine, Birch)*	*Age*		*Density*	*Remarks*
	Wood		*Pasture*		*Per HA.*	*Per Cpt.*			*Year*	*Class*		
	ha.	*a.*	*ha.*	*a.*	m³	m³						
1	3.	50	—	—	120	420	5.4	6.3.1	64	IV	1.0	—
2	0.	70	—	—	230	161	6.1	7.3.0	80	IV	0.7	—
3	5.	0	—	—	—	—	5.5	9.1.0	20	I	0.6	Some patches require plant thinning
4	2.	50	—	—	—	—	6.0	5.5.0	5	I	0.9	Some cleaning will be necessary in the next five years

Swedish Forest Law (Summary)

1. Woods to be managed with a satisfactory economic profit.
2. Any area not used for agriculture or other useful purpose must be productive woodland.
3. There must be a provincial Forestry Board in every province.
4. A Government Forestry Board overriding in Stockholm.
5. Any wood with a growing interest of over 3% may be thinned but not felled. Thinnings to be subject to the approval of the Provincial Forestry Board forester.
6. If all an owner's woods are old woods (less than 3% interest) cutting must be distributed, otherwise an owner could cut all his woods and sell his farm.
7. If an owner ignores the forest law, e.g., by overcutting, he is admonished and must sign an undertaking with the Provincial Forestry Board, stating that such a thing will not occur again. Then he cannot thin, unless under the supervision of the Provincial Forestry board forester, for a period of 5 years.
8. If he persists in bad silvicultural practice or refuses to sign the undertaking, then he is forced to abandon all cutting and is liable to a fine. The Provincial Forestry Board gets the timber. This, however, is a very extreme measure.
9. Woods must be regenerated naturally or otherwise within 5 years after cutting,
10. In cases of woods destroyed by wind or fire, the owner must replant and receives a grant from the State.
11. The owner is obliged to improve his woods to the satisfaction of the local Forestry Board.
12. If the standing timber does not realise sufficient capital for replanting, grants are available from the State up to a 40% maximum.

13. Permission must be sought to convert woodland to agricultural land.
14. Owners obliged to report to provincial forestry boards any excessive fungi and insect population.

Visit to Estate where Owner had been Admonished for Overcutting

Only the best trees had been taken out of a 60-year-old Spruce plantation. Large groups had been cut out in many places leaving only inferior stems.

Discussion on Future Treatment

It was generally agreed to shorten the rotation and clear cut in blocks, then replant each block in turn. All the best trees had gone but some of the remaining trees were suitable for pulp.

A spruce log was inspected which had been left unpeeled. On inspection the characteristic star-shaped galleries of the spruce bark borer were everywhere to be seen under the bark. A few specimens were seen showing the six teeth, three to each wing. All produce must be peeled—spraying is being tried but is as yet too costly.

Officially this was the end of the course. Some interesting Swedish Forestry films were shown to us every evening.

I wish to record my sincere thanks to the Swedish Authorities and in particular to Forest Officer Ake Ahlstrom for his untiring efforts in interpreting and making the course interesting for us. Thanks to him, we two Englishmen who attended the course, were able to participate fully in all discussions and exercises.

Mr. Ahlstrom kindly gave up a week of his leave to take us all over north-central Sweden the week after the course finished, when many interesting aspects of Swedish Forestry were seen. These included a visit to a pulp mill and wall-board mill. Before we left Sweden we were lucky enough to see an elk at close quarters.

Visit to Pulp Mill

Sulphite process. The factory was expanding rapidly, thanks to the great boom and swing towards pulp and paper products.

A section of the mill was pulping birch by the semi-chemical process.

Pulpwood was stacked in huge stacks of 130 m^3.

A very useful barking machine (Swedish) was seen, costing 56,000 Krns. (£3,850) and capable of peeling 2 metres in 4 seconds, fed by an endless belt. Waste and peeled product are carried away on separate conveyors. Sprockets set at angles revolving on an axis, do the actual peeling.

A smaller transportable model is now being used to a certain extent in some Swedish woods.

Finally the "Katrinite" works were visited, with different wallboard and hardboard products.

REPORT ON THE F.A.O.-E.C.E.-I.L.O.* INTERNATIONAL TRAINING COURSE ON MECHANISED FOREST OPERATIONS, HELD IN SWEDEN, 28th SEPTEMBER TO 17th OCTOBER, 1959

By R. E. CROWTHER
District Officer, Work Study Branch

1. General Description of Course

The course was organised and run by Professor Sundberg of the Forest Research Institute assisted by lecturers in various specialised subjects drawn from the Swedish Forest Service, the Forest Companies and other organisations. A series of lectures on logging in Canada and extraction in Norway were the two non-Swedish contributions.

The lectures took place at Farna, a forest village 125 miles west of Stockholm, where the Forest Service own an 18th Century manor house which has recently been renovated and equipped as a training centre for courses on forestry subjects.

Two periods of lectures lasting a week were spent there, interspersed with local excursions to see various demonstrations of mechanical equipment, and two longer excursions of several days each when wider aspects of Swedish Forestry were seen.

Those attending the course were from most European countries including Poland and U.S.S.R. The main language was English with simultaneous interpretation into French and German.

2. Summary of Introductory Lectures

Professor Streyffert, Dean of the Royal School of Forestry, gave an introductory lecture which summarised the position of Forestry in Sweden. The total area of Sweden is 109 million acres, 11 million is agricultural land, 57 million productive forest and the remainder lake, mountain, rock and bog. This is estimated to have an annual increment of 1,900 million H. ft. (ranging from 14 H. ft./acre in the north to 55 H. ft. in the south). In recent years the annual cut has been about 1,000 million H. ft., considerably less than the annual increment. (The annual cut in Great Britain is 56 million H. ft., about 6% of the Swedish total). About half the total cut comes from thinnings.

Forest ownership in Sweden is 50% Estates and small properties, 25% State and 25% Company.

Introductory lectures by officers of the E.C.E. and I.L.O. emphasised that mechanisation of forest operations has lagged behind other industries and that the status, pay and conditions of agricultural workers to whom forest workers are linked was lower than in industry. It is hoped, by this course, which is 5th in a series sponsored by E.C.E./I.L.O., to help remedy this situation.

E. W. Höijer, Director-General of the Swedish Forest Service, emphasised that the trend in the last 10 years has been away from the seasonal employment in the forest, with its dependance on agriculture, towards full-time permanent employment. A steady changeover from the isolated small holdings in the forest to modern houses in forest villages is taking place.

* F.A.O. = Food and Agriculture Organisation of the United Nations.
E.C.E. = Economic Commission for Europe.
I.L.O. = International Labour Office.

He quoted two examples of rapid development in mechanisation in Swedish forestry. Firstly the mechanisation of road transport which has broken the monopoly held by floating, and secondly the fact that 80% of the workers in large-scale forestry are equipped with power saws. A pattern of ownership is emerging in which the large enterprise owns the larger machine, where either considerable financial risk is involved because of development work, or because they need to keep abreast of current costs and techniques if the machines are standard ones, e.g. lorries. Forest workers own the power saws, though some financial assistance in the form of loans may be given.

F. Johansson, Director in chief of the Forest Service, dealt with mechanisation on the small forests' enterprises. As these make up 50% of the total forest area they are of equal importance to larger enterprises of State and Companies. Mechanisation is complicated by comparatively small scale of the operations which makes the spread of the cost of expensive machinery and the training of operators difficult. Introduction of new methods is not easy but much is being done by providing training courses for small woodland owners and their sons.

3. PROFESSOR SUNBERG, Work Technology Department, Forest Research Institute, Stockholm

(a) **Macro-factors in logging**

The influence of area, volume and distance on costs. As an illustration the effect of altering any one of these factors in the supply of pulpwood to a mill was discussed. If a mill wishes to double its output it will require double the quantity of raw material and this will have to be drawn from double the area. This will increase the haulage distance (and cost) by 40%. Conversely an increase in yield of 100% and from an area serving a mill will reduce haulage distances to 70% if the output remains constant.

The effect of tree size on costs was discussed.

(b) **Technical review of barking machines**

The reasons for barking are:—

(1) Requirements of consumer.
(2) Restriction of insect damage.
(3) Assist in floating (by promoting seasoning).
(4) Reduce transport costs by reducing volume and weight.

Types of machine can be classified:—

(1) Knife peelers which depend on cutting action to remove bark.
(2) Cambium shearing by blunt-edged knives or chains, etc.
(3) Drum or trough peelers which depend on the rubbing effect of poles against one another. Poles have to be either stored in water for several weeks or steam-treated beforehand.

Knife peelers are not favoured in Sweden because of the loss of wood they cause. The Cambio which has a Cambium shearing principle is much favoured as a mobile tool and the trough or drum type peelers are common at the mills.

Worked examples of cost comparisions between various peeling methods at different locations and their effects on haulage costs were discussed.

(c) **Costing of machines**

A system of costing was illustrated by a worked example of a lorry. This is similar to calculations used to derive P.V.M. charges except that interest charges on the capital invested in the vehicle and its scrap value are taken into account.

(d) **Transport—cost comparisons**

The following classification of costs was given:—

(A) *Direct transport costs*

(1) Distance cost.

(2) Terminal cost (i.e. loading and unloading).

(B) *Indirect transport costs*

(1) Roads.

(2) Terminal installation.

(C) *Overheads*

This breakdown of costs simplifies problems of transport cost calculation.

Worked examples illustrating how calculations can be made comparing different transport methods and deciding on the best one for certain conditions were given. One example illustrated the method of determining the distance above which it paid to transport men and horses from a village to their work; this is very similar to labour transport problems in this country.

(e) **Road Spacing**

Considerable time was devoted to this subject both in lectures and on the tour. The optimum road density depends on the following factors:—

(1) Yield per acre.

(2) Cost of extraction from stump to road.

(3) Cost of road construction and maintenance.

(4) Interest charges on capital.

A formula can be derived that takes these factors into account, and using the best available figures for a particular forest the optimum road spacing can be obtained. Some modifications to take into account detailed topography are necessary, e.g., obstacles such as rivers, lakes and cliffs which make extraction from both sides of a road impossible. Some of the figures used may be rough estimates only, but Professor Sunberg maintains that it is better to make some calculation than none at all, and that as more detailed figures become available, or as costs of road construction alter, fresh calculations can be made.

Several of the large forest-owning Companies in Sweden have planned their road construction programmes on this basis; we visited one, the Hellefors Company near Filipstad.

4. PROFESSOR SAMSET, Forest Research Institute, Vollebek, Norway

A technical review of tractors, winches and skidding

Much of the work that Professor Samset described was concerned with the effective use of mechanisation for extraction operations on a small scale. He dealt with the characteristics of the ordinary wheeled tractor used on farms and the work done in fitting them with tracks over their rubber wheels to give them good performance on snow (tracks of this type fitted to Ferguson tractors took Hillary to the South Pole). The behaviour of wheeled tractors when pulling a loaded trailer and the reasons for the tendency to overturn on certain combinations of slope, speed and turning circle were dealt with. He criticised the four-wheeled tractor saying that its effectiveness for forest work would be greatly improved if the power of the hydraulic pump was increased and the power take-off had a variable speed.

The work on winches, simple cableways and skidding was described and the skidding equipment demonstrated. The two drum Isachson winch fitted to a Ferguson or Nuffield tractor gave a most impressive demonstration of skidding; detailed costing based on time studies carried out by the Vollebek Institute were made available to the course. The maximum extraction distance is limited to about 100 yards on the Isachson, which is the equipment with the tallest tower and fastest winch. This is found to be fully adequate under Norwegian conditions where the tractor is pulling to a snow road or track. The tractor can skid and load in one movement, and by leaving the cables on the ground take the trailer load to the hard road. Part of the demonstration took place in a thinning where poles had been hand-extracted to rack; this was a successful demonstration though Professor Samset emphasised that the equipment had not been as extensively tested in thinnings as on clear cutting.

The Norwegian Forest Research Institute has spent a great deal of time developing these winches and extraction methods over the past 5 years, with considerable success. The equipment is versatile; it is quickly set up, and the two-drum winch enables the rope to be winched out instead of pulled by hand, which is the main snag with all single-drum winches. This type of equipment is far in advance of anything in use in this country and because of its versatility should provide an answer to one or more of the extraction problems here. The purchase of one set of Isachson equipment for trial is already in hand.

A light cableway system was described but not demonstrated and though the equipment is simple to erect and operate it has only been used on clear fellings. It is unlikely that any normal thinning will produce enough volume per acre to make it an economic proposition.

5. FOLKE RYBRO, Swedish Forest Service

(a) Cost control and accounting system for mechanical and motorised equipment as carried out by the Swedish Forest Service

The forest service, which owns 10 million acres of forest, is organised into 10 conservancies each with 8 to 14 districts. The organisation is decentralised and each district officer has control over his own mechanical equipment. This means effective deployment to deal with emergencies such as severe snowfalls but has the disadvantage that full utilisation within a district is not always possible. With responsibility in many fields the district officer cannot be a specialist and for this reason the Forest Service has special sections whose function is it to keep abreast of new developments and encourage their introduction into the service. There are sections on silviculture, roadwork, felling and transport. These sections all consult the Job Technique Section.

With the increase of mechanisation, the sections have been more and more involved with this aspect and with costing.

Every costing system must be a compromise between what it is desirable to know and what data it is practical to collect. The essential points are to provide:

(1) Data for annual accounts.

(2) Records for taxation purposes.

(3) Basis for comparison with hired machines, contract work and choice between machines.

(4) Data on which to base decisions on machine replacement.

(5) The basis for calculating the economic outcome of mechanised operations.

The Forest Service use a system similar to our P.V.M. accounts which produces standard operating costs per mile or per hour. These are national standards which give a very limited indication of the economy of mechanised operations.

By more detailed examination of operating costs and utilisation per year it has been found that the greater the utilisation the less the operating costs are, per hour.

Estimates of annual depreciation depend on the life of the machine which in turn is dependent on the utilisation and obsolescence. The use of an annual depreciation of 20% is too crude a method to apply to all machines, but data on the limited numbers of machines in the Forest Service are not adequate to give more detailed figures. Estimates of economic life have therefore been made using data from agricultural tractors.

Figures of operating costs are compiled for different machines showing how these decrease with increased utilisation, and these are circulated throughout the service.

Comparisions between different methods are made and here the effect of the new method on other operations has to be taken into account. An example is the Cambio peeler whose high capacity means material must be concentrated in one place, and extra transport costs arise. These can only be determined by study of the job; they do not show themselves in accounts.

Comments were made on the value of international comparisions of machine costs and the difficulties in making them.

(b) **The Cambio Debarker**

This machine, which was introduced into the Swedish Forest Service in 1956, has successfully reduced the cost of peeling compared with hand peeling; now 30 machines are responsible for 25% of the total peeling done by the service. The operating cost of the machine is about 32/- per hour, with an output of 1,500 H. ft. per day of 6 hours. Taking into account the extra costs of haulage and handling involved, and the reduction in labour overheads (holidays, sick pay, etc.) which follow from using fewer men, the saving over hand peeling, is about 1d. per H. ft. The interesting feature of this piece of mechanisation is that early work with the first machine was not cheaper than hand peeling because of inexperienced operators, lost time due to inadequate preparation of working sites, and teething troubles with the machine. Only when these three matters were remedied did economies become a reality. The output of the machine is so large (at least 250,000 H. ft. a year is required for efficient operation) that employment of a mobile unit on a tractor is out of the question in this country, but use at mills is feasible (Sudbrook uses Cambio peelers).

6. DR. R. ERIKSSON, Royal Board of Roads and Waterways
Estimates of Economic Service Life

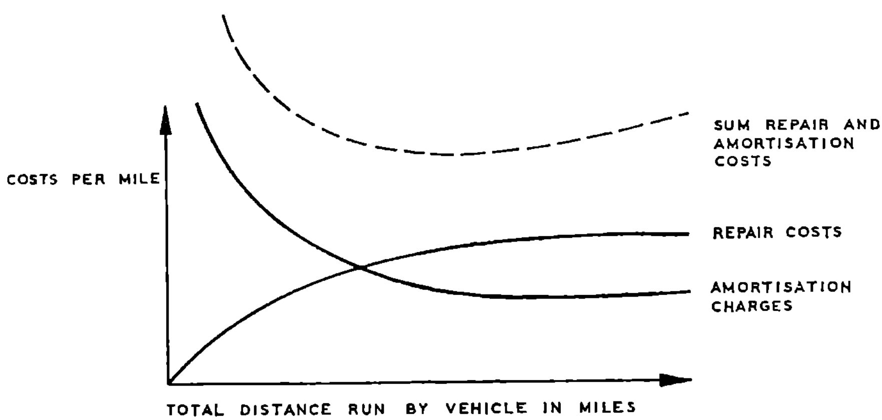

Fig. 11. Diagram showing relationships between, distance run by a vehicle, costs and charges and costs per mile.

The size of the transport undertaking and organisation of maintenance and repair of vehicles was described.

Decision on major overhauls and replacement is based on inspection and history recorded on logs, and not on arbitrary distances run or time elapsed. Calculations of repair costs per kilometre run, and amortisation of the purchase price, are used to derive a minimum cost per kilometre at which the vehicle would be disposed of. (See Figure 11).

The lower end of the combined curve is flattened, implying that the maximum economic mileage is not critical, and little difference is made by running the vehicle an extra 5,000 miles if this means a more favourable sale or there are delays over replacement. Technical improvements in new vehicles tend to shorten life of vehicles already in service.

7. PROFESSOR PAVLSSON-FRENCKNER, School of Economics, Stockholm

Engineering Economics

The application of economic theory to problems of introduction and replacement of machinery were outlined. The speaker deliberately used examples from industries other than forestry to avoid digressions on technical details. His contention that calculations taking into account compound interest charges should be made when deciding on replacement of major items of equipment appear valid, and logically should be applied to other major spheres of forest investment, e.g. establishment of plantations, road construction, housing and other building. He admitted that his calculations could not cover imponderables such as amenity, social or defence considerations, and that much lower interest rates are probably more applicable to state investment than to private enterprise.

8. B. HEDEGÅRD, Development Engineer on Mechanisation, St. Kopparberg Corporation

Lorries and loading equipment

Mr. Hedegård dealt with lorries and loading equipment in a series of three lectures which were illustrated by practical demonstrations of the various types. He summarised the three main requirements of economical lorry transport as:—

(1) Quick and cheap terminal handling.

(2) Large load capacity of lorry.

(3) High transport speed.

(1) Terminal handling

Mechanisation of loading bulky timber scattered over wide areas can be tackled in two ways; either by lorry-borne loading devices such as the H.I.A.B. hoist, or by separate loading equipment such as cranes. Lorry-borne units have the advantage that loading can take place independently of outside help, but they are slow and with small, light material show no saving in costs over hand-loading. For long journeys, too, the reduction in load capacity (5 to 10%) can be a serious drawback. The separate loading device can load the lorry quickly, but requires large quantities and several lorries working from one place to be efficiently employed. Mr. Hedegård thinks that the new H.I.A.B. Elefant, with its hydraulically-operated grabs fitted to a large lorry and trailer unit, is a most promising development that will probably replace the smaller lorry-borne loading devices in Sweden in the next few years.

The use of semi-trailers loaded by a crane or tractor-mounted grab is a promising method where large quantities are available in one place. Unloading, at any rate in Sweden, is not a serious problem where much of the timber is dropped straight off the lorries into water. Unloading cranes, though efficient on individual lorries, can cause expensive lorry delay time at peak periods. (A serious fault at both Annan and Sudbrook).

(2) Large load capacity

Load capacity is limited by several factors such as maximum axle weight the roads can carry, maximum lorry height and width and regulations governing length.

Designers of lorries used for timber transport from the forest are at a disadvantage because the bulk of the load makes length of the vehicle important. To obtain this on rough roads the chassis has to be stronger and heavier than normal, with the result that pay-load is smaller in proportion to the unladen weight than with lorries used for normal road transport.

(3) A high transport speed

On gradients, speed is limited by the capacity of the engine, which in turn is limited by engine weight and its adverse effect on pay-load. Maximum speed is usually limited by legislation; it is 40 m.p.h. for a large lorry and trailer in Sweden.

9. A. BURENIUS, Forest Officer, Swedish Work Study Organisation

This paper covered the performance and costing of power saws and their use in Swedish forestry. Although 80% of the fellers in Sweden now use their own power saws, savings in costs are not as great as might be inferred from this figure. In smaller sizes the power saw may be more expensive than hand work. Nevertheless the saving in manpower is important because the forest labour force is declining, and overheads in the form of transport and housing are rising. From the man's point of view the power saw undoubtedly saves energy on an arduous section of his work, which may enable him to increase his earnings by working harder on the remainder. Such savings are very difficult to assess. This paper gives detailed graphs and figures which make an excellent basis of comparison for work study on power saws in this country.

It is convenient to include here observations on power saws obtained at other times in the course. Some evidence of partial deafness caused by power saws is coming to light in Sweden, and there seems to be little doubt that the majority of power saws are inadequately silenced. Power saws should not be used continuously for long periods by one man for this reason, and Burenius quotes 2½ hours per day as the average time in use in Sweden. Dr. Lundgren suggested that ear plugs would reduce the effect of noise, but that the best remedy would be a quieter saw. One saw demonstrated was silenced to some extent; it is made by Husquarna who have not made power saws before, so this model must be regarded as a prototype. Canadian as well as Swedish experience emphasises that power saws do not operate satisfactorily when supplied by the employer, and the most satisfactory method is for the worker to provide his own, do his own maintenance, and for the manufacturer's agents to provide servicing and spares.

Power saws are developing rapidly and there is fierce competition between manufacturers. Reliability, good spares facilities and cheapness would appear to be the important factors in choosing a power saw, rather than extra fast cutting which may have been achieved at the expense of these.

10. L. BERGSTROM, Industrial Psychologist, Institute of Applied Psychology, Saltsjobaden

Industrial psychology in forest work

Mr. Bergstrom has had considerable experience in applying industrial psychology techniques to forest work, to both men and supervisors. The reason for including a series of talks on this subject in a course on mechanisation is that the introduction of new methods may bring about difficulties at the human relations level, which may reduce the effectiveness of the new method or make it impossible to operate. Amongst older workers (and supervisors!) this may be due to a feeling of being superseded and having one's skill and abilities, developed over a long period, thrust on one side. The remedy, to give the older man a feeling of participation in the new method, is not easy to apply.

An example in the use of psychological testing in selection of potential foremen from forest workers was given. In this case the potential foremen were to be given an expensive training course, so it was essential to avoid selecting and training men who were unlikely to reach the required standard. Candidates were selected by orthodox means (supervisors' reports and interviews) and by psychological tests. The orthodox selection included 8 men which the tests revealed would be unlikely to pass the course. These were allowed to take the course but in spite of assistance from their fellows were unable to make the grade. In this instance the saving in cost of training of these 8 men would have more than covered the cost of testing all the potential candidates.

He touched on the problem of the correct use of junior supervision quoting the example of the senior Forester who treated his subordinates like "errand boys". This method had worked with men promoted from forest worker without training, but was very wasteful of the training and abilities of the younger Assistant Foresters, and led to much friction and frustration. He claimed that a course for such senior Foresters could show them the virtues of delegating responsibility to their subordinates and how to do it.

The institute had carried out a factor analysis between the reports on 140 supervisors assessing their abilities in leadership, mechanical ability, fluency of expression, etc., with characteristics in their handwriting such as pressure, size and rapidity. They obtained a high correlation between certain handwriting characteristics and leadership abilities, that suggests that analysis of handwriting can be used to supplement the usual form of psychological test which does not reveal leadership capabilities.

His view that Work Study personnel required very careful selection and should be highly paid was interesting!

11. DR. LUNDGREN, Institute of Industrial Physiology, Stockholm

The salient features of Dr. Lundgren's lectures were:—

(1) The relationship between oxygen intake and work done is a straight line one, and for an individual worker the oxygen intake is proportional to the pulse rate. By measuring pulse beats of a man doing a measurable amount of work on a bicycle ergonometer it is possible to calibrate pulse rates against work effort. Then by measuring pulse beats of the man on various jobs in the forest an objective assessment of the man's effort is obtained.

(2) Taking pulse measurements of a group of fellers, at regular intervals over a year when they were doing a constant amount of work per minute, on an ergonometer, gave the results shown in Figure 12.

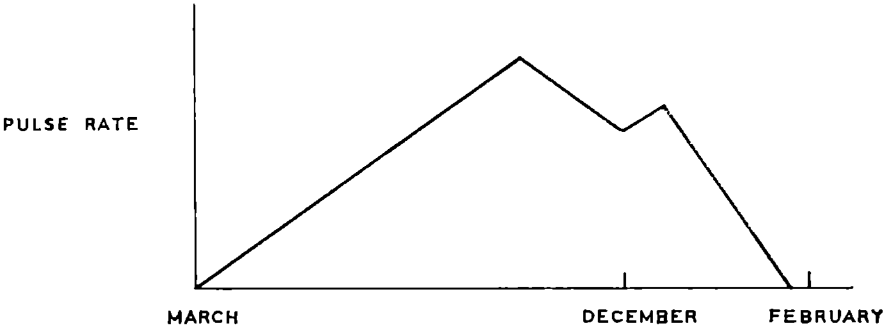

Fig. 12. Seasonal Variation of Pulse rates of forest workers.

This indicates that at the end of the felling season in March the men were fully fit for the job, but that at the beginning of the felling season in October they were far less fit after spending the summer on lighter work than felling. Two men who were keen amateur athletes reached their fitness at a much earlier date than the others. This evidence supports the view that physical training is beneficial to those engaged on heavy work.

(3) He said that there was strong evidence to suggest that heavy work, particularly heavy lifting, was not the cause of back troubles but that a man on heavy work would be prevented from working by a back ailment which would not handicap a man on lighter work.

12. S. I. SJOSTEDT, Swedish Forest Service

Training and accident prevention in mechanised forest operations

Accident prevention should not be regarded as a separate subject because several factors always contribute to accidents; not least of these is lack of adequate training where mechanised equipment is concerned.

Mechanical equipment has the advantage over hand tools in that accidents can be reduced by good design and shielding of moving parts. For example, recent legislation in Sweden prescribed that all new tractors must be fitted by the manufacturer with an adequate safety cab to protect the driver if the machine overturns.

Comparison of accident statistics prepared by I.L.O. and other bodies are of limited value as the basis of compilation is often different. Swedish figures for accidents related to productive working time are open to doubt because of the difficulty of recording the actual time worked by contract workers.

The effect of training is often difficult to assess, but the work on the Cambio peeler showed how increased output is obtained by thorough training of both operators and supervisors.

Training courses in power saw operation are extensively given in Sweden and yield dividends in reduced accidents and increased output.

13. C. R. SILVERSIDES, Woodlands Development Engineer, Abitibi Power Paper Company, Ltd., Canada

Logging in Eastern Canada

Mr. Silversides gave a comprehensive review of logging practice in Eastern Canada. Here the large areas of overmature virgin forest still dominate forestry practice and are likely to continue to do so for another forty years. Emphasis is on protection (fire and insect), building roads and clear felling. Cut-over areas regenerate naturally, and with extensive protection measures the future crops are assured. Intensive management is practised on a limited scale only on more accessible areas.

Pulpwood is the main product, and the traditional way of working this is to fell and cut into lengths at stump in the winter, extract by horse over snow roads to the nearest stream and float down to the mill with the spring thaw. The men live in camps and are employed for the season.

Industry is competing for labour and the trend is now to develop all-year-round permanent employment. This is leading to the development of new logging techniques capable of operation all the year round. Although 35,000 horses are employed annually in the forests, the numbers are declining rapidly as the supply of horses from farms decreases and new mechanical extraction devices are introduced.

The power saw is now used, practically 100%, by all fellers; they own their own saws, maintain them and service them. Earlier attempts by companies to provide saws ended in disaster as company-owned saws were not properly looked after by the operators.

In extraction equipment there is a strong movement away from steel tracks towards large rubber wheels with four-wheel drive. Although these machines are adopted to handle cords of wood already cut and stacked at stump, there is a trend to develop extraction of the whole tree, trim it and crosscut it by machine at roadside. Branches are removed by chain flails or by drawing the tree sharply through a steel ring.

The Americans have developed a tractor that operates a guillotine that will cut through a tree 18 inches in diameter in 3 seconds. It rips off branches, cuts to length and loads on to itself. When loaded it takes the bundle to haulage track and drops it to await a second machine for extraction to hard roads. Although still in the development stage, such machines may become a common feature of large-scale logging in the future.

14. A. LEIJONHUFURD, Director S.D.A., a Swedish Work Study Organisation

Research in mechanisation and operational efficiency in forestry as carried out in the Northern countries

A congress, attended by representatives of the Work Study organisations of Sweden, Norway, Finland and Denmark is held every four yesrs. This facilitates interchange of experience in an area which has many common problems.

Trends in development work in forestry are aimed at solving problems caused by the current changes in labour supply and the development of mechanisation. Forestry has been and still is to a large extent dependent on agriculture for supply of seasonal labour and horses. In order to compete with industry the trend is for permanent forest work to be provided, together with housing and transport to work. The reduction of horses on farms, and their replacement by tractors, has led to much work on the use of the farm tractor in the forest, particularly on winches and skidding methods and more efficient use of available horses.

Teamwork is becoming more important with the introduction of machines, and this is a direct contrast to the traditional one-man working methods in Sweden.

Mechanisation on the lines of whole-tree logging developments in Russia and America do not seem possible in Scandinavia with their scattered clear-fall areas and 50% yield from thinnings.

15. GRANINGEWERKEN LTD., Soleftea, Sweden

The use of punch card and system for basic time book record and pay and tax calculations

This was demonstrated on the visit to Graningewerken, Ltd., Solefteå, Sweden. The ganger measures each log produced and punches dimensions on to a card, together with details of the man and piecework price derived from the piecework tables. Cards are carried in a small box strapped to his chest and are punched on the spot. One card is made out for each log. These are sent into a central office where machines use them to calculate each man's pay (fortnightly), make the appropriate deductions for tax and insurances, and complete a postal draft for the appropriate amount. The data is then taken a stage further by the machine and used for accounting purposes, and for preparing details of stocks of timber of various sizes, species and specifications.

The system is used for about 400 fellers. The company also supplies electricity and the bills are made out by the same machine!

The system does appear to be worth investigating to see whether it could be adopted to Forestry Commission problems of time booking on the A6, pay calculation, preparation of progress reports and posting to account heads. Such a system could incorporate the control figures of % time spent on piecework, average earnings, and the cumulative wet time, as recommended by the Work Study Section.

Whether such a scheme would be practical could be best determined by consulting one of the manufacturers of business accounting machines. This particular scheme was installed by Powers Samas. The economies of it should be investigated carefully, but from a superficial view of what has been done in Graningewerken, Ltd., mechanisation of forest accounting seems to be technically possible and the potential saving in clerks' time at forest level and in Conservancy offices looks to be very large indeed.

16. MISCELLANEOUS

(a) Mechanical slashers

An engine of the power saw type drives an 8 inch circular saw blade on the end of a 4 ft. arm. The saw is supported by straps from the workers' shoulders and used to carry out cleaning of woody weed species from young plantations. One man with one of these machines can cut 2 to 3 times as much juniper and coppice birch from a young plantation as one man with a hand tool. Savings in costs of up to 50% are claimed. Worthwhile savings in manpower are achieved even where cost reduction is not significant.

(b) Remote controlled winches

This small-capacity single-drum winch, similar to the Hathaway, was dragging poles on a light skid-pan over very rough ground. The loader operated the winch by a small radio transmitter carried on his back. This is a new development and not used on any large scale yet in Sweden. The principle is a promising one as it can eliminate the need for a separate winch operator, but small single-drum winches of this type have a limited application and far more effective results will be obtainable when the radio control is adopted to operate the double-drum winches of the Isachson type.

Remote control by electric cable of lifting gear for loading tractor trailers was seen on two occasions. This enables one man to attach the hook to the load, operate the winch and simultaneously guide the load into position. Reduction of loading to one man may make savings but one-man loading, from the safety aspect, seems undesirable.

(c) **Water storage**

Something was seen of timber floating which is a cheap and effective method of transport of large quantities over long distances. Floating is never likely to be a serious method in this country, but the advantage of storing timber in special storage ponds should not be overlooked.

These are:—

(1) Cheap unloading; lorry fittings are made to release the whole load at once and drop it into the water. This is cheaper and quicker than any crane method.

(2) Timber stored fully submerged does not deteriorate.

(3) Timber that has been stored under water can be peeled cheaply and easily in a trough peeler, illustrated in Figure 13.

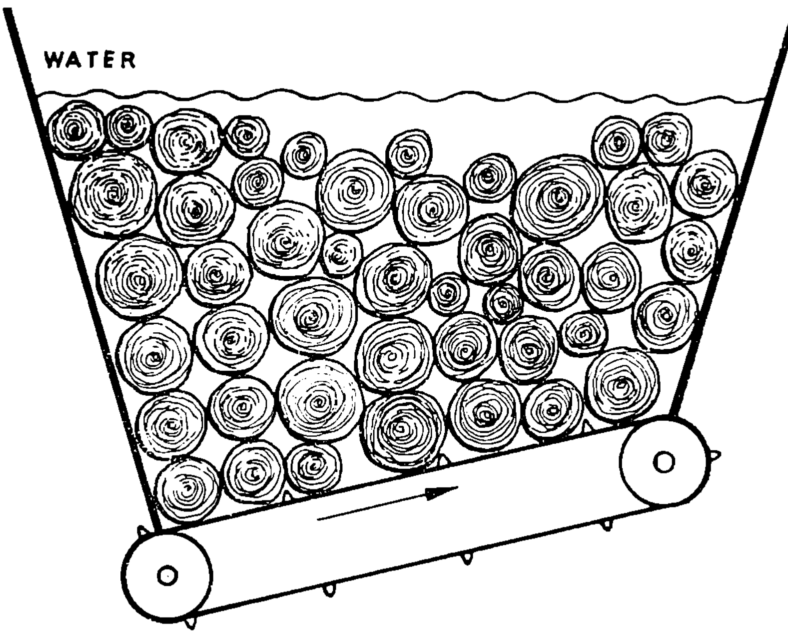

Fig. 13. Trough peeler for logs.

(d) **Charcoal**

Charcoal burning is still practiced in the traditional manner in a large stack covered with earth. Conifer charcoal, which has a lower percentage of phosphorus than hardwood, is still used for smelting special steels.

(e) **Horse extraction in Sweden**

The abandonment of many smallholdings in the forest and the replacement of farm horses by tractors is leading to reduction in the number of horses available for forest work. This factor is intensifying the search for mechanical replacements for the horse, and the Isachson winch system based on the farm tractor is the most promising of these.

To remedy the shortage of horses one company (Uddeholms) operate a horse breeding station which breeds and trains horses. Potential horsemen are given a four months training course. At the age of 2 to 3 years the young trained horse is sold to a horseman who works it on piecework for the company.

Financial asssitance in the form of a loan is available. Double horse boxes (made by Rice Hunt Trailers, England) are used, towed behind the workers' 12-seater bus.

Work on improving horse extraction has resulted in the design of a very effective small rubber-wheeled cart (the Fossingen, price £95) which is used in summer and is ideal on hard rocky surfaces with gentle to moderate slopes. It is designed to take lengths up to 12 ft. Where these conditions exist in this country this cart would be useful but I doubt very much whether it would be effective on soft ground or steep slopes.

The "V.S.A." combination sledge is designed to handle long or short billets on snow-covered or rocky ground, by simple additions to the basic sledge unit.

A sledge of this type has been tried on the soft going of the Border country, but the small wheels proved ineffective. A further difficulty was its tendency to capsize on turning corners, probably because tree-length poles were being extracted. Removal of the wheels and fitting a swivel bolster remedied these two faults.

17. CONCLUSIONS

This was an extremely comprehensive and well-run course. From the wealth of material it is possible to draw general conclusions. Mechanisation of forest operations as general practice is far from complete, and is in transitional stage progressing rapidly from partial mechanisation towards an ultimate goal (which may not be achievable) of complete mechanisation. Some of the developments on whole-tree logging that are taking place in Russia and America are indications of the extent that mechanisation is possible. Machines of this type are expensive and to be economic they must have a large output, hence their development on large clear falls in these countries. This question of size of operation is important, the larger, the easier it is to mechanise. For example the use of special lorry loading equipment, lorry fittings and unloading mechanism leads to great savings if large quantities of one product are being dealt with, but such equipment is wasted if the lorry is to be used for a variety of jobs.

Sweden reaps great benefits from the large scale of her timber industries, as the grouping of different mills together ensures effective use of all the products (e.g. chipwood mill using waste from a saw-mill, a paper-mill taking the pulp direct from a pulp-mill without an intermediate drying stage). The large scale of her floating operations leads to cheap long-distance transport and cheap handling. All these factors explain why Swedish timber and timber products can be exported to this country at prices that home-produced material finds difficult to compete with. The trend towards freer trade between European countries may accentuate this.

Felling and extraction, although on a large scale, takes place scattered over wide areas (50% of the yield comes from thinnings). Large machines are the exception, and the emphasis is on improvements in hand methods, the power saw, horse extraction and transport of men and horses from the new villages to their work. The development of winches on farm tractors is one that looks as if it will rapidly become a general practice.

18. RECOMMENDATIONS

Some of the subjects covered and methods used in Sweden prompt one to ask why do we not use them in Britain? The reasons for not employing a particular method are usually obvious after a little thought, but there are items which obviously should be tried and others which lie outside my experience might be worth looking at.

(1) The double-drum winches for farm tractors should be tested. The import of an Isachson winch is already in hand.

(2) The development of light steel tracks for farm tractors mounted on rubber wheels, although designed for snow conditions, is one that should be tried in this country.

(3) Great importance is being attached to road density calculations in Sweden, and although the technique is familiar to one or two people in the Forestry Commission, very little use of it is made in practice. Over £1,000,000 was spent in F.Y. 58 on roads, and it is possible the money could have been used more effectively by paying greater attention to road density calculations.

(4) There is no doubt that many failures with the introduction of mechanical equipment can be blamed on lack of adequate training of both workers and supervisors. Courses for forest workers in the use of power saws and power slashers are essential if these tools are to be effectively used.

(5) There appears to be a case for considering the application of a punch card system to Forestry Commission time-recording and pay calculations.

REPORT ON A GENERAL COURSE ON RATIONALISATION IN FORESTRY, AT ARNHEM IN HOLLAND

By I. TOULMIN-ROTHE

Forester, Work Study Branch

GENERAL IMPRESSIONS

I think it is important that I should observe at first, that a course run on exactly the same lines would not *necessarily* be a complete success in comparable circumstances in Britain. One must make allowances for differences in national temperament and personality, a different approach to learning, and dissimilarity in labour relations. We were two Englishmen (I hope my Welsh friend will forgive me), in a group of twenty students, only one other of whom was a foreign national. So that our behaviour and approach to the instruction may not have been quite typical of an average group of British students. Which brings me to a very important principle with which the instructors endeavoured to impress their pupils. To create the best atmosphere in which to conduct the course, they exhorted the students to mix together as much as possible, whichever part of the country (or the world), they came from, whether they were foresters, foremen, or labourers. The aim being to eliminate any insularity of thought which would impair the proper atmosphere for consideration and discussion of any problem.

Having meals together naturally made us feel much more at home with one another. And every lunch hour it was the practice for everyone to join in a game of what I believe is known in this country as "Volley-Ball", a game which not only gives healthy exercise, but also calls for good team-work. Our instructors were sincere in the belief of the importance of an active interest in things outside work, for men who are brought together in their work, thus giving each one a better understanding of the other.

The instruction was at all times aimed at a moderate level of intelligence, reasonably so, as these courses are essentially intended for forest workers. And yet the inference that a man of high intelligence would be wasting his time is not true, on the contrary, such a man would be able to benefit more from such a course than his intellectual inferior. The latter may not benefit from the theoretical instruction although the practical instruction cannot fail to be of value to anyone interested enough to attend. But the intelligent man has an opportunity to learn of commonsense theories and principles, a knowledge, which as far as I know, is not so cheaply and easily available in any form of forestry education in either Britain or Holland. Most of these are basically very simple and easily understandable, and yet perhaps unknown to many men of great experience, owing to a lack of fundamental education in the simple basic elements of any job.

The instigators of these courses feel that they have achieved, in Holland, a revolution in working techniques and methods, and although most of the changes have been essentially very simple ones, I am sure that this statement is true, by comparison with previous standards. Although the programme was astonishingly thorough and comprehensive, the instruction, whether theoretical or practical, was always conducted in a manner that appealed to one's rational judgment, every statement or demonstration was an invitation for debate or criticism, favourable or otherwise. Every working method, for example, was taught and demonstrated as being the result of considered experience, and not necessarily the right or the only way to do the job under comparable conditions. Such a method of teaching must always have much more impact than the "take it or leave it" style of education.

An enormous amount of time was spent in the instruction on tools and their maintenance, and the practical work done in the sharpening and care of tools. To anyone unfamiliar with any form of work study, this may seem quite unreasonable, but I think that it is in true proportion to its value to active operation. Whatever the job, one must know how, and have the tools with which to execute it. To *anyone* in the industry, the importance of these two factors cannot be over-stressed. To have one without the other, is quite useless. And to have the right tools one must know how to keep them in good working condition. For the practice of tool maintenance, there are some fields, for instance saw sharpening, which *may* be better done by the specialist, although this is a matter which must largely be decided by circumstances; but the *knowledge* at least should be common to all, and the best way to acquire this is by a combination of theoretical instruction and actual practice.

There were two practical instructors with the course full-time, who were able to instruct, assist, and demonstrate every single practical operation. Further, I would say that *all* members of the staff were proficient enough in all these skills to do likewise, though they were obviously not required to do so all the time. The demonstrations were done most thoroughly, with great attention to the detail of method and technique and were generally most impressive. My reservation implies a slight disappointment in some of the demonstrations, one in particular, was a most amusing example of how *not* to do a job. But on consideration, I am inclined to think that this is perhaps the way it should be. No man can be a master of every job, and in any case things always seem to go wrong in demonstrations! The *very* highly skilled demonstrator is apt to make a job look too easy, and on experimenting oneself, one is apt to feel that even a moderate skill could never be acquired. It is much more human to adopt the attitude of "If I can, *any* fool can do it". And the truth of this applies very much to most operations, the normal man can learn to do them skilfully, providing he has good tuition, keen interest and sufficient experience, and of the latter not so much as may at first be thought.

I was much impressed by the fact that the practical instructors were *themselves* very willing to learn. In the field of tool maintenance, in which I personally have some experience, I felt compelled to disagree on some minor points of theory and practice, and my instructors were most willing to try it my way, even though it was contrary to their normal practice and conception.

This is not a course I would suggest to anyone desiring a holiday abroad. I was very grateful to have the opportunity of attending. In my three weeks in Holland I was at times fascinated, always interested, and enjoyed every moment. I am not alone in thinking that it is perhaps too intensive, the staff themselves agree. But the fees for the school have to be paid often by private individuals, who obviously want their money's worth. And surprisingly, the great majority of the students remain keen and interested, though most days are long and the work sometimes exacting. A wonderful course, but you have got to work, and unless the individual is prepared to do this, at least within his capacity, it is not one that I would recommend without some reservation.

For the British students, the greatest snag was of course the language difficulty. We were the only two who could not speak Dutch fluently, and all the lectures were of course conducted in Dutch. Most of the instructors could speak passable English, but I am quite sure that *very* few of them could give their lectures in English even if this was practicable, and I am equally sure that, no one short of a trained linguist could interpret the whole lecture, and for various reasons it would be impracticable to employ the services of such a man.

Coming to the question of differences in conditions I was much surprised to find that there is great similarity. True, in Holland, the forests are completely flat, for the greater part; steep hill slopes are practically unknown, but the growing conditions are very like ours, and consequently methods of felling for instance could be very much the same. There must, in fact, be many areas in Britain, with forest conditions very similar to those commonly met with in Holland. Consequently, even some of the planting methods, for instance, now being advocated in Holland, may also be suitable for these areas.

One feature of the courses which impressed me very much was the method of delivering the lectures. Each lecturer, who had obviously well prepared himself beforehand, arrived with a file of paper headings, as well as stencilled notes which were later distributed. Instead of writing his headings on the blackboard in the conventional manner, he took the pieces of paper and placed them on a felt board to which they miraculously stuck. I do not remember the name of this system, but it is an extremely good one, as the strips act as notes for the lecturer and he may elaborate each point and the class may discuss it without causing him to break his concentration.

An important principle was maintained throughout all the instruction. The endeavour to see that everyone's point of view was considered. We were told not only what the worker should do in each different job but also what his forester or manager should also do to meet with his share of the work. The instructors tried to see each question from the worker's point of view, and endeavoured to balance it with that of his superiors.

DESCRIPTION OF THE COURSE

When all the students had been received, introduced and made to feel at home, the course began with an introductory lecture by the Principal, M. van Hattem. He first explained the "set up". This gentleman is an officer of the Netherlands Land Development Company, a private non-profit making organisation, whose researches led to the initiation of the courses. So also is his assistant M. van Der Bremen; and the two practical instructors, M. Schut and M. van Liaar, are both employed by this organisation. Many of the other lecturers also come from the N.L.D.C., while others come from Netherlands State Forest Service, Wageningen University, etc. The courses take place in Sowsbeek House, a building belonging to the N.L.D.C., and used for a technical school for aspirant foresters as well as for the courses. These latter are now conducted by an organisation sponsored by the Land Development Company State Forest Service, other public authorities, the three Forestry Trade Unions and by private companies and individuals.

The students attending the course came from all parts of the country, sent there by many different organisations and individuals. Included in the class of twenty were forest workers, students doing practical training, foremen, a member of a Mission Brotherhood, a member of the staff of the N.L.D.C., and two British, both from the Forestry Commission. The students were accommodated in various boarding-houses throughout the town, and had come from home with working clothes and a bicycle.

M. van Hattem went on to give a short history of time and study work in America, its initiation in Holland, application to Forestry, and explained that it was due to the research done in this field that the necessity for education for forest workers became apparent, and after many years work, has resulted in courses like this one, apart from research in other forms of work rationalisation. He explained that the reason for rationalisation was to make work cheaper and more efficient, resulting in better and cheaper goods. The means to achieve this end being:—

(1) Easier working techniques.

(2) By use of good tools.

(3) Good working methods.

(4) Mechanisation, wherever such is possible, practicable and economical.

(5) Proper level of Wage Payment, whereby workers are paid in proportion to the work done.

(6) Good labour relations and working conditions.

(7) Good instruction.

In the afternoon we were introduced to the workshops. The saw maintenance room where every man had a drawer in which was kept all the equipment needed for saw-sharpening, and the workshop where there was one locker for every two men, containing all the tools required for felling work and scrub clearing. In this shop there were also electric grindstones, and all the equipment necessary for sharpening and maintaining tools, wood working equipment, etc. Both these shops were extremely well lit and heated, with everything kept in first-class condition.

Lecture on sharpening of peg-tooth cross-cut saws

This was given by illustrating with a simultaneous demonstration, the only effective way to teach saw sharpening. As in all subsequent lessons in saw sharpening, the working method of the saw was explained, and then the class was taught the way to sharpen step by step, great attention being given to detail. Although this saw is largely out-of-date, the tooth type is used on other saws such as bow-saw blades.

Note. The standard of instruction on saw sharpening was throughout very high, especially as the practical instructors were not specialists in this one field. But they had received instruction in this subject, which I felt was a little inferior to that received by our own tool specialists in

Britain. However, I am sure that only an expert would be aware of the fine differences in principle and technique which were apparent to me.

This lecture was later followed by a German film illustrating the method of sharpening the peg-tooth saw.

WORKING PHYSIOLOGY

The human frame as a source of energy

This lecture was given on the first evening by M. van Hattem. It was extremely interesting indeed, dealing with the functions of the human body, calorific reserves and the proportion of these which may be properly spent in a day's work. The research work on energy consumption by use of respiratory and cardiographic devices was described. This work has produced amongst other things the following list of *Don'ts* for physical labour:—

(1) Don't work STOOPING, if avoidable.
(2) AVOID STATIC MUSCULAR WORK—Work where the muscles are trained in a static position.
(3) No heavy work with TIGHT MUSCLES.
(4) Don't work with TOO HIGH A TEMPO.
(5) Don't take INSUFFICIENT REST.
(6) Don't work with UNDERTRAINED MUSCLES.

I found this lecture quite fascinating. It was well illustrated with diagrams and finally by colour slides.

Lecture on Peeling Spades, their Use and Maintenance

This lecture was given by M. Spaarkogel, an officer of the Netherlands State Forest Service, who specialises in Rationalisation and took part in almost every activity throughout the course. He began by stressing the importance of peeling by illustrating that peeling in the forest is not only heavy work but takes from 30 to 40% of the total time for sawing, snedding and peeling. Hand peeling work can be improved by:—

(1) Using the right kind of spade.
(2) Using a very sharp spade with a good method of keeping it so.
(3) Learning a good peeling technique.
(4) Using a good working method, learning to use the spade both right and left handed to give muscles a change.
(5) Always peeling the wood fresh, particularly in the case of softwoods.

We were then shown various types of peeling spades of German, Swedish and other origins, and discussed their respective merits. And finally the principles for the correct sharpening of the peeling spade were explained and demonstrated.

Practical Work on Sharpening of Edge Tools

Throughout the course considerable time was devoted to this subject. Basically the same techniques may be applied to the sharpening of all edge tools, though the application differs slightly for each particular type of tool. The instruction given was extremely thorough and all the students learned a great deal. This is not always as simple as might be imagined; most forest workers are experienced in the use of axes, peelers, etc., and from constant practice of very simple techniques often imagine that they know all there is to learn on the subject. An interesting feature was the use of a pocket miscroscope to illustrate the effect of different sharpening media, e.g., examination of the metal surface of the edge to show the vast difference between a "Ground" edge and one that had been subsequently "Honed".

During these periods of practical instruction on tool maintenance, the course was split into two groups so that for every ten men there was a least one instructor, often two, to demonstrate with thorough explanation, and subsequently assist each man in achieving the desired result in the best manner.

Added to the work done in this field was the making of protective covers for edge tools, and also of kneepads. These were made quickly and easily from sheets of rubber, which when cut to shape were held in desired position with metal clips. So great is the variety of edge covers that manufacture appears to be uneconomic, whilst this hand method is reasonably economical, allows for slight differences in taste, and is useful employment of wet time which is often otherwise wasted.

WORKING METHODS—M. van Hattem

This lecture explained how work may be improved and simplified by study of the working methods. Each job is divided into a series of smaller elements, and careful analysis will indicate how and in what order these elements should be executed, provided that each is necessary to the completion of the job. "Time and motion study" fairly describes this sort of research.

The essentials required for improvement of the working method are:—

(1) **The necessary tools for the job,** of the **right type** and in best condition.

(2) **The size of the gang of men to do the work most favourably.** In this respect research has revealed that the least number of men is the best, but for operations requiring more than one man, even numbered groups are preferable.

Size of Gang

The advantages of one-man working are:—

(a) No waiting time.
(b) Less walking time.
(c) Change of work.
(d) The man's own tempo.
(e) Rest times of his own choosing.
(f) Earnings in relation to his own work.
(g) Responsibility for the job is of one man only.

The disadvantages of groups of more than one are:—

(a) Difficult organisation involving more waiting and walking time.
(b) Less output per man. The pace of the gang is invariably set at that of its slowest member.

(3) The carrying and placing of tools in the correct manner

(a) A good system is necessary to carry tools from the camp to job, and from job to job, e.g. from tree to tree.
(b) Tools should be placed in such a manner that although they are at hand when required, they constitute no threat of injury.

If these two points are observed, much avoidable walking time may be eliminated, and the job may be done with greater safety.

(4) Cycle of operations

If a series of operations are to be done on a number of products, it is usually preferable to do *all* the operations on one product at a time, rather than to do one operation on all the products and then proceed with the next operation.

For example:—There are 100 trees which require felling, snedding and peeling. The extreme alternatives of method are:—(a) to fell, sned, and peel each tree in turn, or (b) to fell 100 trees, sned 100 trees and peel 100 trees. The latter method even takes longer to describe! In this instance the walking time is trebled, and there is an element of fatigue in doing the one operation too long. The only advantage of this latter method is that there is only one tool to be considered for each operation, and this may be offset by efficient organisation as in (3) above.

The advantages of fully processing one product at a time are:—(a) a great saving in walking time (b) change of work giving rest to some muscles whilst using others.

(5) Consideration of subsequent operations

This is an important factor in deciding the working method. The work must be done not only in the best way for the operation, but also so that subsequent work may be made easier, e.g. felling trees in such a way that consequent extraction is simplified.

The last point raised in the lecture concerned the responsibility for the work devolving on the manager on the one hand and the worker on the other. The duties of each individual were clearly pointed out, as no operation can be efficiently carried out unless both comply with these requirements.

The duties of the manager are:—

(1) The place of work must be properly marked and defined, e.g. in a thinning, all the trees must be clearly marked on both sides, and the boundaries of the thinning must be indicated.
(2) He must give reasonable notice of future work.
(3) He is responsible for the supply of the proper tools for the job.
(4) He must decide the size of the working gang and indicate where each man or gang must work.
(5) He should lay down the general working method to be used.
(6) The standard and quality of the work must be prescribed.
(7) In the case of operations which are unfamiliar to the workers, he must be prepared to give instruction on method and technique.
(8) He is responsible for the supervision, the use of the time, and control of the quantity produced.

The duties of the worker are:—

(1) To be familiar with, and practice, a good working method and technique.
(2) To plan his working day to make the fullest use of it.
(3) To use a "camp" or "lunch-place" which is most suitable for his work.
(4) He is responsible for the proper maintenance of all his tools.

I have reported this particular lecture in considerable detail, because many of these principles were raised again and again in subsequent lectures, as applied to individual operations.

At the conclusion of each lecture, time was set aside so that questions might be asked, and relevant points thoroughly discussed. The session was then concluded with illustrations of slides, as in this case, or in others with films.

WEEDING OF SCRUB GROWTH IN YOUNG FOREST—M. Spaarkogel

The purpose of this operation is to give more room for the growth of the main species. To achieve this, all harmful scrub-growth is removed, and it is the practice in Holland to remove at the same time any trees of the main crop which may eventually become harmful ones, having consideration for normal silvicultural rules, such as ensuring that the formation of the canopy is not affected, i.e. by not removing too much at once.

Organisation

Good Tools

These must not only be of good quality, but must also be the appropriate ones for the particular conditions.

Good Instruction

The forester must make quite clear *exactly* what he wishes done. It is the responsibility of the worker to decide for himself the best working method, and he must have considerable experience of the techniques involved, as this knowledge cannot be conveyed by the forester in his instructions.

Tools

Scythes

Various types were shown. The conventional types are used for light weeds such as grass, etc., where there is sufficient room to use them. An interesting variation was a German scythe, specially made for cutting light scrub. The blade is extremely short, and is not used in the normal manner but in a short chopping action towards the body. It is most efficient in use, and is quite safe, cutting stems up to an inch diameter. A long scythestone is used in the sharpening of all the above.

Gertels

These are very similar to our billhooks, except that the blade is longer and narrower. They are used for cutting stems which are not large enough to warrant the use of saws or axes. For these, the same type of maintenance is required as for axes, i.e. grinding or filing and honing.

Saws

Various saws may be used in this work. The most useful of these in undoubtedly the "JIRI" saw. This is a German saw with a curved blade rather like a pruning saw, with a tooth-shape that cuts only on the pull stroke. This saw is now fairly widely used in Holland as a felling saw, and whilst there are limitations in its use in this field, I was much impressed by its application to scrub clearance, and can thoroughly recommend it. Its one great disadvantage is the difficulty of sharpening it, though this should present no problem to the expert.

Slashers

Many types were shown, some of them being short-shafted, others long, choice depending on taste and conditions. One very interesting example was a Finnish slasher, which was much more stoutly made than conventional patterns, but with a shorter blade. This tool may be used for "slashing" and also for light axe work. Maintenance as for axes.

Pruning Shears

These tools may be used for work which requires great care, e.g. for weeding in Christmas trée plots, or cutting out double leaders. These tools require a special type of maintenance, which is however not difficult.

Axes

Axes are rarely the best tools to use in this sort of work.

Working methods were discussed, stressing many of the points discussed in the preceding lecture. One of the most important is the necessity for one-man-working, not only from the point of view of efficiency, but also because of the danger of men working close together. Long-handled tools are also inclined to be dangerous, and should only be handled by men with great experience.

Quite considerable work was done in scrub clearance, each man being shown techniques in the use of the various tools, and having opportunity to practise them in a variety of conditions. However, whilst very interesting, description of the work will add nothing further to this report.

WORKING TECHNIQUES—M. Spaarkogel

This lecture was a practical illustration of the principles brought out in the one on physiology, and in spite of the fact that my knowledge of the Dutch language is somewhat limited, this detracted very little from my enjoyment of it, and I found it one of the most fascinating lectures I have ever attended. I have little in the way of notes, and in any case these would be of little use, as it was by illustration with the body that the salient points were driven home.

The main features are the *balance of the body as a whole*, the *best use* of the *available muscular power*, and the *way in which these muscles are used.*

(1) Balance of the body

The human frame is essentially upright, the normal stance being quite vertical, with the centre of gravity running from the head, through the frame, to the feet. Any deviation from this line calls for muscular effort to retain the balance, a tension or static muscular action which I shall discuss later. Consequently anything that can be done from a standing position has the advantage of saving so much physical effort. There are, of course, degrees of erectness or being upright, and many jobs cannot be done completely so, but in most cases the frame or torso may be kept straight if not erect; the arms and legs, being more flexible, can usually be used to ensure this. Quite apart from a matter of simple balance, this is important for several reasons, the chief of these being the strain on the back caused by a bent position. The spine is a highly flexible part of the body, but the muscles controlling it are not particularly strong. The bent position of the body is not only a strain on these muscles, but in a static position also strains the individual parts of the spine. This one factor largely accounts for the fact that a very large percentage of forestry workers suffer, at some time during their lives, from some sort of back ailment. Another important reason why the torso should be kept as straight as possible, is that this is usually the best position in which to keep the muscular power of the body in line with the direction in which most of the effort is required. This is rather difficult to explain, I can illustrate it better with an example. A man may cross-cut a log by keeping his body behind and in line with the saw; by standing beside the saw; or by working with it between his legs. In both of the latter methods, the body is obviously off balance, and only a very limited number of muscles may be properly used. The first method is obviously the only one economical in muscular effort, and in which the body is at all reasonably balanced.

(2) Best use of the available muscle power

One does not need to have a very profound knowledge of anatomy to know that there are a great number of muscles in the human frame, varying greatly in both size and purpose. Such being the case, it is obviously only common sense to use the larger and stronger muscles of the body to the fullest extent, saving wear and tear on the smaller ones. But many forest operations are done utilising only the muscles in the arms and wrists, and these muscles if used for a long time naturally become very fatigued. For instance, a man cross-cutting with a bow-saw often only uses these muscles, whereas by proper use of his body he can utilise the powerful units in his calves and thighs. It is surprising in how many working positions this strength may be used, and the consequent saving in fatigue on the arm muscles is enormous.

Not only is it possible to use a far greater number of muscles than one does naturally, but it is also possible to utilise the force of momentum to a very great extent. By a rhythmic movement of the body, enough force can be gathered to carry through in the stroke without much further use of energy. Most jobs may be done with this type of body movement, and it is particularly important that the heaviest work should be done in this way. For instance:—felling, sawing, snedding and peeling are all heavy work, and this rhythmic movement may be successfully used in all of them. In this way, the available muscular power is used to the full; and what is more important, it is used in the right manner.

(3) Way in which the muscles are used

There are two ways in which they may be used. One is "Static", and the other is "Dynamic". For instance, when a man lifts a pint of beer off the counter, that is dynamic effort; but when he holds it to look at it, that is static effort. It will be noticed that even the accomplished pint-lifter will seldom practise this latter form of exercise, and that is because static effort is extremely tiring. To exert this energy, the muscles must be held in tension. The physiological effect of sustained muscular tension is that the blood drains out of the muscle, causing a strain which will normally result in "cramp". This static effort is involved whenever the muscles are kept taut, for instance, gripping a tool tightly with the hands; and when the muscles are so contracted they cannot then be properly used in dynamic action. Thus the secret in any form of activity is to be at all times properly relaxed, the whole body should be loose and at ease even when the muscles are being used, and whenever possible, all movements should be done with a relaxed and easy rhythm.

The positioning of the body is naturally important, certain postures allow a far greater degree of body movement than others; parts of the body bend more easily and naturally when the proper use is made of the joints. For example, in sawing, the best position is to have the feet pointing in the line of the saw, so that there is complete freedom of movement in the ankle and knee joints. Sawing in this way, most of the swinging motion of sawing is done by the powerful leg muscles; the rest of the body, including the arms, moves in easy rhythm with the legs, the body remains relatively erect, all the muscles work loosely and easily without any great expenditure of effort.

This, of course, is all pure theory, but this lecture was given with liberal illustration of the way in which these principles may be carried out, with particular application to certain jobs. To acquire these techniques, a great deal of concentrated practice is required, and the older a person is, the more experience of the job one has, the more difficult are they to acquire. At first, one is apt to find these techniques rather tiring, as muscles are being used which are out of training; that is why there is an emphasis on the importance of exercise and gymnastics in these courses.

The follow-up on this lecture was a film on working techniques by a Norwegian expert. This film demonstrated the correct use of the body in one-man felling work on large trees, showing methods and techniques in sawing, snedding and peeling. Apart from being very pleasant to watch, the work gave the impression of being quite effortless. I found this really fascinating, the best demonstration of this kind I have ever seen.

OCCUPATIONAL TRAINING OF THE FOREST WORKER—M. Spaarkogel

My introductory note says "Essential for the status of forest work". And there is a great deal of common sense in that statement. In both Holland and Britain, forest work has been long despised by the common run of industrial workers, the work being regarded as unskilled labour. As we all know this is far from being the truth, but it is true to say that as an industry we fall behind many others in certain fields, particularly that of the technical education of our skilled workers. An industry cannot have technical progress unless its employees are fully trained in the latest methods and techniques. otherwise the work will deteriorate into mere labouring by comparison with modern standards. We in forestry are now faced with the problem of having to learn new methods to keep up with the times, and a proper form of technical education for *all* grades of forest staff is essential to disseminate this information in the places where it will do most good.

Formerly, the only real education readily available to the worker has been the experience of his elders, sons have learned from their fathers, who have in turn learned from theirs. This has been the basis of education in forestry for many years, and whilst excellent in a way, obviously we tend to rely too largely on methods which may now be out-of-date. Even if the foresters are well trained in methods, etc., they have not, or should not, have the time to thoroughly train their workers. Whilst the forester can do much himself, it is perhaps easier for a specialist to do the most good in the shortest time. The forester is by necessity obliged to spend some time in training, but it is only reasonable that he should expect at least partially trained men to do the majority of his programme of work.

The reasons for vocational training were given under the following heads:—

(1) The results of technical progress. One of the results of this progress has been the introduction of many new tools. One must know not only how to use them, but a certain knowledge of the tools themselves is essential, so as to be able to judge if they are of the requisite quality and type.

(2) Although some degree of education is necessary for all, it is particularly important that the younger element receive as much as possible, since it is on their ability that the future of the industry depends. Experience has taught us that a young man intending to make a career in forestry cannot begin to learn about his job too soon.

(3) Forestry is a job that calls for a very high degree of skill; there is a very great difference between the production of skilled and unskilled work, and a very large amount of initiative can be given to the skilled worker.

(4) Good training must result in much safer working. Forestry work can be very dangerous; it is not safe to allow unskilled workers to use some of our tools without considerable training. Swiss research in this field has revealed that a great reduction in accidents in the forest can be made by the use of good methods and technique.

(5) Economy. The basis of the cost of our work is a question of time, and if the forest worker can learn methods which save time, he will himself benefit by increasing his wages, and his employer will save money by a decrease in costs.

(6) The psychological effect. This is one of the most important, because the contentedness of the worker is an essential to the well-being of the industry. Vocational training is character-forming, gives the worker satisfaction and pride in his job, and a sense of self esteem.

ONE-MAN FELLING TECHNIQUE—M. Spaarkogel

The different parts or elements of the job were first detailed, and a table given for the proportional percentage of the time taken for each element. These elements were:—

Walking,
Consideration of the line of fall,
Clearing round the tree,
Sawing (and preparation),
Taking down,

Snedding,
Peeling and Turning.

The tools recommended for this work are:—
Bowsaw (90 cm.) or Jiri saw (60 cm.).
Light Axe,
Peeling spade (heavy or light),
Lifting Hook (in pouch),
Felling Wedge (pocket size),

Whetstone,
Flask of lubricant (paraffin and oil mixture),
Knee pads,
Gloves,
Raincape,

Spare blade (for bowsaw),
Setting pliers (for bowsaw),
File,
First-aid Kit.

Work relative to the Operation

(1) Finding a central "camp".

(2) Preparation. Sharpening tools, etc.

(3) Looking for the marked trees, and deciding on the correct line of fall.
 (a) Starting in the middle of the strip.
 (b) Carrying the tools in a safe manner.
 (c) Considering the likely line of extraction.

(4) Laying down the tools in the best place.

(5) Ensuring a good foot-hold.

(6) Making of a lay-in (one stroke of the axe).

(7) Sawing of the tree.
 (a) Using a wedge if the saw jams.
 (b) Guiding the fall of the tree with the peeling spade.
 (c) Pulling the butt-end into the "tush" with the help of the lifting hook.

(8) Removal of moss, etc.

(9) Snedding and Peeling.
When working on heavy trees it is necessary to sned first and peel afterwards, but when the trees are lightly branched, these two operations may often be done as one, thereby saving considerable time. However, the axe is usually needed for a few branches and cutting off the end, and this calls for intelligent placing of the tools.

(10) Dragging into "tushes".
It is important that the felling should be done with full consideration of the positions of the tushes into which the poles are to be dragged. With proper planning, considerable time can be saved, and the subsequent extraction simplified.

(11) In very small thinnings, it is often practicable to do complete extraction by hand.

A great deal of practical work was done during the course in one-man felling operations, and the instructors endeavoured to instil into the pupils the importance of the principles named above. It will be understood that these apply to a relatively small range of conditions, but in Holland conditions usually conform to a much closer range than those encountered in Britain. This is largely due to the difference in topography, i.e. the comparative flatness of all the Dutch forests. In any case, methods used need only minor modification to be suitable for felling on hill-slopes.

Table Model of Felling Site

A very interesting method of teaching planning in felling operations is by use of a model. This one consisted of a series of boards joined together to represent a certain size of plantation. The boards were perforated at regular intervals, and in these holes sticks were inserted to indicate standing trees, the stems being spaced according to the stage at which the crop was supposed to be. The trees marked for thinning were indicated by inserting short pegs into the holes, into which in turn, long sticks were inserted, so that at any stage of the mock felling work, the marked trees or the remaining stumps could be recognised. The "forester" then divided the thinning block into convenient drifts for each man or gang. It was then the job of each "feller" to indicate how he would fell each tree, and subsequently how, and to where, the poles should be extracted. By simple conversion, the distance involved in the hand extraction was measured, and points given for the shortest distance, and the way in which the poles are placed for the after-extraction by a particular method, which was in this case by horse and wheeled bogie.

Use of such a model is extremely instructive, and may be used for a variety of operations, and for many different grades of thinning and crop densities. A certain amount of trouble is involved in the setting up of the model, but this is well worthwhile in view of the amount that may be learned from it. The discussion which took place during the period when this was being used, was the most interesting and animated one during the whole course, and as the instructors pointed out, there are certain things that may be taught with this method of instruction which cannot be conveyed well either by lecture or even by demonstration on the ground.

MAKING OF AXE SHAFTS BY HAND—M. H. van der Bremen

The making of axe shafts could not be considered a vital part of the course, yet I feel that I should mention it for two reasons. Firstly, because this is normally considered to be a skill that is very difficult to acquire, and the lecture and subsequent demonstration showed that this is in fact far from being the case; anyone with a reasonable amount of dexterity can make a shaft, using the very simple methods shown. And secondly, because of the tremendous interest shown by the men in this subject.

During the lecture, not only were the methods of manufacture explained, but there was also some discussion on relative matters. We were told which woods were suitable for shafts, how logs should be cut or split into billets, and how the selected size of billet should be cut and shaped.

I have myself often tried to shape axeshafts by hand, but have found that it is extremely difficult to achieve any accuracy without some very exact method of working, but with the method taught at Arnhem I found no trouble in making a shaft both accurately and quickly. And in spite of the fact that many of the

Plate 1. The late Billy Vaughan, Forestry Commissioner, seen with Ganger Arthur Howells during an inspection of afforestation work in Coed Morgannwg, Glamorgan.

Plate 2. General view of the Fire Control Centre at the Santon Downham office, Thetford Chase.

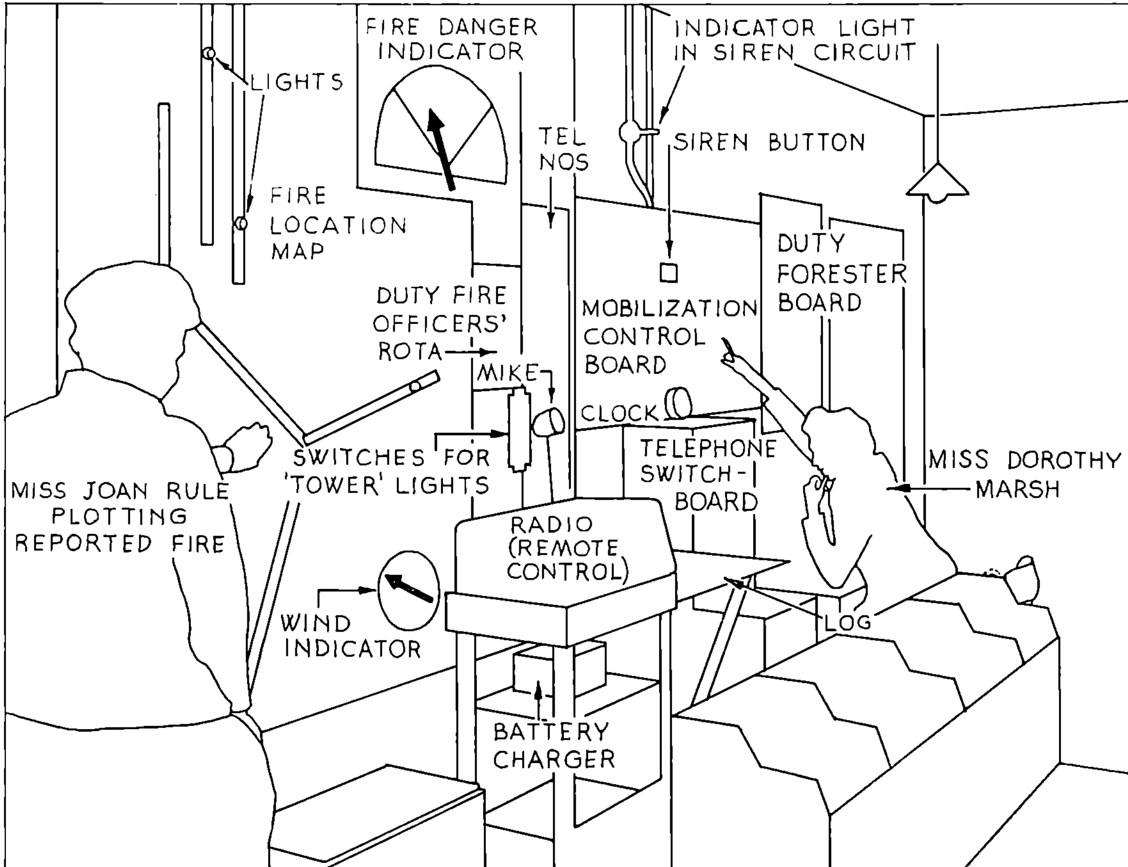

Plate 3. Key to Plate 2.

Plate 4. Another view of the Thetford Fire Control Centre, showing panels for recording action taken.

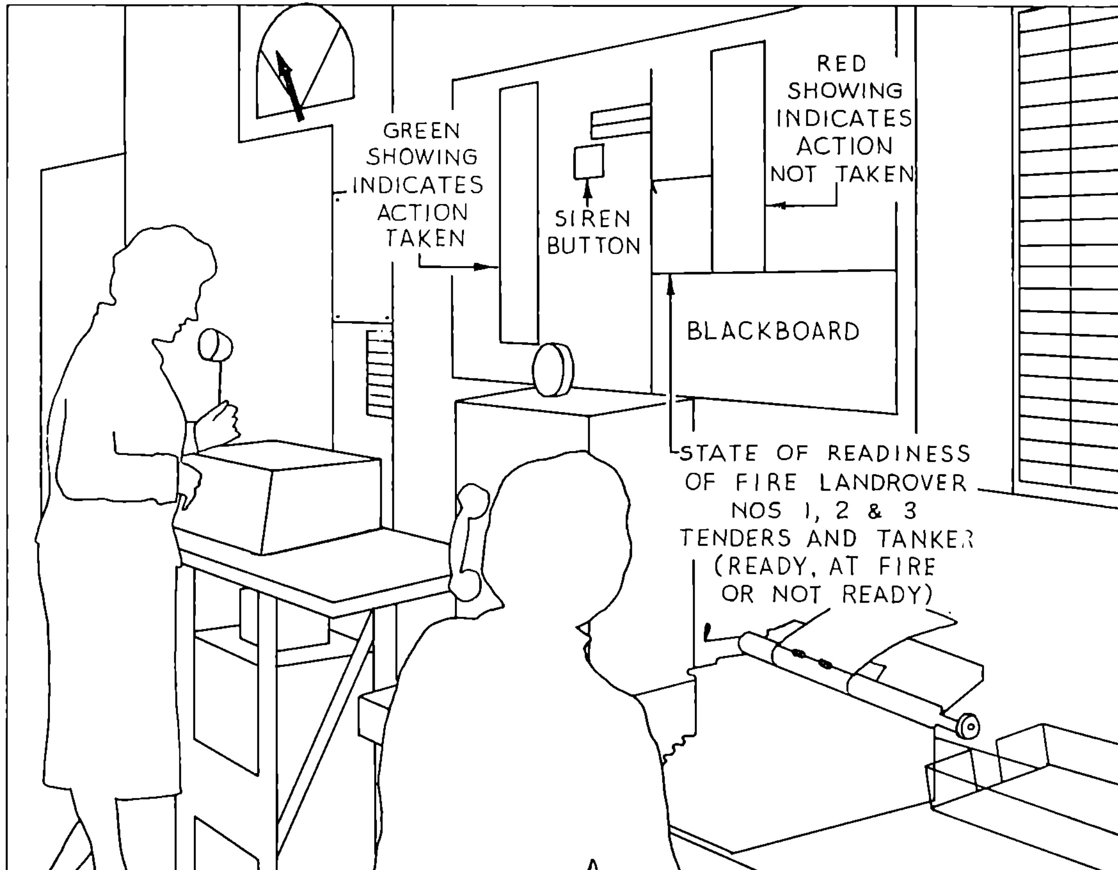

Plate 5. Key to Plate 4.

Plate 6. Sign indicating the start of a forest fire danger zone, set up beside a railway line in South Scotland.

Plate 7. Stem of young beech, almost gnawed through by common rat, at Micheldever Forest, Hampshire.

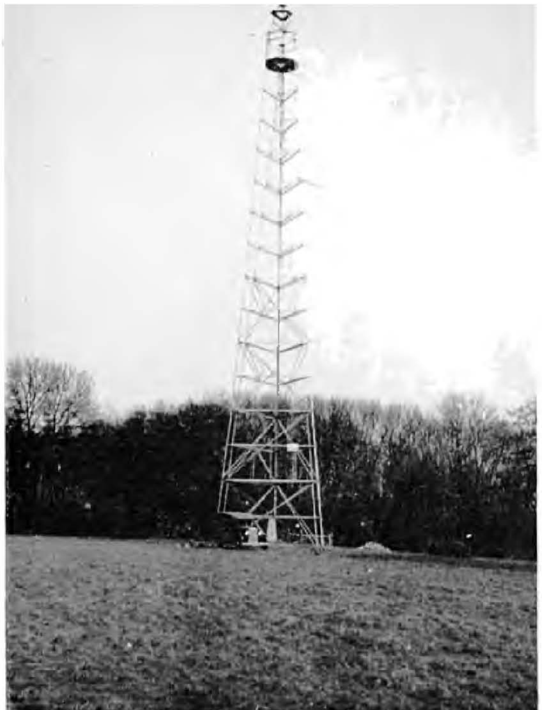

Plate 8. Bilby Steel Tower, used by the Ordnance Survey to take bearings over flat country; theodolite isolated in centre, to avoid sway.

Plate 9. Ordnance Survey Triangulation Pillar, on a hilltop, with Electric Beacon Lamp in place.

Plate 10. Using the Tacheometer to survey difficult ground in a Welsh mining valley.

Plate 11. Survey party fixing Revision Points, as a basis for final stages of chain surveying.

Plate 12. View of Rila Forest and Rila Monastery in Bulgaria.

Plate 13. Weeding young pines established amid light shade and shelter of oak coppice in a Bulgarian forest.

Plate 14. Family of badgers outside their sett in a Surrey woodland.

Plate 15. A badger gateway at Pershore Forest, Worcestershire: the gate is not hung until the badger accepts the gateway.

Plate 16. Badger gate complete with trap door.


Plate 17. Afforestation of an open-cast site at Aberpergwm, Glamorgan. Alder and Corsican pine 6 years after planting.


Plate 18. Afforestation of an Open-cast Site at Aberpergwm, Glamorgan. A view of High Wall still too steep to plant: 6 year old Corsican pine in foreground.

Plate 19. Afforestation of chalk wolds at Scardale, Yorkshire.

men had no previous experience in woodworking, they all managed to complete a presentable job. As I have said, this work aroused a great deal of interest, and was well worth including in the course for this reason alone.

TWO-MAN FELLING WORK—M. Spaarkogel

One of the surprising features of rationalisation, is that often more work is entailed in carrying a greater number of tools with the method advocated than is usual in traditional methods, but the advantage of always having the correct tool for the job immediately at hand, far outweighs the disadvantage of having to carry them from job to job. With a little thought and a well-practised method, tools may be carried and placed wherever required with very little trouble or time; nevertheless, it is very difficult to persuade a man who is accustomed to carrying only one tool, (e.g. an axe), of the truth of this statement.

The tools recommended for use in two-man felling work were as follows:—

Personal tools

- 2 heavy axes,
  The definition "heavy axe" describes axes of up to 3½ lb. in weight. "Light axes" are usually of no more than 2 lb. in weight.
- 2 Peeling spades,
- 2 Pocket felling wedges,
- 2 Whetstones,
- 2 Files,
- 2 Pairs of kneepads,
- 2 Pairs of gloves,
- 2 Raincapes,
- 2 First-aid kits.

General tools

- 1 Cross-cut saw,
- 1 Large canthook,
- 1 Splitting hammer,
- 2 Socket wedges in case,
- 1 Flask of lubricant.

This must seem a dreadful list of tools to be carried about from tree to tree, but in fact they are easily enough carried, and with the possible exception of the kneepads all these tools are necessary, though the peelers may be dispensed with if peeling is not required. Some of the tools, i.e. the raincapes and files, may be left at the camp, as their use is not called for all the time.

Procedure

(1) *Preparatory work*

(a) Choosing a suitable camp.

(b) Donning of suitable clothing.

(c) Sharpening of tools. It is normally expected that tools such as the saw which requires extensive maintenance will be brought to the job ready to use, but edge tools such as the axe require constant sharpening with a whetstone, and the work should start with all tools in proper working order.

(2) *Looking for the marked trees*

Consideration must be given to where the best place is to start felling, and when this has been decided, all the tools should be carried to that spot. The tools may be split up so that:

A. carries his own tools, the cross-cut saw and the canthook.

B. carries his own tools, the splitting hammer and the wedges.

(3) *The line of fall*
The following factors should be considered:—
(a) Extraction.
(b) Stance of the tree.
(c) Undergrowth. (In the case of underplanted ground).
(d) Perimeter of plantation. (Walls, fences, buildings, etc.).
(e) Form of crown.
(f) Direction and force of wind. Felling should not be done in gale-force winds.

Note. The point that seems to have been left out is the relevant position of other trees, but the exercise with which this lecture dealt referred to clear felling rather than thinning.

(4) *Laying down of tools*
(a) In accordance with the method.
(b) Away from the line of fall.
(c) Close at hand.
(d) Safely.

(5) *Clearing the base of the tree*
(a) Brash, etc.
(b) Levelling the ground if necessary.

(6) *Cutting off the buttresses*
(a) Not on the side of the saw-cut.
(b) Not on the side away from which the tree leans.

(7) *Axing or sawing of the "lay-in" which must be:—*
(a) With the face of the lay-in at right angles to the line of fall.
(b) With its base low and horizontal.
(c) Not too wide, and not deeper than 1/5th of the diameter of the stem.
(d) With the edge cut out on whichever side it is not required.

(8) *Felling of the tree.* (Sawing and wedging)
It is important to note that the saw-cut should be only ½ inch above the base of the lay-in. If it is any more there is a loss of control, if it is lower than the lay-in then the butt-end of the tree will be damaged. The lecture goes on to explain, by means of diagrams, the way in which trees may be felled in a desired direction, when that line is far removed from the natural one.

(9) *Bringing down the tree*
When it fails to fall, it may be brought down by:—
(a) Twisting or levering with canthooks.
(b) By horse or hand-winch.

(10) *Axing of the "lip" and the "beard"*
With a good technique in laying-in and felling, the lip left on the stem and the beard on the stump are negligible, but they must be removed and with poor workmen the work is considerable.

In the following section which deals with the snedding and peeling of the tree, I cannot personally agree with the principle that two men should be employed on the one tree. Even when it is too large to be turned by one man, it is very difficult to organise the work in such a way that one man does not have to wait for his mate to finish. Normally, it is possible to fell, at the one time, two or more trees reasonably near one another, and although this results in more walking time, it usually results in a saving of waste time, since each man may be employed in snedding or peeling by himself, for some considerable time. However, there are cases in which the two-man method may be justified, and many of the following points apply equally to one- and two-man felling.

(11) *Working the topside of the stem*

A. works on the lower half of the stem.

B. works in the crown.

A and *B* must so divide the work that they will both be ready at the same time to turn the tree.

A starts peeling at the butt-end of the tree, and throws his axe to where the first thick branch starts. When he reaches this point, he changes his peeler for the axe, and sneds up to the point where *B* started. He then goes back to his peeler and continues peeling to the point. *B* throws his peeler to the point, sneds from the centre up to it, then peels from the point to the butt, leaving one thick branch on the stem for turning.

(12) *Turning*

A, taking his peeler with him, goes to the butt and turns with the canthook, meanwhile *B* turns with the branch he left on.

(13) *Working the underside of the stem*

A works as before, with *B* working in the crown. If it should happen that one finishes before the other, the first man should make for the next tree, and start to prepare and lay-in.

Felling of "middle-weight" trees

As was suggested, the above 13 points relate to the felling of very heavy trees; the method should be slightly modified for those trees which though not exceptionally large, are yet too big to fell by one-man working. The following tools may be substituted:—

(1) Light axe in place of the heavy one.
(2) Large bowsaw in place of a cross-cut saw (or shorter cross-cut saw).
(3) Two small canthooks in place of the large one.

The following changes should be made in the method:—

(1) Nos. 1 to 10 as for heavy trees.
(2) When one tree is felled, one or two more should also be felled.
(3) Consequently, each man may work on his own tree, and the man who finishes first may prepare the next tree.

PRUNING OF POPLARS, ROADSIDE TREES, ETC.—M. van Hattem

A tree is a living organism, the parts of which are:—

(a) *Above the ground.* The stem, branches and leaves.
(b) *Below the ground* The roots.

The stem and the branches carry water and minerals and form the skeleton, the leaves carry out the process of food production, and the roots draw the water and minerals from the ground.

It is important to note that *two of the possible results of pruning are:—*

(1) Less wood production, since there are less leaves to produce the food.
(2) Epicormic shoots may form, as the growth of the tree will react to the smaller crown.

Reasons for pruning are:—

(1) Timber production.
(2) Amenity.
(3) Shelter.
(4) Combinations of the above.

Good principles for pruning:—

(1) Prune early, well and regularly.
(2) Retain as far as possible the natural form of the tree.

Ways of pruning:—

(1) Raising the crown. The lower branches should be removed as far as possible. It is not worthwhile starting to prune old trees. Young trees should have 2/3rds crown, older trees 1/2 crown, mature trees 1/3rd crown.
(2) Taking off (or shortening) of heavy branches. These should be removed to give a tighter crown with less weight of branches.
(3) Eliminating false leaders. There should be only one leader, and any branches competing with this must be removed.
(4) Removal of epicormic shoots. If allowed to remain, these will affect the quality of the timber. This work should be done just before the end of the growing season.

Season for pruning:—

Generally speaking, pruning is done in the winter, but there are many arguments for summer pruning. The advantages of summer pruning are:—

(a) Much better conditions for working.
(b) Little or no growth of epicormic shoots.
(c) Quicker growing-over, of the wounds.

Disadvantages are:—

(a) Difficulty of seeing into the crown.
(b) Branches are harder to cut, and there is more chance of having bark torn off.
(c) Damage to the stem may be done by climbing.

When the desired degree of pruning has been achieved, no more should be done except to remove new shoots. Too much pruning is a mistake, and one should not attempt to improve on nature.

Guides in pruning:—

(1) Do not prune in hard frost, or when the trees are frozen or covered in snow.
(2) Smooth-off wounds.
(3) Do not cut into the stem. Heavy branches should be cut off leaving a stump.
(4) Pruning wounds should be covered to prevent disease, with tar. (Not poplars).
(5) Good maintenance of pruning tools.
(6) Use a safety belt when climbing in large trees.
(7) Prune as much as possible from ground level, with long-shafted saw, shears or chisels.

Owing to a variety of reasons, the course was unable to do any practical work in pruning, though we were able to see the results of both good and bad pruning on a wide variety of species and age classes. The lecture was later very well illustrated by two films.

PRODUCTION AND WAGES (as applicabie in Holland)—M. van Hattem

There are two normal methods of payment for work, these are:—

(1) Time pay and

(2) Piecework pay.

The disadvantages of time payment are:—

To the worker:

(1) A lower scale of wages.

(2) More supervision.

(3) Less interest in the work.

To the employer:

(1) Less production, bringing an increase in overhead costs if not in the unit costs.

(2) More supervision.

When time pay is justified:

(1) When working on units that are not easily measured.

(2) When the proposed work is to be done for too short a time.

(3) When the work is a new operation to the worker, or when it is proposed that it should be done in a different manner.

Both employees and employers are responsible for the time-work rates, and in cases of dispute, impartial arbitrators are called upon to make a decision binding on both parties.

Piecework

In Holland, there is a restriction on the maximum amount that may be earned by a man on piecework in forestry as well as many other industries. This ceiling of 30% above the basic wage, though largely due to the economic situation, is also due to the fact that neither employer nor unions can agree to given rates or tariffs for particular jobs. There is great conflict of opinion on this matter and the only hope of a relief of this situation is that time studies may produce sets of rates which may be acceptable to both parties.

WORK EVALUATION—M. van Hattem

Apparently, a great deal of work has been done in Holland in this study, and there are some industries which work a system of job evaluation within the industry. M. van Hattem, however, was more interested in pointing out the importance to forestry of work evaluations as a whole; since the experienced forest worker, from being the lowest paid worker in the country, might, by evaluation of his job, become one of the best paid. There is no doubt that, done properly, much of our forest work requires a great deal of skill, and consequently, skilled forest workers should not be paid as unskilled workers as they are at present.

As regards job evaluation within forestry, although at the moment there seems to be a wide difference in the amount of skill required for different jobs, by the introduction of more advanced and productive techniques in all jobs in forestry, this disparity may largely disappear.

TIME STUDY AND PIECEWORK RATES—M. A. G. Gerritsen

The important feature of rates produced from time studies, is that they are based on time and not on money, so that even though wages increase, the basic time for any operation remains the same, from which the cost of a minute at present values may be worked out, and from this the cost of the operation itself.

Piecework rates so worked out will cover a reasonable range of conditions, and should apply to any forest with similar conditions. The amount of money paid for a minute's work should relate only to a 'normal' production.

Normal production depends on several factors. First, it must be presumed that the worker will be using both good tools and good working methods, that he is sufficiently experienced and of average ability. The amount of effort used should not be too great, and the standard of quality of work must be that which is prescribed. All these conditions must be present if normal production is to be expected.

Qualities required in one who prepares general time study rates

(1) He must have very expert knowledge of the work.

(2) He must be absolutely impartial.

(3) He must be conscious of social principles.

(4) He must be exact in all his work.

Time studies may be made on men with compliance with the following conditions:

(1) The worker must volunteer to do the work and should not be chosen at random from any forest gang.

(2) The worker must work:—
 (a) with suitable and well maintained tools.
 (b) with a good working method.
 (c) with a good working technique.

(3) He must be a skilled worker, but *NOT:*—
 (a) A bad worker.
 (b) an extremely hard worker.
 (c) a worker who is not used to being watched (nervous), or one who is not willing to help.

(4) At various seasons.

(5) Over the whole country.

(6) A variety of workers, different in respects other than those above, should be timed to produce good average times.

Rating

The 'production rate', i.e. the effectiveness of a man's work, will vary from time to time, and from man to man. This factor is known as the 'Rating', and depends on the dexterity and application of the man, as well as the effort he is putting into the work at the time of 'timing'. So that obviously a standard is required, and this is known as 'normal' rating, and is the rate that would be expected of a man working on bonus or piecework. If this rating be fixed at 100, then a rating may be given for any working element from the observations of the study man, and so the observed times may be modified to give a true 'basic' time. For example:—

Observed Times (centiminutes)	*Rating*	*Basic Times (centiminutes)*
200	100	200
200	110	220
200	80	160

Time Studies

(1) *Direct times* (e.g. in felling)
 (a) Times directly related to the work, i.e. walking, clearing the foot of the tree, sawing, bringing down.
 (b) Working times which relate to the tree, but which do not occur consistently, e.g. cutting undergrowth, moving logs, etc.

(2) *General times*

Times which are not related directly to the work, but which must be taken into account.

(a) General preparation. (For the day's work, or for a particular job).

(b) Time for maintenance of tools.

(c) Delays. (Payment of wages, instructions from the foreman, repair of broken tools, etc.).

(d) Personal. Time for short breaks for smoking, drinking, nose-blowing, etc.

Later on in the course, a lecture was given by a forester who was engaged in time study, describing the way studies are done in practice, and the way in which they are worked up to give the basic information for setting rates. The 'basic' times have allowances for rest, contingencies, etc., added on, which produces a figure of 'standard' minutes, from which the cost may be worked out.

GYMNASTICS

The importance of Gymnastics in relation to occupation has long been realised, and as the forest worker is engaged in work involving a great deal of physical effort, reasonable forms of exercise will assist in keeping him in good health, and help him to do his work with the smallest amount of energy and strain. By 'reasonable' forms of exercise, I mean that they should be moderated to the age and activities of the individual. Exercises which are designed to help the man engaged in particular tasks are especially valuable, and in the gymnastic periods during the course, much time was used in the practice of this form of exercise. M. Haagsman, a professional instructor, has made a study of the type of exercises most suitable for the forest worker. Though some of us were not in the best of physical condition, and others were getting on in years, (the oldest man being 52 years old), none of us found the exercises *too* strenuous, and we all of us enjoyed these periods very much. As in all other activities, the instructors all joined in during these lessons.

MECHANISATION

Lectures and demonstrations were given during the course under this head, and these were illustrated with sone extremely good films. It will be realised, however, that as special courses are given in these subjects, only an outline of the subject was given on this, the general course. The importance of mechanisation of forest operations wherever practicable and economical was stressed, though the difficulties and disadvantages were not forgotten.

A VISIT TO THE POLDERS

The making and exploitation of polders, i.e., land reclaimed from the sea, is an essential feature of life in Holland. The Dutch people undoubtedly know more about this type of land development than anyone else in the world, and with modern methods and mechanisation have made reclamation a very economic proposition. During our visit we saw the new polder, which has only just been dried out, and an older one which has been in this state for ten years. The creation of these polders is a stupendous undertaking, involving the investment by the Government of huge sums of money. When one considers that more than one-fifth of the land area of the Netherlands has been reclaimed throughout the centuries in this way, it is easier to understand how the Dutch people can contemplate projects of the size that are tackled today in the new polders. It was fascinating to see how life develops in these areas. In the N.E.

Polder, which was only completed ten years ago, almost every piece of land had been put to use. All the agricultural land had been divided up into different sized farms, farm houses had been built, even quite a big town with churches, shops, hotels, etc., giving the appearance of having been there for a very long time. I was most intrigued to see such a fine thriving community on land which only twelve years before had been submerged under the sea.

Forestry is of great importance in Holland for a variety of reasons, in the polder areas much more so than elsewhere. Some land areas in these polders are considered unsuitable for agriculture, so that conventional forest of a high productivity may be established within them. But apart from this an extensive work in establishing woodlands and trees is necessary to the other parts of the polder. As may be imagined, these new areas are at first wild, dreary and exposed; trees are required for shelter, amenity and use of land that is otherwise unproductive.

Since these new, large projects are entirely State controlled, the State Forest Service is responsible for the planting of all trees within the areas. This involves not only the forest areas but also all shelter belts round farmhouses, on ditch sides and roadsides, and the establishment and maintenance of wooded parkland for recreational facilities. In the early stages the sheltering of the new land is of the utmost importance, species such as alder being used for this purpose; whilst at the same time species such as poplar, elm, beech, etc., are planted for the dual purpose of timber production and shelter. Poplar is of particular importance, as the good soils and conditions are particularly favourable to high timber production of this species.

The flat, tillable soil of the polders is particularly suitable for mechanisation in most forest work. During this visit we were able to see many forms of nursery machinery, multiple planting machines, etc. Planting by machine is done extensively not only in plantations, but also on roadsides, while there are often as many as ten rows of trees planted on either side of the newly established roads. We were able to compare polders in different stages, and the biggest visual difference was that made by the growth of the trees, which are of great value to the communities in many ways other than transforming the land into pleasant and interesting countryside.

THE ONE-MAN POWER SAW. USE AND MAINTENANCE

Report on the Woodmen's Course—3rd to 13th December, 1958 at Saverne, (Bas-Rhin), France

By A. S. TURNER

Assistant Forester, West Scotland

These courses were started in 1953 by the French Forest Service, ("Administration des Eaux et Forets",) Conservancy of the Bas-Rhin.

Their aim is to give a theoretical and practical idea on:—

The modern tools for forests exploitation,
Their use and maintenance,
The organisation of work,
Accident prevention,

and to attract attention on the general problems of the forest and forestry economy.

The ultimate goal is to improve production and, therefore, the well-being of the woodman.

First stage courses deal exclusively with hand tools. After having attended the first stage, the woodman is entitled to take part in the second stage, which is the ten days' course on One-Man or Light Power Saws.

Description of Average Light Power Saw. (See Figure 14)

Engine:	Two-stroke, air cooled.
Fuel mixture:	From 5% to 10% (e.g. 1 part oil to 10 parts petrol).
Power:	Average 4 B.H.P. at top revs.
Cylinder capacity:	From 66 c.c. to 100 c.c.
Maximum revolutions:	From 4,000 revs. per min. to 9,000 revs. per min.
Clutch:	Centrifugal or hand operated.
Chain guide:	From 18 in. to 36 in., male or female, with or without end pulley, movable or fixed.
Chain:	Chipper chain used mostly nowadays. Butterfly or scratch type used previously.
Chain lubrication:	Automatic or hand operated.
Fuel tank:	Movable or static, usually 1¾ pints capacity.
Starter:	Cable with spring-loaded self-rewinding mechanism.
Weight:	From 26 lbs. to 33 lbs. with empty tanks.

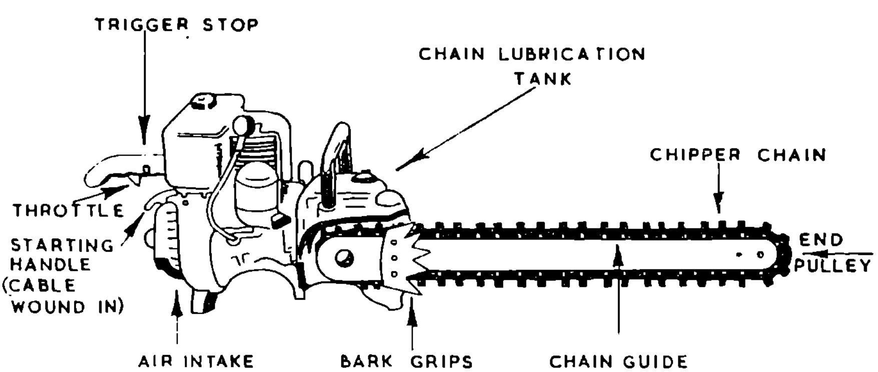

Fig. 14. Typical one-man power saw.

Maintenance of Chipper Chains

Chipper chains are among the easiest saws to sharpen. A round file, constant diameter, of 5½, 6 or 6½ mm. diameter, according to size of teeth, is the normal file to use. It is recommended to use a fine spiral cut file. The chain may be sharpened on the saw guide held in firm position on work bench.

Correct Position of File on Cutting Tooth

(1) Hold file at an average angle of 60° to line of sawing and file in the direction of the cutting edge with a rotary motion into the tooth. Increase angle to 65° maximum for hardwood and decrease to 55° minimum for softwood. File should protrude 1/6th to 1/5th of its diameter above top edge of tooth to obtain complete sharpening and vertical edge. (Figs. 15 (a) and (b), 16 and 17).

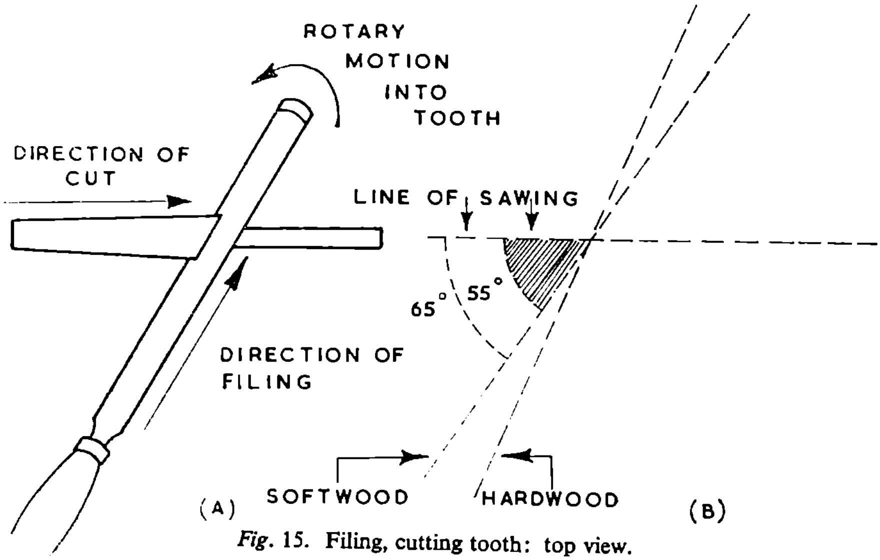

Fig. 15. Filing, cutting tooth: top view.

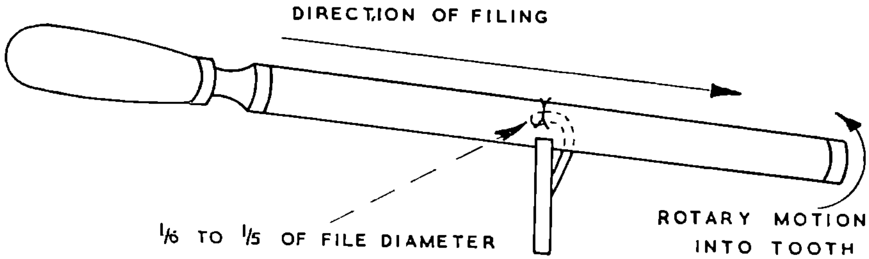

Fig. 16. Filing, cutting tooth: end view.

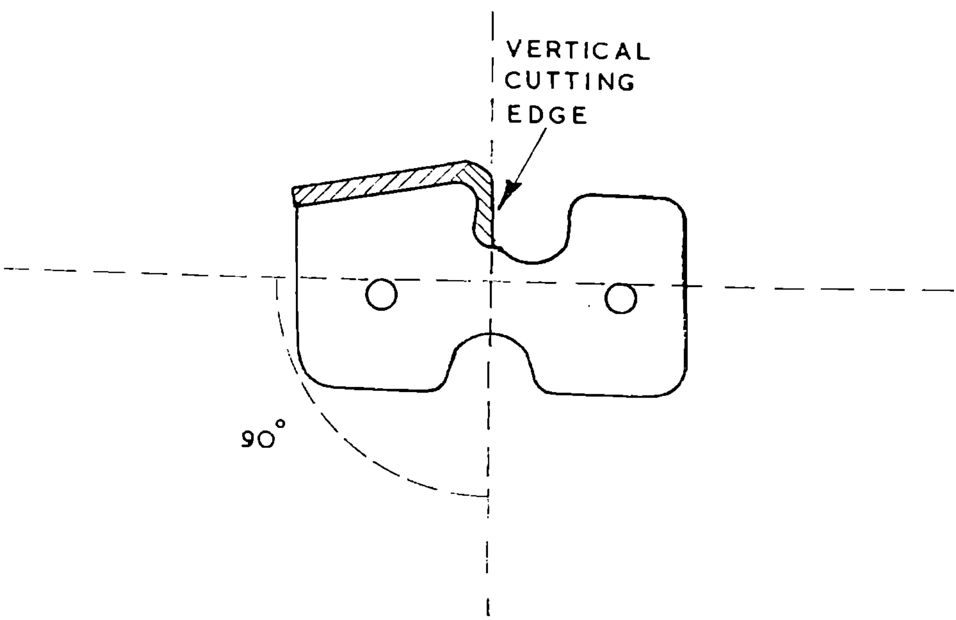

Fig. 17. Filing, cutting tooth: side view.

(2) File should be held up, rather than down (about 5° above horizontal). (Fig. 18).

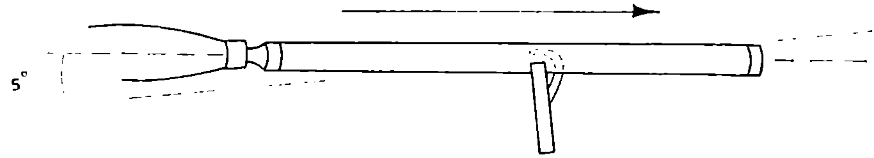

Fig. 18. Holding the File: end view.

(3) Deburr with file handle.

Should a new tooth have been inserted in the chain, file it back to correspond to the other teeth in length and height. (Fig 19 (a) and (b)).

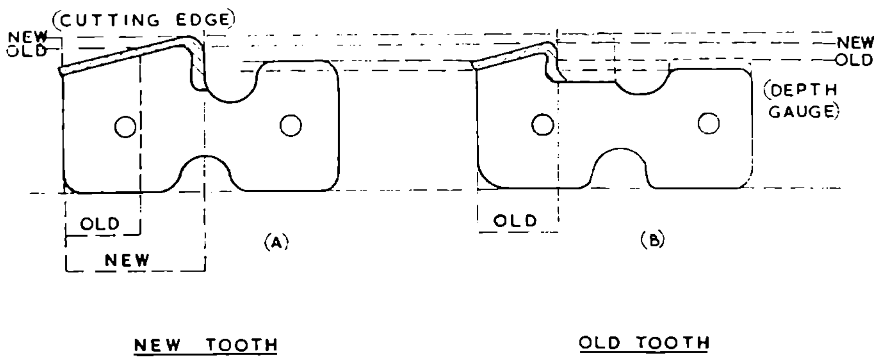

Fig. 19. Deburring with File Handle.

Lowering of the Depth Gauge

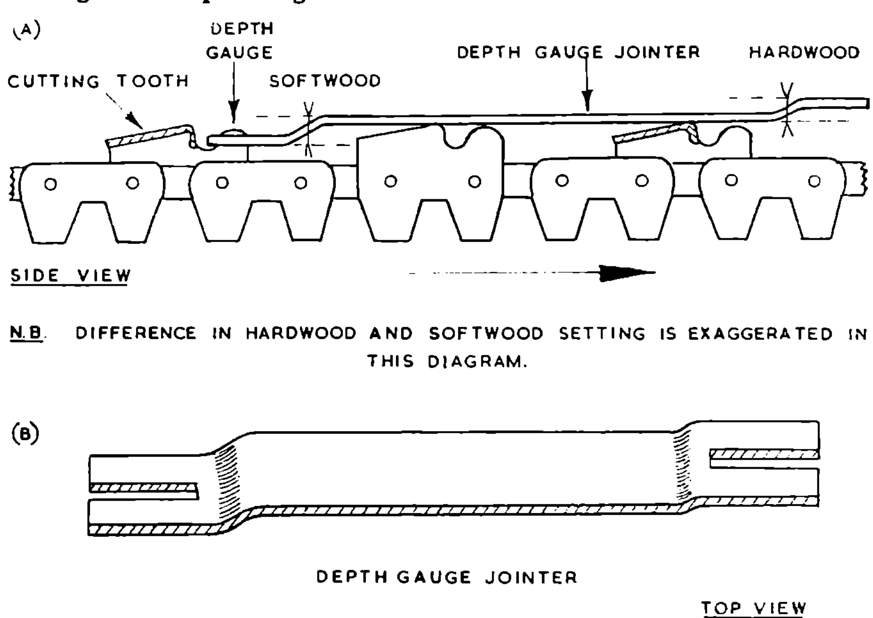

Fig. 20. Lowering the depth gauge.

It is most important to adjust the height of the depth gauge after having sharpened the cutting teeth (see Fig. 20) to obtain maximum cutting efficiency. This has to be carried out very carefully and it is advisable to use a depth gauge jointer (Fig. 20 (b)). Too deep setting will overload engine and cause stalling. Too shallow setting will cause cutting teeth to bite into wood to insufficient depth and saw will cut too slowly. Depth gauge jointers should be a part of normal saw maintenance tools. Usually, these have a separate setting for hardwood and softwood.

(1) Place depth gauge jointer firmly on, at least, two cutting teeth. (Fig. 20).

(2) Depth gauge will protrude through slotted end. Shallower setting will be used for hard or frozen wood; deeper setting for softwood.

(3) Using smooth, flat, 7 in. to 8 in. file, lower part of depth gauge projecting through slot until level with depth gauge jointer.

(4) Remove jointer and round off corner facing cutting direction. (Fig. 21 (a) and (b)).

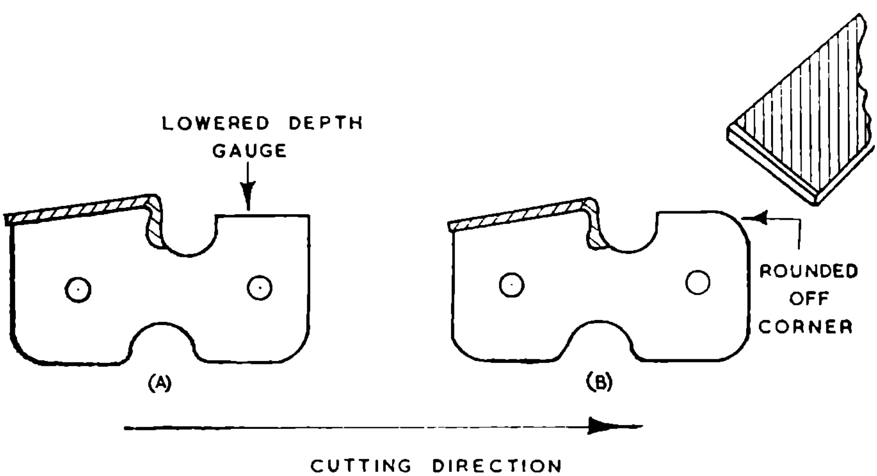

Fig. 21. Rounding-off the corner.

Average depth gauge settings are from .020 in. to .055 in. below cutting teeth, depending on chain type used.

Practical Advice:—

(1) Sharpen saw frequently.

(2) Filing should be carried out with steady, gentle strokes.

(3) File off only what is strictly necessary.

(4) Have cutting teeth and depth gauges at same height and length.

(5) Never file top of tooth, or gullet between tooth and depth gauge (Fig. 22). Keep file up.

(6) Tighten rivets occasionally. Links should move freely but not be slack.

(7) Always use the proper type of rivets when replacing links. Have some in tool kit. Sawn-off nails will not do.

(8) After sharpening, remove chain from guide and wash out in Diesel oil to rid it of filings. Wash out chain guide.

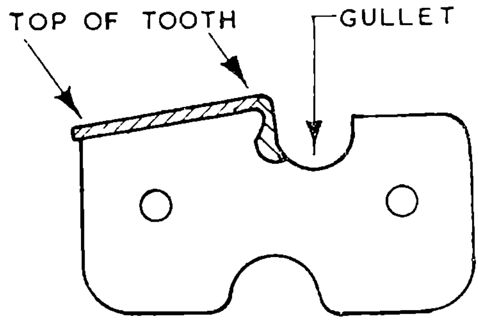

Fig. 22. What not to file.

(9) For female chain guides, occasionally place piece of steel plate, slightly thicker than drive links in chain, into guide groove, and close it with hammer. Repeat the operation throughout whole guide. (Fig. 23).

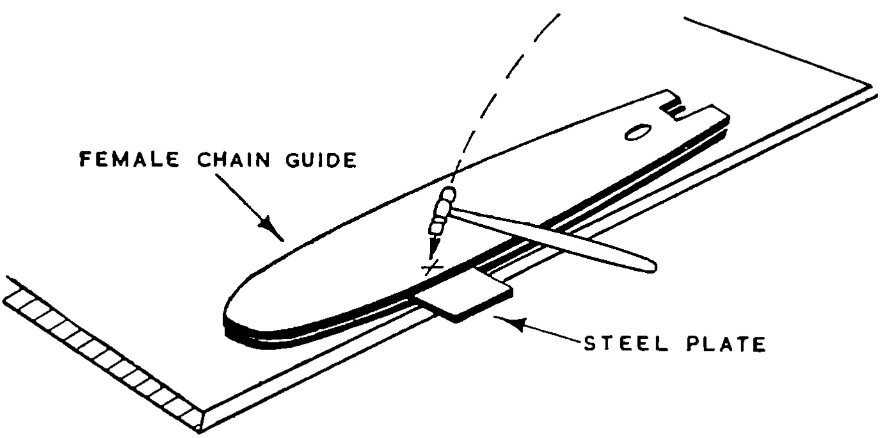

Fig. 23. Adjusting female chain guide.

(10) Watch for even wear of saw guide. (Fig. 24).

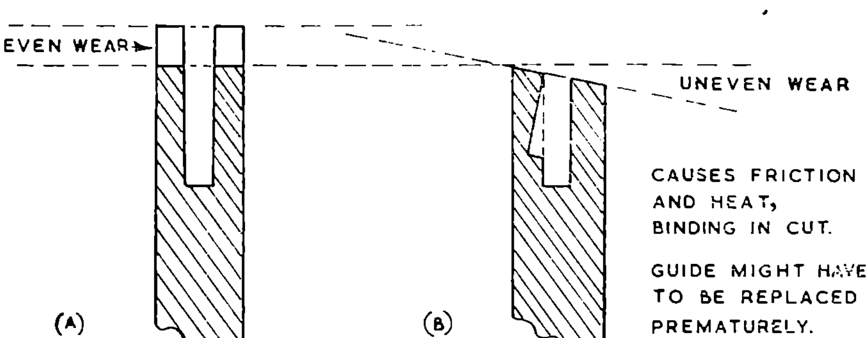

Fig. 24. Checking saw guide for wear.

(11) Do not allow guide to wear down too far—oil must be able to circulate between bottom of groove and drive link. (Fig. 25).

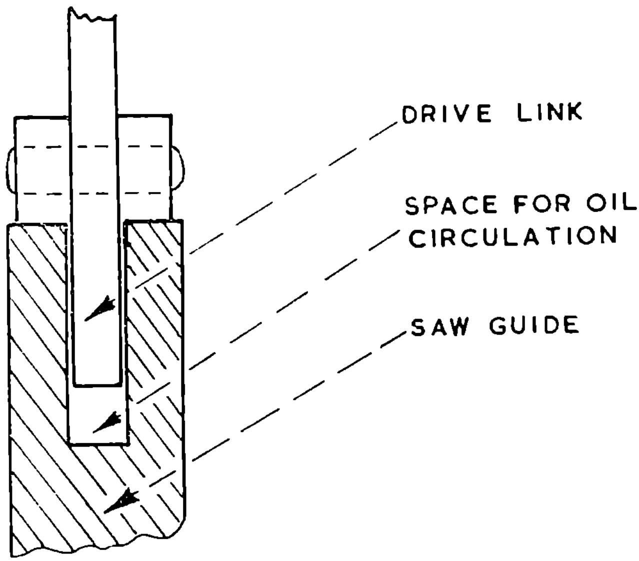

Fig. 25. Allowing space for oil.

Several types of filing guides, to help accurate sharpening, may be obtained on the market.

Power Saw Maintenance and Starting

Study and follow carefully instruction booklets issued with saws

Maintenance

(1) Wash air-filter in petrol.
(2) Clean plug and correct gap.
(3) Check and maintain correct chain tension.
(4) Put correct petrol-oil mixture in fuel tank.
(5) Keep oil tank for chain lubrication full.
(6) If lubrication is of hand-operated type, try pump by depressing knob several times.
(7) Grease pulley at end of chain guide.
(8) Once a week, wash engine and cooling fan completely in Diesel oil.
(9) Once a month, clean exhaust, starting mechanism, contact breakers.

Starting Drill

(1) Do not smoke, for fire prevention.
(2) Place machine on level ground, in firm position, blade free of obstacles.
(3) Check oil and fuel.
(4) Try lubrication pump.
(5) Check chain tension (varies with different makes of saws).
(6) Shake machine to ensure petrol and oil mixture.
(7) Choke engine.
(8) Open petrol tap.

(9) Flood carburettor.
(10) Depress trigger-stop if fitted on machine.
(11) Give a few slow, short strokes on starting cable to draw fuel into cylinder. Keep cable *in line with orifice* to prevent wear.
(12) Short, sharp pull on cable to start. Never pull out cable to fullest extent.
(13) Do not let cable handle go but keep in hand and release gently.
(14) Rev. engine to heat up.
(15) Open choke.

Cross-cutting

(I) **When Whole Length of Log Lies Evenly on the Ground.** (Fig. 26 (a) and (b)).

Start cut from side of log and carry on cutting by lifting pistol handle slowly, thus bringing blade down, with machine pivoting around bark grips. Be careful towards the end, and avoid touching the soil with the chain. Finish off with the end of the blade.

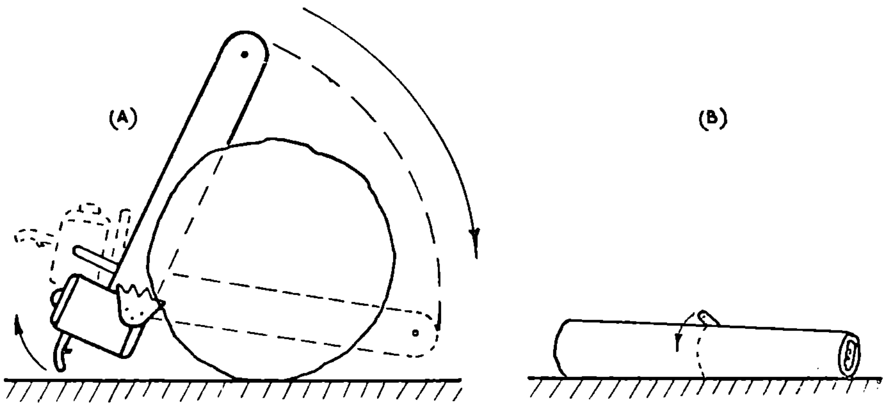

Fig. 26. Cross-cutting log on even ground.

(II) **When Log Lies on Uneven Ground, but with Sufficient Space to Saw from Below—(log tends to bind).** (Fig. 27 (a) and (b)).

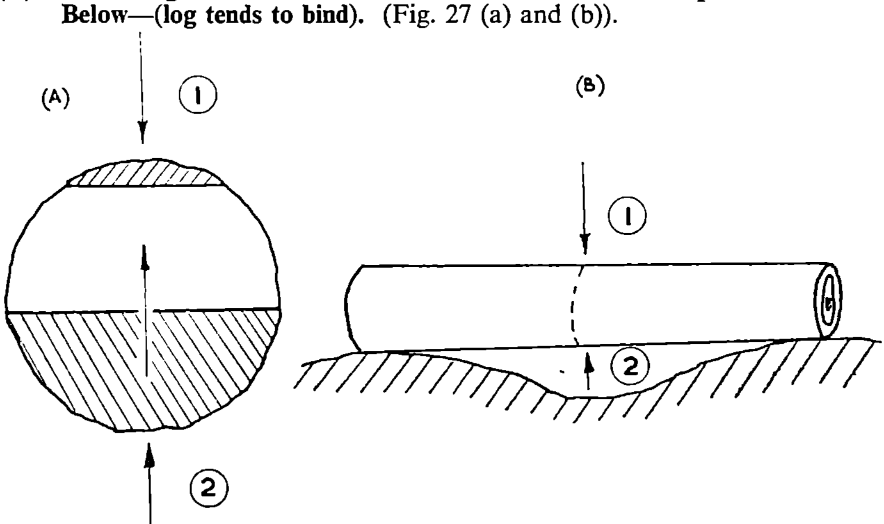

Fig. 27. Cross-cutting log on uneven ground, with space below.

Start cut from top of log for a few inches (1), then place blade below log and cut upwards with top of blade (2). The woodman will have to adopt a stable position, rest the engine on his knee and push the machine against the log to compensate the throwing-out effect of the chain.

(III) When Log Lies on Uneven Ground with Insufficient Space to Saw from below. (Fig. 28 (a) and (b)).

Start cut from top of log (1), then, holding machine firmly, pierce log in its top third with blade tilted down in "diving" position at start, then levelling out (2). When log is pierced, cut downwards till blade reaches bottom of log (3). Then finish off cut upwards (4).

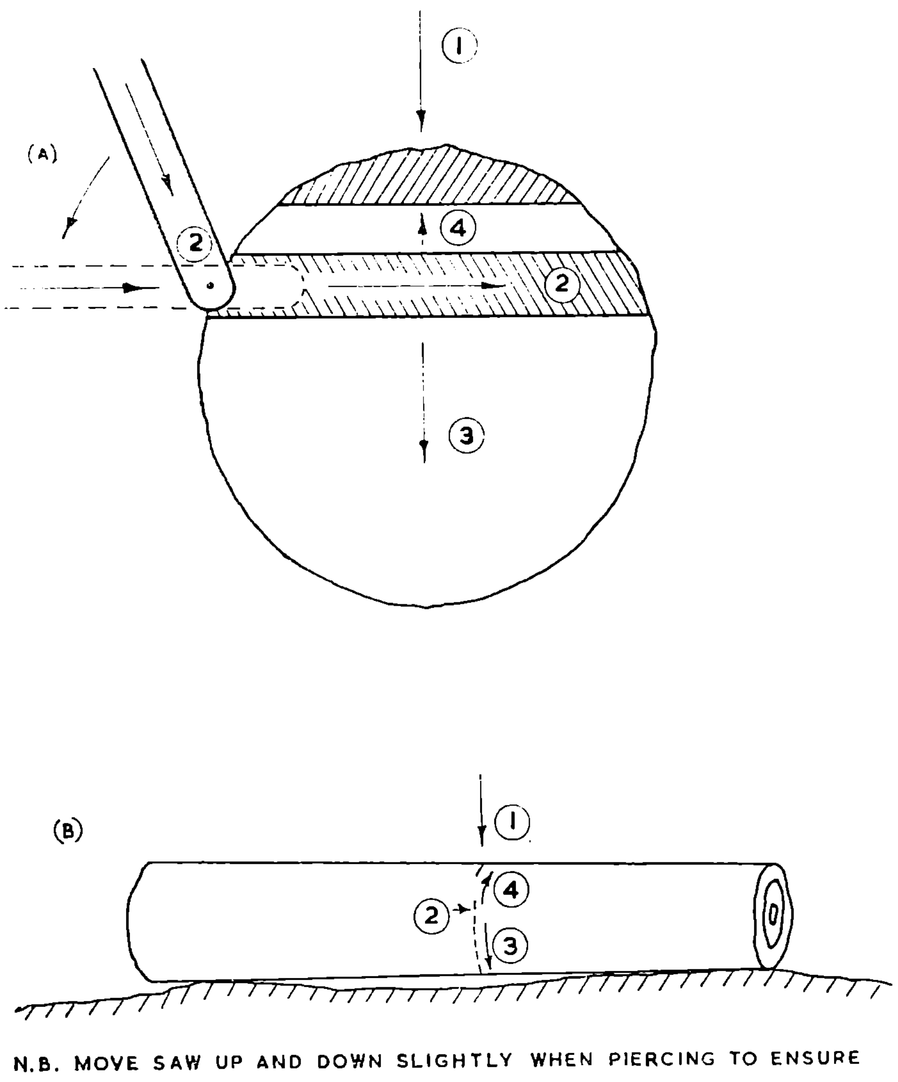

Fig. 28. Cross-cutting log on uneven ground, with no space below.

In general, there is no need for wedges in any of these operations.

Felling

The felling operation can be carried out entirely with the power saw. Axe will only be used for snedding.

(1) Clear the foot of the tree of stones and accumulations of dead foliage and twigs.

(2) Panel tree with power saw (Fig. 29). Cut tight round tree with blade in horizontal position (1), then cut off buttresses with blade in vertical position (2).

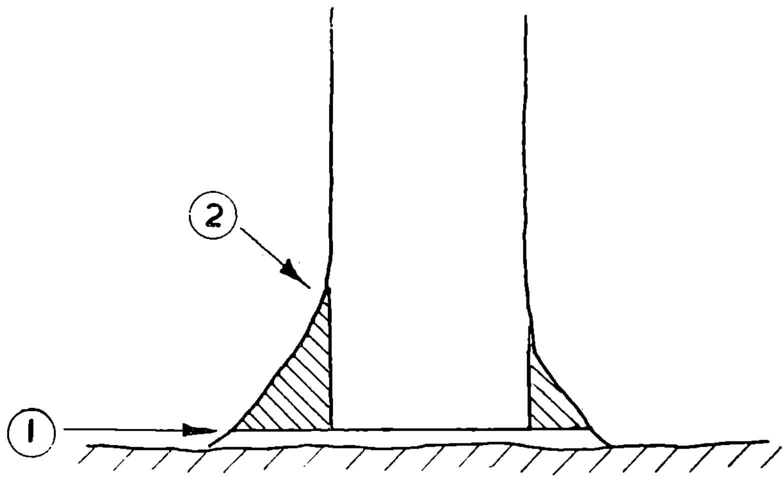

Fig. 29. Felling: removing buttresses.

(3) Cut sink, facing direction of fall (Fig. 30 (a) and (b)). Normally ¼ to 1/3rd of diameter of butt, horizontal bottom cut first (1), down cut, with blade at an average of 45°, second (2).

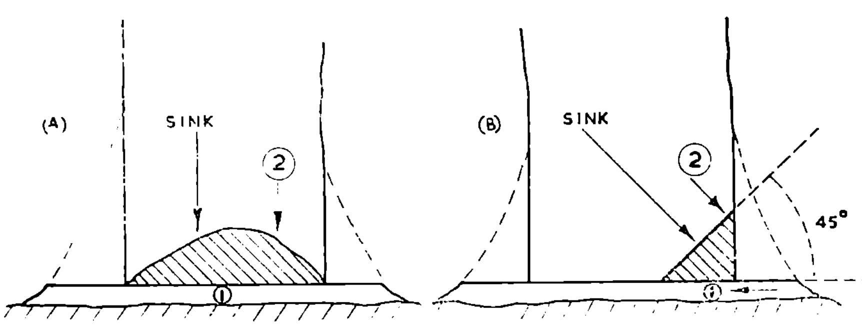

Fig. 30. Felling: cutting the sink.

(I) If Blade is Longer than Diameter of Tree

Place saw near one side of the sink, leaving high enough shoulder to prevent splitting (according to size of tree), blade in horizontal position. Pull saw by pistol handle, making it pivot round bark grips, chain biting into wood (Fig. 31 (a) and (b)). Have sufficiently strong hinge. Use wooden wedges to prevent binding.

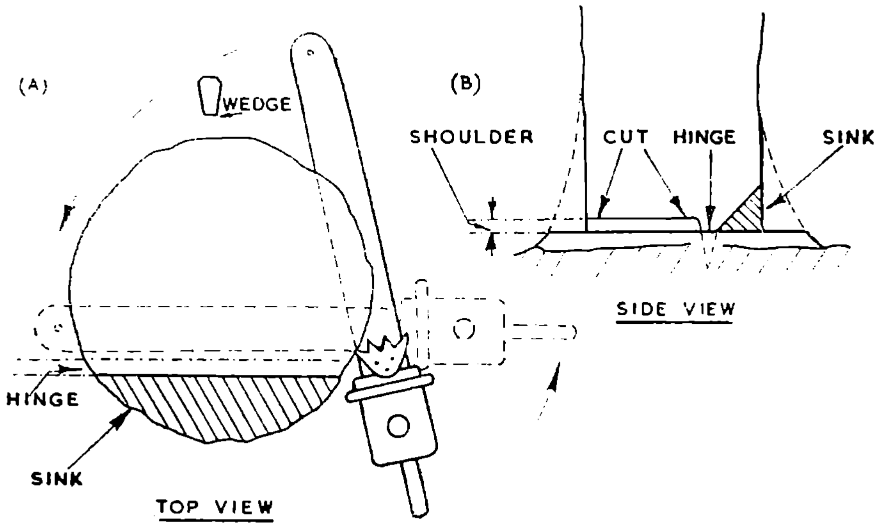

Fig. 31. Felling where blade is longer than diameter of tree.

(II) If Diameter of Tree is Greater than Length of Blade, but Less than Twice its Length. (Fig. 32).

Place saw in position (a). Cut section (a) by pulling handle in direction of arrow. Move saw to position (b), cut. Then to (c), cut and so on, if required.

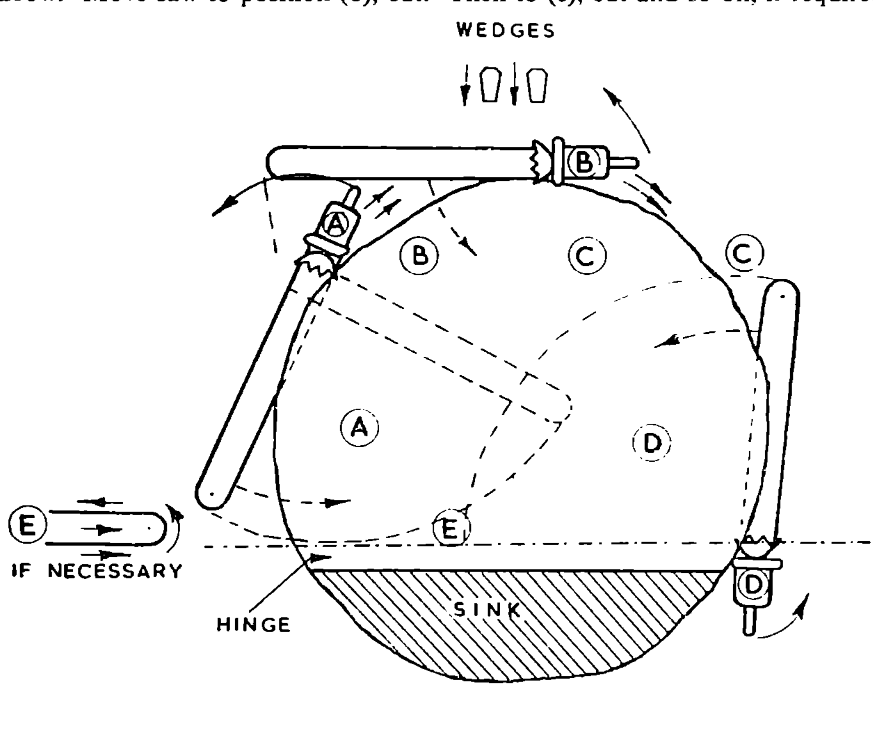

Fig. 32. Felling where diameter of tree is greater than length of blade, but less than twice its length.

Finally, place saw in (d) and cut section (d). Should a small section (e) remain, finish off with back of blade. Insert wedges as soon as possible.

(III) If Diameter of Tree is More than Twice the Length of the Blade, but not over Three Times. (Fig. 33 (a), (b) and (c)).

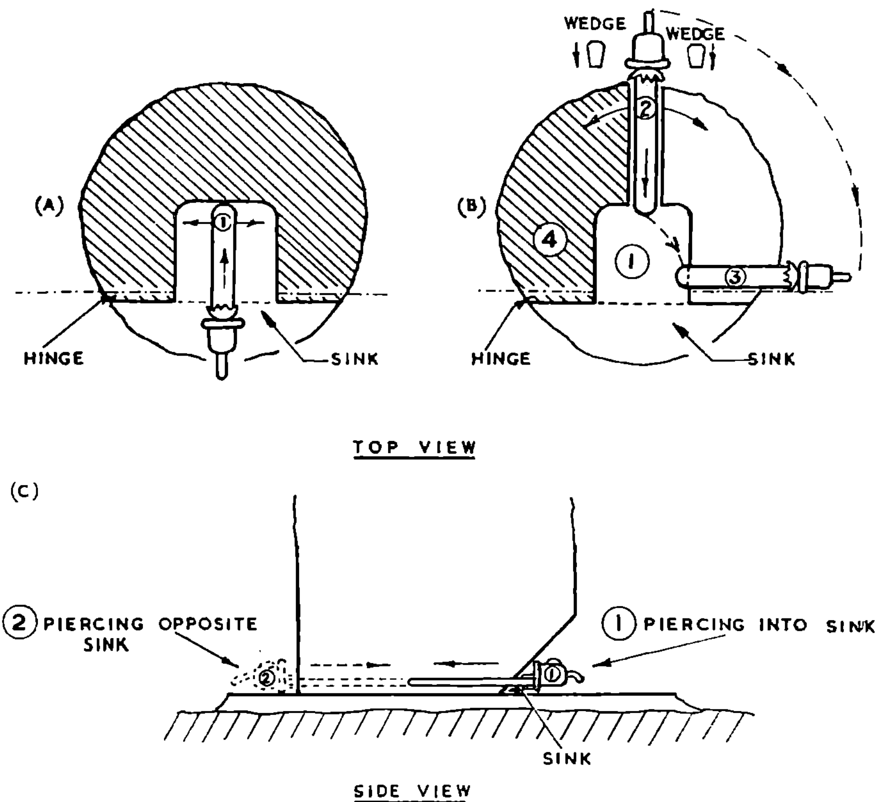

Fig. 33. Felling where diameter of tree is more than twice the length of the blade, but not over three times.

(a and c—1) Pierce into the sink, moving the saw to left and right to a certain safe distance.

(b and c—2) Pierce from opposite side of sink.

(b—3) Cut one section by describing arc of circle until hinge is reached.

(b)—4) Cut last section by repeating operation in opposite direction. Use wedges as soon as possible.

Safety Precautions

(1) The power saw must be handled with as much caution as a loaded rifle.

(2) Wide sleeves, unbuttoned jackets, hanging scarves should not be worn. The woodman's clothes should be of the boiler-suit type, without floating parts liable to be caught in the chain.

(3) Each sawing operation should be carried out by one man, without interference or assistance from any other.

(4) No one else should come nearer than 2 yards from the machine in motion.

(5) The noise of the machine muffles calls for caution (e.g. "Timber!" when tree is falling) and, therefore, the men should work sufficiently far apart.

(6) For starting, stand the machine on the ground and hold firmly, with rotating, or fixed, blade in vertical position and clear of soil.

(7) Do not smoke when operating machine (see Starting Drill).

(8) When machine is carried, engine should be stopped. For short movements, from tree to tree, engine ticking over (for centrifugal clutch), hand operated clutch disengaged.

(9) When carried, the blade must be pointing forward. The operator must not step backwards.

(10) Always use wooden wedges in conjunction with power saws to prevent top side of chain from coming in contact with steel accidentally.

(11) When felling, remove saw from cut before tree falls.

(12) Checking chain tension will always be done with engine stopped.

(13) Do not run machine indoors. Petrol fumes are dangerous to health.

(14) Always have saw in good working order.

Conclusions

The light power saw is adapted for use in the forest. It replaces the cross-cut saw and partly the axe.

In a team, each man should use the saw in turn to distribute fatigue evenly (noise, vibrations, breathing in of fumes) and to increase production.

One must not rely entirely on the saw to increase production. It is only operated for about 20% of the working day and other parts of the operation should still be carried out efficiently.

It is a fairly expensive tool and should be carefully handled and maintained.

It is also advisable to insure the saw against breakages and theft.

The saw should be as light as possible. Frequently it has to be carried on steep slopes and in difficult conditions. A good example is an American saw weighing 20 lb. Adding 2 lb. for fuel and oil, it means that the operator carries only 22 lb. about in the forest.

The engine block-cylinder-tank should make one compact unit with no parts sticking out and liable to be broken. Components should be easily accessible for minor adjustments.

The whole saw should be well-balanced for ease in handling.

An 18 in. blade is long enough for normal forest operations. It will cut a 4-foot diameter tree without undue difficulty. Too long a blade tends to vibrate when in use.

A high revolution engine makes the machine easier to operate because it reduces vibrations.

The centrifugal clutch, which puts chain in motion through increased speed of engine, seems the best solution; however, Norway produces a very good saw with hand-operated clutch.

A direct drive from crank-shaft, through clutch, to chain cancels out unnecessary gearing and reduces weight.

The blade should be fixed. The whole saw should be able to operate in any position. A membrane carburettor makes this possible, but is, unfortunately, very difficult to clean.

Narrow chain guides are better for undercutting and piercing. Wide guides stay more rigid and do not wear quickly at end.

Female guides wear out less quickly, but accumulate saw dust faster, than do male guides.

For chain lubrication, hand-operated pumps are considered more economic and safer than automatic lubrication. With automatic lubrication, the only obvious sign of empty oil tank may be the overheating of the blade, whereas with the hand-operated system an easy motion of the oil pumps will immediately indicate a lack of oil.

A well-sharpened chipper chain will cut as clean as the old butterfly type and is easier to sharpen.

Fuel tanks should contain enough fuel to run at least one hour at one filling.

Starter cable should be self-rewinding.

Exhaust should blow forward to rid operator of saw-dust.

Air filter should point forward so as not to be closed accidentally by arm or clothing.

A well-trained team should be able to earn at least 25% more than otherwise, with power saw, after deducting costs of running and depreciation on machine.

EXTRACTION OF FOREST PRODUCE BY CABLEWAY IN ITALY AND SWITZERLAND

By R. E. HUGHES

Assistant Engineer, North-West England

This report is submitted following participation in the international course for cable operators, organised under the auspices of the Joint F.A.O./E.C.E. Committee on Forest Working Techniques, from 14th September to 4th October, 1958. The first half of the course was held in the Foresta Demaniale near Florence, Italy, and the second half at Chur in the Canton of Grisons, Switzerland.

Cable Systems

There follows a table of cable systems as used in Italy and Switzerland with brief notes on their various advantages and disadvantages.

The four systems which commend themselves for trial in British forests are:

(i) Mobile monocable (Cable Lasso and others).

(ii) Fixed monocable.

(iii) Tricable or Valtellina.

(iv) Short Distance Cable crane.

(i) and (ii) for the extraction of pulpwood and fire wood.

(iii) for extraction of all types of produce in combination with tracks or cranes.

(iv) for extraction of timber.

System	*Brief Description*	*Application*	*Advantages*	*Disadvantages*	*Remarks*
1. **Mobile Monocable**	Single cable operating over patented pulley systems. Down loads acting under gravity provide traction for return of carriages, provided the terrain permits, otherwise motor assistance is necessary.	Extraction of small produce from fairly regular slopes: Downhill.	Covers fairly large polygonal area. Loading and unloading at almost any point. Operates near ground level and is therefore accessible to the workers.	Limited to small produce, average 120 lb. per load.	Pulleys are patented. Cable Lasso and others. Comment by lecturers therefore unfortunately limited.
2. **Fixed Monocable**	Single cable tensioned between supports at arrival and departure stations. Loads are attached to hooks or pulleys and halted by a simple buffer of brash at the arrival station. Hooks are collected and bundled and returned by hand to the departure station. Length up to 1,000 yds.	Extraction of fuel or pulpwood. Slopes up to 60% downwards. Forests with 10 to 15% of useful timber are probably best tackled with this system, converting even useful timber into fuel or pulpwood.	Easy to install and operate, capable of considerable output. No motor or winch. Inexpensive method.	Limited to small produce of low value where damage is unimportant. Max. load 220 lb. No control over rate of descent. Loading at only one point.	Simplest and most ancient form of cableway. High element of danger to workers under cable and at delivery end.
3. **Bi-cable**	Single load cable tensioned between departure and arrival stations, with an open traction system working from a motor winch at the upper end. Loads are attached to the main cable and pulled by the traction cable. The empty carriage is then returned for re-loading.	Normally for up hill extraction. Weight of load restricted only by cable size and winch capacity.	Simple installation. No braking problems. Easily controlled. Even tensioning.	Transportation capacity very dependant on distance. Only one load can be carried at a time and time has to be allowed for the return of the empty carriage. Links only points where there are loading platforms. Motor not utilised to full advantage, e.g. on lateral supply and loading.	Not now widely used. Being superseded by cable-crane.

System	*Brief Description*	*Application*	*Advantages*	*Disadvantages*	*Remarks*
4. Tricable (a) Valtellina	Italian tricable system. Two main cables, one to carry loaded carriages and the other, which is of a smaller size, to carry unloaded carriages, are tensioned between terminal anchorages at the departure and arrival stations and carried on a series of intermediate supports. A closed traction cable is attached to the loaded carriages which descend under gravity and provide propulsion for the return of the empty carriages. The carriages are moved between cables by hand at the arrival station. Intermediate stations join two separate systems or permit change of direction.	Transportation on down gradients (normally) over long distances, of all kinds of forest produce. Very appropriate means of transportation where 2 distant points have to be connected.	Large capacity, independent of distance. No winches or motors. Small operating costs. Most items capable of local fabrication. Suitable for all types of slopes. Relatively slow speed requires only simple braking technique.	Large labour expenditure on installation. Requires large numbers of supports and two main cables. Loading can only be done at certain points, to which the timber has to be brought by other means.	Very adaptable to local skill and ingenuity. Good organisation essential. Combination of Valtellina and Crane or Tracks may be extremely profitable.
(b) German	Similar to Valtellina except that the loaded carriages are shunted on to a rail system at the arrival station, unhooked automatically and refixed to the return cable.	As for Valtellina.	As for Valtellina but rails and carriages very expensive.	As for Valtellina.	Used principally for heavy continuous goods traffic at mines, docks and factories.

System	*Brief Description*	*Application*	*Advantages*	*Disadvantages*	*Remarks*
(c) **Va-et-Vient**	In this cable system both cables are load-carrying and the traction system is open. Loads descend on each cable alternatively, returning the empty carriage on the other cable.	Transportation on down gradients over short distances of all kinds of forest produce.	Small operating cost. No winch or motor.	Expensive installation. Two main cables. Limited capacity.	Not used extensively.
5. Short Distance Cable Crane	Cable crane carried on load cable and operated through a traction cable by high speed power winch. To load, the crane travels to the loading point where it is arrested by a movable clamp secured to the main cable. The "nose" of the crane descends and pulls the traction cable to the ground from where it is taken, by the workers, into the forest and the load affixed. The traction cable is then winched in, so tushing the produce to the cable, lifting it to the crane and taking it at high speed to the arrival station, where the process is reversed for unloading.	Normally for uphill extraction, working to and accompanying the road system. Lengths up to 300 yds. Lateral supply 20 yds. each side (of 300 yd. cable). Serves 2.48 acres. Deals economically with 840 to 1,400 cu. ft. per installation, i.e. 336 to 560 cu. ft. per acre yield. Cable cranes are also used for downhill movement but operation is then more complicated and awkward.	Very large load-carrying capacity. Works at high speed causing the minimum of damage to the load, crop and ground. Full use is made of the motor for lateral supply as well as on-the-cable movement. Cancels out need for horse tushing to the cableway. Loading and unloading can be carried out at any point.	Expensive equipment. For downhill extraction a special carrier is necessary which enables the load to be carried parallel to the cable. This carrier is heavier and more cumbersome, so restricting the use of the cable on the lateral supply. Downhill extraction can be 50% more expensive that uphill extraction.	High operating speeds and efficient braking requirements demand that only the best equipment is used. Simple, cheap equipment has not succeeded in any country. All S.D.C. equipment seen in Switzerland was of Kupfer manufacture.

System	Brief Description	Application	Advantages	Disadvantages	Remarks
6. **Medium Distance Cable Crane**	Operated similarly to the Short Distance crane although supports would tend to be higher and therefore more expensive.	Used for lengths of 300 to 800 yards. A crane cable 650 yards long would give a lateral supply of 65 yards on either side thus serving 8.7 acres. The yield for this type of installation should be 450 to 550 H.C.F. per acre or 3,915 to 4,785 H.C.F. per installation.	As with S.D.C.	As with S.D.C. although downhill movement is not quite so difficult as the cable is normally at a higher level.	An Austrian crane, the the Fieldkirch - Nessler "Alberg" is particularly well suited for medium distances.
7. **Long Distance Cable Crane**	The operational method is similar to the Short Distance Crane. The crane moves at high speed (up to 30 km./hour) and is carried on high and elaborate supports. Vertical lift can be 300 to 400 ft.	The Long Distance (Wyssen) Crane is employed down valleys where there are no roads. Used for lengths of 800 yards to over 2,000 yds. An installation 1,650 yds. long would cover a strip 100 yards wide, or 34 acres which, at 450 cu. ft./acre would mean a total yield of 15,300 cu. ft.	Transports large quantities, of upwards of 70 cu. ft. per load, over long distances at high speed. The importance of heavy loads on long hauls cannot be overstressed.	A minimum production of 14,000 cu. ft. per installation is essential for the Long Distance Crane to be an economic proposition.	The crane seen was the Wyssen Skyline Crane with airbrake winch.

Roads and Cables

In the design of a forest extraction system it is essential to decide as early as possible in the life of the forest the extraction method or combination of methods which will be used when the production stage is reached. The principle means of extraction to be considered are either (i) a network of roads and tracks or (ii) a cable system or (iii) a combination of both.

Roads are multi-purpose, providing means of access to the forest for labour deployment, supervision, inspection and fire fighting as well as for produce. Once built and properly maintained, they are there for the rotation of the crop and successive crops. No other system fills so many roles or offers so many advantages and in a flat or gently undulating country a density of roading approximating to a mile per 80 acres is both desirable and economic. However on steep hill slopes the effectiveness of a road diminishes by anything up to 50% and the density has to be greatly increased to give the same coverage. Such terrain usually has obstructive features, rock outcrops and ravines, which increase the difficulty of bringing the produce from stump to roadside. Extraction costs in hill country rise sharply compared with those in less difficult areas.

Therefore, in most cases, a road fed by a track system is the most efficient means of extraction and is by no means superseded by cableways. Nevertheless in difficult and steep country the employment of cableways or a combination of roads and cableways may be advantageous. The general tendency at present in mountain areas with a high anticipated yield is to install a road system with contour roads at intervals of 150 to 200 yards, but the cost of haulage from stump to roadside and the problem of handling heavier timber is ever increasing. Wider spacing of contour road alignments to say 300 to 350 yard intervals working in conjunction with portable short distance cable cranes may reduce the amount of capital investment and at the same time provide a more efficient means of produce extraction.

A working committee to advise and draw up a policy on this aspect of mountain extraction is suggested as an urgent requirement. If it is found that cableways or cable cranes should become integral parts of the forest plan then road alignments in new areas should be planned with this in mind. To continue to plan and build forest roads in accordance with present notions and then at the extraction stage decide that they should be supplemented by cable installations will mean that the capital investment is higher than it need have been if the use of cables had been envisaged originally and the road system designed accordingly.

An important factor to be appreciated is that it is easier to install a portable short distance cable crane—the form of cable operations most likely to commend itself for general use in this country—in a *downhill* direction from the road and extract *uphill* to the road. It therefore follows that in those areas which are approached by a high elevation public road it is not necessary to take the forest road down to the lowest contour. Steep gradients and "zig-zags" may then be avoided. Cableways are single-purpose tools and it is of course acknowledged that they do not satisfy access requirements for the movement of labour, fire fighting, etc. Obviously a balanced plan is required with roads and cables working in a complementary manner.

In Switzerland the extremely difficult mountain forests are being tackled entirely with permanent long distance cable cranes, of lengths up to 1¼ miles, converging on to one or more collecting and converting points on a road at the foot of the slope. Portable short distance cable cranes feed uphill into the long distance cable crane in "herringbone" fashion. Similar areas in the United Kingdom will be rare but a trial site would yield valuable information and experience.

Lateral supply is always a problem and cable cranes in particular offer a solution. They have a distinct advantage over all other forms of off-the-road haulage in that four movements are carried out in one operation.

(a) the timber is tushed by the traction cable from the stump to the carrying cable.

(b) the load is lifted up to the cable.

(c) The load is transported at high speed to the roadside where

(d) it is lowered into the conversion centre or direct on to the lorry.

Thus repeated and expensive manhandling is eliminated and power is always available where it is most needed.

Tushing by horse, tractor or winch rope on steep gradients in regions of high rainfall can give rise to serious soil erosion and it is a virtue of overhead cable systems that this is largely avoided. Damage to the standing crop is also minimised and, in the case of a cable crane, the clearing in which the cable is to operate need be no greater than 10 feet wide.

First thinnings, pulpwood and firewood are most economically extracted by the monocable, converting even useful timber into small wood where the proportion is less than 15% of the total volume. The short distance cable crane is employed when there is upwards of 350 H.C.F. per acre of timber to be extracted and preferably where the crop is open enough to make full use of the traction cable on the lateral supply.

Numerous forest areas are approached by long, tortuously winding and narrow roads through agricultural land. For extraction purposes they are non-productive but nevertheless give rise to high maintenance expenditure.

Frequently they are negotiable by Land Rovers and light lorry traffic but impracticable to heavy, wide vehicles without reconstruction. In such cases there is much to commend an Italian Valtellina, or Tricable system between the forest and the nearest practicable public road, with tracks and/or Cable cranes within the forest. On down gradients and with uniform loading the Valtellina is gravity operated; otherwise a powerwinch has to be incorporated into thesystem.

The building of necessary cable supports and anchorages accounts for a large proportion of the expense of a cable installation. Fabrication from steel or imported wood inevitably increases costs so that wherever possible the standing trees and timber cut on the site should be utilised. Careful attention has also to be given to the maintenance of the installation, the greasing and handling of the cables, to reduce the depreciation factor as much as possible.

The Italian and Swiss forest authorities undoubtedly have extremely good results with cable extraction because of the skill and ingenuity of the workers. Until teams in Britain have developed the same skill and resourcefulness which can only come through experience over a number of years, very close supervision of all installations will be necessary. Successful cable extraction has to be well organised, efficient and rhythmical. Workers at all points in the system have to be kept fully employed and bottlenecks and holdups avoided.

There is an element of danger in all cable installations which cannot be over-stressed. All safety precautions should be taken. Probably the most dangerous system is the fixed monocable on which loads descend freely under gravity and are arrested by a simple buffet arrangement at the arrival station. During a demonstration on the course, a load of small wood broke up on striking the buffer and an interpreter and two participants were injured by flying logs.

Cable extraction in Italy

Produce extraction in Italy is almost entirely by monocable, bicable and tricable (Valtellina) systems. Only in one forest block was a cable crane seen in use and this was a recent acquisition. Systems which rely on the traditional ingenuity of the forest worker and require the minimum of motor power undoubtedly fit in best with the Italian forest economy.

The wage of the average forest worker (in the Foresta Demaniale) is 1,200 to 1,400 lira (13/- to 15/6) per day and normally he is unemployed for 3 months of the year. He is a skilful worker, manufacturing axes, cant hooks, pulley wheels, etc. from scrap metals. The cable systems used involve a large number of man hours on building supports, stations and anchorages, but this is not an important consideration when labour is so cheap. Curiously, although labour is cheap road work is expensive, averaging over 10,000,000 lira per mile, and cable systems are sometimes employed on sites where roading would be a practicable proposition in Britain.

Chur Forest (Grizons Canton). Roads and Cables

Chur forest covers 2,400 hectares and employs a gang of 30 men, or 1 man per 80 hectares. About 1% of the standing volume is cut and extracted annually. The forest is highly mechanised and possesses interalia 2-cable cranes, 8 power saws and road-building plant. All haulage including horse-haul, is by private contract, the most popular vehicle being the Unimog short wheel-base, 4-wheel-drive, lorry, equipped with a Schneider rear winch.

Over 90% of the existing roads and tracks were constructed before 1917and were then built for horse-haul only and so are very narrow and unusable by other than tracked vehicles. A proportion of these are now being rebuilt as motor roads.

The old tracks were placed at intervals of 130 yards, but due to the use of cable cranes, the spacing of new roads is being increased to 275 to 430 yards. In areas which are unroadable, or roadable only at prohibitive cost, sites are selected for permanent long distance cranes to be fed by portable short distance cranes.

Economic Considerations

It is impossible to make strict economic general comparisons between cable and other extraction systems. Each case has to be considered on merit and investment and in the light of local circumstances. Nevertheless experience gained through site trials will enable the influential factors to be analysed and catalogued.

A cable extraction system may be costed as follows:—

(i) $A = E + O$ where

$A =$ Total investment

$E =$ Cost of installation and removal made up of labour costs +overheads, consumable materials, depreciation of non-consumable items.

$O =$ Operative cost made up of labour+overheads, fuels and lubricants, maintenance, repair and depreciation of capital investment.

The unit proportion of E/cu. ft. diminishes as the amount to be transported increases. The number of installations rather than the length of operation is the principle depreciation factor, as cables are usually damaged during installation, not while in use. Amortisation therefore has to be considered during working, erecting and dismantling hours. The operative cost will include (a) transportation from stump to cable and (b) transportation on cable.

(ii) Transportation on the cable is expressed as

$B\left(D_T \cdot t_T \cdot \frac{V_1}{L}\right)$ Where B = operating cost/time unit.

D_T = Average transportation distance on carrying cable.
t_T = Speed of transportation over 1 yard of the carrying cable, allowing for return of carriage.
V_1 = Volume of timber to be transported.
L = Expected average load.

(iii) Transportation from stump to cable (lateral supply) is expressed as:

$B\left(D_Z \cdot t_Z \cdot \frac{V_2}{L}\right)$ Where D_Z = average distance to carrying cable laterally.

t_Z = time taken to transport cable.
V_2 = Volume to be carried.
L = Expected average lateral load.

(iv) Thus $A = E + B\left[\left(D_T \cdot t_T \cdot \frac{V_1}{L}\right) + \left(D_Z \cdot t_Z \cdot \frac{V_2}{L}\right)\right]$

Example

Consider the simplified case of a rectangular forest block, isolated from the nearest motor road by agricultural land, from which produce is to be extracted to roadside by cable crane.

Area of block = 20.6 acres.
Yield per acre = 450 H.C.F.
Total yield = 9,270 H.C.F.

E = say £300.
B = say £2 per hour or £0.03/min.
D_T = 1,000 yards (average transportation distance).
t_T = 0.015 yards (allowing 15 mins. for up and down journeys).
V_1 = 9,270 H.C.F.
L = 25 H.C.F. (same laterally as on cable).
D_Z = 28 yards (10 yards each side of the main cable is omitted leaving 40 yards lateral movement. The average distance, allowing for an oblique haul on the slope, will be about 28 yards.
t_Z = 0.33 mins./yard. (The actual figures would be the subject of a time and motion study).
V_2 = 7,416 H.C.F. (omitting the produce under the cable).

(ii) Movement on cable $= B\left(D_T \cdot t_T \cdot \frac{V_1}{L}\right)$

$$= 0.03\left(1{,}000 \times 0.015 \times \frac{9270}{25}\right)$$

$$= £167.$$

(iii) Lateral supply $= B\left(D_Z \cdot t_Z \cdot \frac{V_2}{L}\right)$

$$= 0.03\left(28 \times 0.33 \times \frac{7416}{25}\right)$$

$$= £82.$$

(iv) Total cost of movement from stump to roadside

$$= A. = E + B\left[\left(D_T \cdot t_T \cdot \frac{V_1}{L}\right) + \left(D_Z \cdot t_Z \cdot \frac{V_2}{L}\right)\right]$$

$$= 300 + 166 + 82 = £548.$$

Cost per cubic foot $= \frac{548}{9270}$

$$= £.059 \text{ or } 1s.\ 2d.$$

In the same manner other methods and systems may be examined to see whether a more favourable result may be obtained, e.g. Valtellina system. combination of crane and Valtellina, use of horses on lateral haul, etc.

Cost of Cable-crane extraction

Stump to roadside extraction costs in Switzerland (Chur), where labour and other costs are similar to those in the United Kingdom, were given as follows. taking the rate of exchange as 12 Swiss francs to the pound.

(a) Short distance cranes. Lengths up to 300 yards.
5¾d. to 7¼d. per Hoppus cubic ft.

(b) Medium distance cranes. Lengths of 300 to 800 yards.
9d. to 10¾d. per H.C.F.

(c) Long distance cranes. Lengths of 800 to over 2,000 yards.
1/1d. to 1/4d. per H.C.F.

With each of these installations the supports were built up from timber on the site and usually incorporating one or more standing trees. To import suitable timber for this purpose, or fabricate the supports from other materials, would obviously greatly increase these costs. The same is true of the terminal anchorages.

Uphill and Downhill Extraction by Short Distance Cable crane

Obviously the method and *direction* of stump to roadside extraction greatly influences the layout of a forest road system. It is commonly supposed that downhill movement is preferable and roads tend to be aligned on the lowest contour. However, so far as cable crane extraction is concerned, this is an incorrect supposition, uphill movement being considerably easier and more economical.

Frequently it is practicable to construct a road at the top of a valley slope rather than in the valley bottom and there are occasions when such a road would mean easier gradients. Installation of a cable crane from a high road downwards means that the winch, crane and cables can all be delivered to the site by road and is therefore relatively simple. The timber is carried perpendicularly and provided the upper end of the load has free passage, the bearer cable need not be very high. This, of course, simplifies lateral haulage and reduces the height of the supports.

The short distance crane is only used for downhill movement where there is no high road and rock outcrops and ridges prohibit normal downhill extraction. The winch and equipment have to be taken up through the wood which is a troublesome and difficult operation, Installation is always carried out downwards from the top anchorage and winch site.

A downward tush can get out of control and it is therefore necessary for the tush to be dragged *uphill to* the cable before being carried downhill *on* the cable. The road has also to be secured parallel to the cable.

A mountain face is normally irregular and broken up by gullies and ravines. For maximum efficiency in uphill extraction the cable crane should be aligned on the ridges so that timber can be brought in from two ravines. When the extraction is downhill the cable line should be in the ravine and minimise damage to standing timber.

HOME-GROWN TIMBER AND THE BUILDING TRADE

By JOHN HOOPER
District Officer, Estates, North Wales

Up to the commencement of the last war less than 10% of the timber consumed in the United Kingdom was home-grown. During the war over 60% was home-grown. Although much of the best home-grown timber was sacrificed in two great wars, it must not be thought that it is in any way inferior to the imported. Prime qualities of home-grown timber are equal to their counterparts in any part of the world. The recession of the home-grown timber trade up to 1939 was principally on account of price—not quality. Imported timber could be brought half across the world and still be cheaper than the English equivalent. The large forest areas abroad enabled mass production methods to be used with consequent reduction in costs. The proportion of land areas under forest in Britain is very low, about 6.5%, compared with the timber-producing countries in Europe—e.g., Sweden 56.5%, Norway 23.8%. (A.1.).

Naturally there is only a limited amount of prime quality timber available in Britain and this state of things will remain for some time, and all the lower grades have to be sold as well. Wartime uses of home-grown timber have accentuated the lower qualities, since nothing could be wasted and all had to be used. Present and future consumers have to be convinced that home-grown timber is equally reliable as the equivalent imported timber.

The Commission's 1958 Annual Report (B) deals with some uses of home-grown timber (2). It is fairly evident that the need for timber by the railways and mines may continue on a downward trend. The picture of the demands by the building trade however is by no means a dreary one. The outlook is encouraging. The building trade is enjoying a considerable uplift. The demand for timber and man-made timber products is very vigorous.

Because of the country's heavy demands for softwood, in which the building trade is eminent, we found it necessary to import £170 million worth of timber (excluding timber products such as pulp, paper and veneers) in 1957 (3). The Editorial of the Timber Trades Journal (C) quotes United Kingdom imports in 1958 as 1,365,000 standards of timber (1957: 1,539,000 standards) from all sources. Principal supplying countries were Sweden 350,000 standards; Finland 320,000 standards; U.S.S.R. 263,500 standards; Canada 250,000 standards. These figures indicate the vast size of the softwood trading industry.

Zuckerman (D) states that 85% of our timber and timber products are imported. This indicates a small margin of production from home-grown timber sources. Such a large import market could now be very remunerable to the impact of a skillfully executed challenge from the home-grown timber marketing trade.

The Board of Trade and the Timber Trades Federation state that figures dealing with the amount of softwood used in the building trade are not available. The National Federation of Building Trades' Employers state that as far as they can judge the building industry use about 750,000 standards of timber per annum.

Forest Record No. 42 (E) states it is believed that more than 40% of the total sawn softwood consumption is used by the building industry for the construction of dwelling houses (4). It is reasonable to presume however in spite of the absence of confirmed figures that the timber requirements in the building trade are enormous. There are no unsurmountable reasons why a generous slice of these demands should not be fulfilled by home-grown timber producers. Generally speaking the demand for timber by the building trade falls into three main categories.

(i) Chipboard and pulpwood materials.
(ii) Structural and carcassing timbers.
(iii) Joinery timber and other high class demands.

(i) Chipboard and Pulpwood Materials

An excellent example of the use of timber waste, and timber unsuitable for use in sawmilling, is now established at Queensferry, Flintshire, where insulating boards are produced. Celotex produce a "Sealcote" hardboard, which needs no priming prior to painting, and this competes favourably with all equivalent imported boards. Weyroc, Waydec and Hardec are produced from roundwood up to 12 inches diameter. At the Weyroc Annan factory, slightly over 1 million hoppus feet of home-grown timber is consumed annually; species used consist mainly of spruces, Douglas fir, and Scots pine.

Supplies of raw materials for these industries are made readily available from home-produced sources. Here then is a ready and willing market. The building trade, at this moment, and for a number of years ahead, will make an enormous demand on this industry for supplies of building boards of various types and for various purposes. There is a word of warning required here however. Home-grown timber will not be the only raw material competing for this building trade market. Boards and sheeting materials made from other raw materials are available now and could become increasingly popular. Stramit board and similar boards for example, made mainly from straw, are very successful products. Plastic and fibre glass products are beginning to appear.

South Africa is at this moment importing a building board made from a species of the eucalyptus tree (*Eucalyptus saligna*). This tree is grown on a 10-year rotation. The boards produced are one of the most superior types on the market, and probably the most successful to resist wet conditions. These examples serve therefore to indicate that the building board market is not an exclusive market for home-grown timber products. It will remain essential to know how to bring about ways and means of reducing the market cost and improving the quality of home-grown building boards, should competitive market conditions make this necessary.

A Board Mill Survey (M) was arranged by the Forestry Commission to study the possibilities of establishing fibreboard and wood-chipboard industries in the United Kingdom. It is a complementary study to the Small Pulp Mill Survey (L).

(ii) Structural and Carcassing Timbers

The builders' needs must be studied. It is essential to know precisely what the demand is. Quality, quantity and size are the three factors that have to be satisfactorily fulfilled. Two factors alone without the third will result in a poor challenge to the market as it stands at present. Poor quality timber will involve the builder in waste and excessive labour in sorting out. The merchant must deal with quantity because small lots will result in increased handling costs. Sizes, and particularly lengths, are important so that the full range of the builders' requirements are catered for. Neither the merchant nor the builder would wish to deal with smaller sizes only of home-grown timber, and larger sizes of imported timber. The demand might inevitably be for the full range of sizes in home-grown timber, or none at all. Imported timber fully meets the demand of sizes and lengths which is important to the builder. Forest Record 42 (5) suggests the range of sizes of 17 feet lengths, 8 inches width, and 3 inches thickness. This range has limitations and will necessitate asking the building trade to exercise a degree of tolerance towards the home-grown product. Nevertheless it may be a risk worth taking when launching the initial challenge to the import trade market.

A very useful little publication (F) was produced about 10 years ago during licensing days dealing with the use of timber in the building trade. It sets down the sizes of timbers used for various purposes. They range from battens at 1½ inches by ¾ inch, to purlins at 9 inches by 3 inches. The average builder does sometimes exceed this range of sizes. The most comprehensive book obtainable dealing with wood-frame house construction is one produced by the United States Department of Agriculture (G). Every aspect of construction and timber needs is dealt with in expert fashion. The Timber Development Association have produced a leaflet, (H) details of which were presented in "The Farmer's Weekly", which deals with the use of timber for farm buildings. A Handbook of Softwoods (J) helps the user in selecting suitable timber for his work and enables him readily to know its characteristics so that he can utilise it to the best advantage. The recently-published Forest Record No. 42 (E) sets out a most informative guide to the species and dimensions of timber used in the building trade. From the above-named publications, can be obtained information enough to determine the species, sizes and gradings of timber required by the building trade.

There is competition to timber used for structural and carcassing purposes by concrete and steel products. Wall sections, floor joists, strengthened metal roof covering which reduce timber support, are some examples. Perhaps the competition is not imminently serious, but it is important to realise that this competition exists. As perhaps a counter-measure to this however, timber engineers have produced made-up timber beams, such as the new "Corrply" beam. This is an H-shaped beam with a plywood web combining the advantages of lighter-weight construction with effective strength.

(iii) Joinery Timber and other Higher Classes of Timber

The strong competition existing from the import market dealing with higher quality timber grades, is one we will have great difficulty in overcoming. The quality of imported timber varies considerably. Evidence of this is contained in F. R. No. 42 (E). The Scandinavian "Unsorted" grades are typical of the general better qualities of timber that can be obtained, and which are in great demand. The builder and the joinery manufacturer are assured of finding timber to meet their needs from the import markets. They have always done so and their confidence and faith rests at this present time in the import market. Little thought is even given to using home-grown timber and one is faced with the fact that there is a prejudice against using it. This is the state of the market that the producer has to face, therefore, a pretty formidable one.

There is one form of timber construction which it is most appropriate to draw reference to. This is the recently perfected engineering feat of laminated timber structure. This present building era will witness a great deal more of this system of timber engineering skill. One of the principle timbers used is Douglas fir.

An analysis of timber markets in the building trade reveals therefore that there is a ready market already in existence for chipboard and pulpwood products. Home-grown timber is adequately suited as raw materials for these markets. A constant observance of building trade trends must be exercised in order to ensure and maintain the assured place of the home-grown timber trade which is being enjoyed at this present time. Supply of timber for structural carcassing and joinery needs from the home-grown market are a more serious and difficult problem. A great deal has to be done, not only in producing timber capable of holding its own against the imported product, but the prejudice created by years of using imported timber has yet to be met and overcome.

Architects, surveyors and others who are responsible for specifying building materials often rely on the British Standard Specification (K) method when specifying timber. F. C. No. 42 (6) refers to this in relation to our enquiries and interviews with many Local Authorities throughout the country. There is ample evidence that both home-grown pines and spruces could be used on a wide scale if a good standard of seasoning and preparation were assured. Seasoning should receive particular attention, because it was on account of inadequate seasoning during the days of softwood consumer licensing that home-grown timber obtained a poor reputation. Accurate sawing, followed by grading for the exclusion of dead knots and excessive wane, should ensure that much home-grown softwood is suitable for carcassing, especially where the average number of growth rings is greater than four per inch (as required by British Standard C.P. 112).

The enforcement of the existing grading rules for home-grown softwood (Forest Products Research Laboratory Leaflet No. 49) (N) would undoubtedly facilitate its wider use in the building industry. That is because this system of grading is designed to meet the appropriate British Standard. Grade I timber would comply with British Standard 1186 for timber in joinery, Grade II would comply with British Standard C.P. 112 for timber in structural work, and Grade III could perhaps be used for non-load-bearing timbers.

The Watson Report (P) issued in 1956 deals exclusively with development of markets for timber produced by the Forestry Commission and from privately owned woodlands. Its report and conclusions can be regarded as the starting point for the creation and development of a healthy and profit-making post-war home-grown timber trade.

One of the important results of this report has been the setting up of the Scottish Woodland Owners' Association, and the Timber Growers Organisation (for England and Wales) which have now developed on a regional basis.

Two comments could be offered concerning the detailed summary of the Watson Report:—

(i) The need for organisation (para. 140, page 58). This paragraph points out the need for some form of overall organisation in the home timber industry. This is a vital necessity and is to be endorsed as it gets to the heart of the matter.

(ii) A Central Consultative Body (165 and 166, pages 65 and 66). Broadening the scope of the representation is a wise move. Consumer interest is most important. It is the consumers (and their agents) who have to be convinced that home-grown timber is a worth-while product which can be specified and used with full confidence.

The suggested appointment of a trade unionist is a wise and worthy recommendation. Independent representation could well include The National Federation of Building Trades' Employers, and The Royal Institute of Chartered Surveyors.

Silviculture

Forest plantations that are scheduled for, and being managed in respect of, the chipboard and groundwood markets will require certain different considerations than forest plantations which will be grown to yield timbers acceptable to the building trade for structural carcassing and joinery purposes. We know that timbers grown in South Africa, which are specifically scheduled for the manufacture of building boards, are grown on a 10-year rotation. Areas are clear felled at the end of the rotation and then replanted. Whether a similar short rotation system can be adopted, in certain instances, in this country is one matter that should be considered by the home-grown timber producer.

Preservative Treatment

It is highly desirable that treated timber should be used wherever there is danger from fungi or insect attack. In recent years there has been an increase in the use of treated wood. Consideration should be given to its wider use and even perhaps to accepting preservative treatment as a standard practice. The treatment of timber for building purposes should be regarded as an insurance premium paid once at the time of erection in order to ensure lasting freedom from fungal and insect attack. Timber used under the following conditions should always be treated:

(i) In contact with the ground.
(ii) At or below damp-proof course level in buildings.
(iii) Wholly enclosed in or in contact with brickwork, concrete or masonry.
(iv) Where adequate ventilation cannot be provided.
(v) Where fungal and insect attack are known to be prevalent.

There are a number of different types of preservatives. To quote one example, the copper/chrome/arsenate "Tanalith C" pressure treatment method costs approximately £11 per standard. This would place less than £50 on a timber house so this would be money well spent.

There have been a number of instances recently where joinery windows, produced from Scandinavian timber felled at an earlier age than normal, having a higher proportion of sapwood present, has given rise to cellar fungus (*Coniophora cerebella*). The suggested cure has been steeping or dipping in an organic solvent wood preservative.

Aims and Objects

The organised aim must be to succeed in producing efficient supplies of home-grown timber of the desired quality and size, and which are properly seasoned and prepared to a good standard. The time will then be ripe to make an effective impact on the softwood import market. To oppose the import market before the fulfilment of the essential conditions could be a gross error. There must be no risk of fostering further prejudice in the building trade towards home-grown timber.

Manufacturers of home-produced chipboard and groundwood products know that the goods they are offering to the building trade are of top quality for the purpose. They are able to compete with similar imported products, such as Swedish hardboard, and products made from raw materials other than timber. They back their products up with a professional advertising campaign which captures the interest of architect and building artisan alike. The companies of Weyroc and Celotex are two perfect examples of this advertising efficiency. Celotex use the slogan "Made in Great Britain from All-British materials". When the time is ripe therefore a similar system of advertising could wisely be adopted to impress the building trade on the advisability of using home-grown timber for structural, carcassing and joinery purposes. The British public are very prone to advertising which displays a national spirit. What better example is there than "England's Glory Matches" proudly claimed as British made? (What about "Scottish Bluebell Matches?" *Editor*).

There are other mediums of advertising and demonstration, such as the Building Trade Exhibition. There was no noticeable reference to home-grown timber in the 1959 exhibition. The Building Trade Olympia exhibition is to the building trade what the Royal Show is to British farming.

It is encouraging to find articles appearing in trade publications dealing with home-grown timber. A full report of the Minister's speech on 4th June, 1959 was reported by the Timber Trades Journal (7). There is a great deal being done to organise marketing, and the effort is on the increase. Even so, it must be appreciated that a lot remains to be done before home-grown timber faces a healthy profitable market in the face of the softwood import trade and other competitors introducing materials alternative to timber.

To summarise the considerations for the future, the following points should be borne well in mind:—

1. The timber producer and the merchant must thoroughly understand the needs of the building trade. The full range of products demanded must be readily available at a competitive price.

2. The prejudice of the building trade must be overcome, and therefore the efficiency of the home-grown product must be proven by demonstration, and effectively put over by professional publicity.

3. There must be created an intimate liaison between the three DISTINCT sections involved, namely:—

 (i) The timber grower.
 (ii) The converting agency.
 (iii) The building trade.

4. The timber grower must examine his silvicultural and management systems and decide if amendments are required to standard practices, so that market needs are more adequately catered for with a resultant increasing profitability.

5. The merchant must pay particular attention to seasoning and converting when producing structural, carcassing and joinery timbers.

6. Consideration should be given by the building trade on the advisability of timber preservation as an economic factor. Increased adoption of timber preservation could well reduce its overall cost.

The proof of any trading concern is the effect it has on its particular trading market. The home-grown timber trade is no exception. Timber conservation is no longer the criterion. Proof of success will be evident when the softwood import market is partly replaced by a profit-making home-grown timber trade.

Finally a note of interest. By way of an experiment in North Wales Conservancy this year, a timber house and a number of forest buildings are being constructed entirely from home-grown timber treated with Boran wood preservative. The first consignment of timber consisted of 19 standards. Species used are Sitka spruce, Norway spruce, Japanese larch and Scots pine.

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1	page	271	(A)
2	,,	12	(B)
3	,,	10	(B)
4	,,	1	(E)
5	,,	8	(E)
6	,,	5, 6	(E)
7	,,	61	(C)

A VISIT TO THE OLYMPIA BUILDING EXHIBITION, 1959

By JOHN HOOPER
District Officer, Estates, North Wales

It is not often that I leave the market town where I live to visit London. A fortunately-timed duty call to the City coincided with the holding of the Building Trades Exhibition at Olympia and it was with great pleasure that I was able to combine the two.

Upon my arrival at Paddington at 1.30 p.m., with luncheon having been taken aboard, I transferred to the Underground Railway and proceeded to Earl's Court. There I changed to a special delightfully decorated train marked clearly "Olympia". This train was crowded and I had no seat, but the journey was not long. The cleanliness and efficiency of the service was remarkable. This set my visit off to a very pleasant start.

Upon arrival at the entry barrier I joined the "Complimentary Ticket" queue. It struck me as remarkable that this should be the longest queue. The cash entry people were in a distinct minority. Two "musts" lay ahead before I commenced my viewing. The first was my programme. Whenever I visit a show, no matter what sort, I always purchase a programme. I regard it as most essential. In this instance I had already decided to form a plan of action as opposed to indiscriminate viewing. The second "must" was the cloakroom in order to deposit coat, hat and bag. I know that tramping from stand to stand can be a tiring and indeed thirsty exercise, and encumbered by baggage would be most inconvenient.

Unhampered by coat and baggage my next step was to find a seat where I could comfortably work out my campaign. A number of exhibitiors very wisely provide comfortable chairs on their stands so that tired viewers could ease their aching feet. I had not neared this stage of course but nevertheless took advantage of this provision.

The programme catalogue had two fold-away plans, well prepared and easy to follow. This is very necessary of course. I could see that the Exhibition was divided up into sections. For example, bricks and tiles were together, heating appliances, timber products, woodcutting machinery and so on. I decided that my main interests were the uses of timber, modern materials and methods for house building, woodcutting machinery and the apprentices section. The reasons for my choice are really simple. Before the last war I was an apprentice carpenter, house design is my hobby and timber is mainly my business.

Due to the layout of the exhibition my order of viewing was to be housing materials, woodcutting machines, timber and its uses and last but not least the apprentices section. I hoped to take in other stands whilst passing along my planned route.

Funnily enough, the first impression I gained in the bricks and tiles section was that the most impressive stands were constructed of Douglas fir timbers cut and wrot to a distinctive finish. What an excellent example of the use of timber. It seemed ironical that the exhibitors were selling bricks and tiles. Plastics and fibreglass are making efficient strides. A range of plastic rainwater goods was on show. I was not particularly impressed but I have expected this was on its way and now here it is competing for markets. Fibreglass sink units and distinctive partitions were very catching to the eye. We will see a lot more of this material yet. One stand of marble showpieces looked a Rolls-Royce to me and yet the price did not seem too high. I was impressed enough to retain the exhibitor's business card. Next, kitchen units enough to dazzle, planned to perfection and a housewife's dream. Then small-bore pipe central heating, but I can never decide which fuel to choose, so commanding are the advertised merits of them all.

I felt at home amid the whir and whine of the saws and planers. I stood so that the shavings from the planer fell into the sleeve of my coat. Only those who have grown to love and appreciate timber will know what depth of feeling can combine with its many crafts.

What of the uses of timber? Building boards galore are on the market. Chip and pulp boards are competing for the extensive markets that exist. Boards made from both imported and home-grown timbers were being shown side by side. From South Africa, eucalyptus, from the hills of Wales and elsewhere the spruces. I feel there will be an ever-increasing threat from the plastic and fibre glass industries to this method of timber utilisation. How serious these competitors will become only time will tell.

Now what is the Rolls-Royce decision in timber. There is no doubt in my mind that it is the laminated timber process of engineering. This is specialist work where a high standard of technology is required. The two components are timber and synthetic resins. Several proprietary resins were being shown and most efficient they appear. Douglas fir and imported hardwoods are the timbers. I have seen illustrations of the vast monolithic concrete structures that exist in countries as far afield as Mexico and Grand Canyon and cannot but admire them. To me, however, the beauty and craft so creatively displayed in the timber laminated structures are far more desirable. One exhibitor had erected a hyperbolic paralleloid roof structure which was craft and beauty itself. What a wonderful use of timber. A high class grade of timber would be essential to the engineer. I fear our home-grown timber market is woefully far behind in this particular engineering field.

Timber house construction was very efficiently and effectively exhibited by Canada House. Canada offers a wonderful range of timbers, hemlock, cedar, pine, Douglas fir, and others. This stand was a show-piece in itself. What a great pity home-grown timber was not shown or emphasised elsewhere in the exhibition.

Time, like many things, will not wait. All that this enemy had left for me was a flying visit to see the apprentices exhibits. The learners of today are the leaders of tomorrow. All industries should support the apprentices. The building industry sets a wonderful example.

I had by no means seen all the exhibits, but what I had seen left me greatly impressed. Building and engineering is a competitive and specialist industry. Great studies and changes are being made. The future is encouraging.

To finish on a personal note—my only real regret was to note the absence of emphasise on home-growing of timber, its uses and its marketing.

THE THETFORD FIRE PLAN

By R. CHARD
District Officer, East England

In view of the importance of fire protection measures, this Plan is reproduced in its entirety, Photos of the control centre and notices appear on our centre pages.—Editor.

EAST ENGLAND CONSERVANCY
THETFORD CHASE, THE KING'S AND SWAFFHAM FORESTS

MASTER STANDING FIRE PLAN

F.Y.60 TO F.Y.64

This Plan cancels any previous instructions or arrangements which are at variance with it.

Prepared by *R. Chard*
Rank D.O.I.
Date 15.2.60.

Approved by *G. W. Backhouse*
(Conservator)
Date: 15 Feb. 1960.

> To obtain assistance in the event of FIRE all staff should notify Forestry Commission Fire Control Centre, telephone number: BRANDON 271.

THETFORD—MASTER FIRE PLAN

Distribution	*Copies*	
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PART I—GENERAL

1. Area Covered

This is a Master Fire Plan for the 15 Beats of Thetford Chase, Brandon Depot, The King's and Swaffham Forests. The arrangements for mobilising assistance apply to fires in Forestry Commission houses or other property as well as to plantation fires.

Approximate areas are:—

Thetford Chase, including reserved plantations on War Department land in the Stanford Practical Training Area	44,000
The King's Forest	6,000
Swaffham Forest	4,000
Total acres	54,000

Out of this total, 44,000 acres (about 69 square miles) are under plantations.

Outbreaks of fire on land (including the Stanford Practical Training Area—known as the Battle Area) outside Forestry Commission boundaries will be fought if there is the slightest risk of such fires spreading to Forestry Commission property. Mobilisation to help fight other fires within the Breckland region will be undertaken at the request of the County Fire Services provided that the Duty Fire Officer decides that this can be done without prejudice to the protection of the Forests. (Such mobilisation will normally be regarded as training and charged accordingly).

2. Hazard

This is classed as high. Average annual rainfall is low (24 in.), relative humidity is frequently less than 50%, and windless days are few. The ground vegetation is mainly grass and bracken with some areas of heather and gorse; also reeds in the river valleys. The forests are predominantly coniferous, and although generally less inflammable than when consisting mainly of young crops in the thicket stage, could be the scene of huge conflagrations if crown fires developed in the large blocks of plantations.

3. Risk

The risk is very high. The forests are intersected by many main and secondary public roads and by railway lines. The introduction of diesel engines for some train services has reduced the risk from the railways), but the risk from the roads (vehicle exhausts, cigarettes) has increased. Military training is a special risk, as is the possibility of aircraft crashes since there are a number of important airfields close to the plantations.

It is the practice of local farmers to burn stubbles and to burn twitch and other weeds removed in cultivations. These operations, although usually controlled, are a risk, and they are of necessity carried out when fire hazard is considerable.

The risk of fires being accidentally started by Forestry Commission employees is slight, but since there are always staff changes, it is necessary to record it so that training in safety measures is not overlooked.

4. Special Danger Areas

The areas of greatest danger are young pine plantations, particularly those not brashed, where they are near railways, public roads, the Stanford P.T.A., rifle ranges, houses, Thetford Golf Course, or other constant sources of fire risk.

On this basis each Beat has its special danger areas which must receive special attention from the Forester-in-charge as regards maintenance of access routes, water supplies, fire brooms, and authorised fire breaks.

5. Danger Periods

Fire risk is always present but increases with the influx of the public into the countryside such as may be expected on fine weekends from March to September and especially at holiday times.

Fire hazard varies continuously according to daily changes of weather (particularly humidity and wind strength) and growth or death of vegetation. Drying winds can arise quite suddenly particularly between February and April.

Generally a dangerous combination of risk and hazard may be expected any time from the middle of February until June before grass and bracken become green, and again during hot weather from July to the beginning of October when grass on the sandy soil can be quickly shrivelled. Heather and gorse will burn in any season if there is a dry spell.

On average, 2 p.m. Greenwich Mean Time or 3 p.m. British Summer Time is the most likely time of day for fires. Exceptionally there are periods without dew when hazard may be high even in the morning.

By the 'fire season' is meant the period from commencement of fire tower duties until the lookouts are finally stood down in the late summer or autumn.

6. Access

In addition to a good system of public roads, there is a network of forest roads and motorable rides. The whole terrain is relatively level, and the generally good drainage and light soil lends itself to the inexpensive creation and maintenance of good access for wheeled vehicles.

Improvement of access must be an important consideration. A question which staff should always be asking themselves as they go round the plantation in their charge is: "If this plantation was threatened by fire, could fire tenders get to it easily?"

7. Water Supplies

The forests contain some natural and semi-natural accessible water supplies, but these are not well distributed and the provision and maintenance of static water tanks is necessary. A second question which staff should practice answering is: "Where are the nearest water supplies?"

8. General Principles of Fire Protection Measures

I. EARLY DETECTION OF SMOKE.
II. ACCURATE LOCATION OF OUTBREAKS.
III. RAPID MOBILISATION OF FIRE FIGHTERS AND EQUIPMENT.
IV. USE OF WATER IN THE FIRST ATTACK.

The application of these principles demands an efficient system of look-outs. a means of co-ordinating their reports, pre-determined arrangements for mobilisation, and above all good access to permit tenders to get to outbreaks before they have had a chance to develop.

9. Responsibility for the Administration of the Plan

Overall responsibility rests with the State Forest Officer (Thetford). Both District Officers, with the assistance of their Head Foresters, are responsible for preventive measures and organisation within their Districts, and will require the Beat Foresters to take all necessary protective measures on their Beats.

The S.F.O. will decide when fire tower duties will begin and finally end. During this period, known as the fire season, one District Officer or Head Forester will be on duty in accordance with a rota prepared by the S.F.O. This District Officer or Head Forester will be known as the Duty Fire Officer and he will be primarily responsible for the suppression of fires in the whole of the Forests.

During periods of high or extreme fire danger he may be assisted by the District Officer or Head Forester from the other District as may be arranged by the S.F.O.

10. Upkeep of Equipment

The maintenance of all vehicles, power pumps and other mechanical equipment is the responsibility of the Foreman Mechanist at Santon Downham.

Radio sets receive normal maintenance under a contract with Messrs. Barnetsons of Thetford. The Duty Fire Officer is responsible for ensuring that faults are reported to them. The main set aerial, mast and guys on the water tank at Santon Downham are also inspected and minor adjustments made, under contract. This contract is at present held by Messrs. Skymasts, Bendon Road, London, W.6.

Repairs or renewals not covered by these contracts must be arranged by the S.F.O. The suppliers of the present equipment are Messrs. G.E.C., Communications Dept., Ford Street, Coventry.

The Conservancy Engineer is responsible for the maintenance of the structure of fire towers.

The maintenance of hand tools and equipment (including the batteries of radio pack sets) in the Fire Station and Fire Control Centre at Santon Downham is the responsibility of the Fire Wardens.

The maintenance of hand tools, equipment, signs and notices in the Forests is the responsibility of the District Officers, Head Foresters and Foresters. It is particularly important that all signs and notices shall be kept smart and efficient-looking and shall be of uniform design throughout the Forests.

The Foreman Surveyor at Santon Downham is responsible under the general direction of the S.F.O. for keeping all fire maps up to date. All holders of maps are responsible for seeing that their maps are deposited with the Foreman Surveyor, together with a note of requirements by the 30th November each year, in order that they may be amended and returned by the 1st February.

PART II—PREVENTION

11. Natural Fire Breaks

The main block of Thetford Chase contains very few tracts of agricultural land wide enough to stop a crown fire in conditions of extreme fire hazard, but in moderate conditions roads, rivers and broad rides would check fires sufficiently for them to be fought to a standstill.

12. Prepared Fire Breaks

(i) **Cultivated.** Access for wheeled vehicles is an important feature of all fire breaks and no cultivations are to be made to the detriment of access.

Cultivated strips must have, on the plantation side of them, access routes for vehicles.

Cultivation will be by harrowing, so timed to maintain permanent absence of vegetation. Once fire breaks are established in this way cultivation can be shallow thereby creating firm enough conditions to allow if necessary the passage of fire tenders and landrovers.

Cultivated fire breaks about 2 chains in width will be maintained alongside railway lines, and narrower breaks on external boundaries where there is a combination of high hazard and risk.

Roadsides within the forests are not classed as external boundaries and will not be cultivated.

In laying out large blocks of new planting, consideration will be given to leaving very wide rides for cultivation and cropping by sporting tenants. This will be the only internal cultivation carried out on forest land.

(ii) **Mowing.** Roadsides (excluding verges mown by local Councils) and rides will be mown sufficiently to maintain good access and to reduce fire hazard.

Such mowing must begin early enough in the summer and continue reglarly enough to eventually eliminate bracken. Vegetation must be mown before it becomes rank, otherwise the mowings temporarily increase hazard.

Levelling of roadsides should be carried out wherever practicable in order to permit mechanical mowing.

Under certain power lines the cost of mowing is recoverable from the Eastern Electricity Board.

(iii) **Controlled Burning.** There will be no controlled burning by the Forestry Commission. The British Transport Commission undertake controlled burning on their own property and liaison is necessary between Foresters concerned and local railway linesmen so that the time and location of this burning is known in advance and reported by Foresters to the Fire Control Centre at Santon Downham.

(iv) **Brashed Belts.** Young conifer plantations adjoining definite sources of fire risk, e.g. railways, public roads and heathland accessible to the public, will be brashed as early in their life as is silviculturally possible. The brashings will be cleared back into these plantations for a distance of one chain.

(v) **Hardwood Belts.** The objective is to divide the whole of the forests into blocks of not more than 400 acres, by hardwood belts of from one to two chains in width. These belts will be adjacent to roads or rides.

Most of these belts have now been planted but will not prove fully effective for some years. Maps showing them will distinguish between effective and non-effective belts.

13. Public Relations

(i) **Notices and Warning Signs.** It is important that notices and signs detract as little as possible from the appearance of the forests. Notices and signs will be of standard design throughout and will be kept to the minimum necessary particularly as regards the numbers of different signs erected at any one point. Neatness and smartness are vital since poorly designed and neglected looking signs create the impression that fire precautions are not of much concern.

The standard warning notices are the fire broom stands made of creosoted pine and manufactured at Thetford Chase Creosoting Plant. These should each hold two birch fire brooms, and some will have affixed to them Forestry Commission fire warning notices.

The fire broom stands should be sited mainly on roadsides and other places frequented by the public.

A number of creosoted frames to hold large (8 ft.×4 ft.) warning notices will be permanently maintained at points on roadsides where they are most likely to be seen by motorists entering or passing through the Forests. Three of these large notices will be available for each District for erection when fire danger is likely to be high or extreme. They will bear slogans such as "You can prevent forest fires", and will be moved from point to point at fairly frequent intervals. It is important that they should be taken down when fire danger is unlikely to be high. The responsibility for arranging erection, movement, and taking down of boards rests with each District Officer.

Notices, to be held by Beat Foresters, will be hung on certain gates during high fire danger, warning the public not to enter.

Warning notices for display on vehicles will be used during the fire season if available.

(ii) **Warning Leaflets.** No arrangements for leaflet distribution are planned. See Appendix C for specimen letter sent by Conservator to neighbouring land occupiers at the beginning of the fire season.

(iii) **Propaganda Talks.** Requests by schools and many different organisations and individuals to visit the forests are numerous. The need for fire prevention will be given publicity on these occasions.

(iv) **Burning by Neighbours.** Foresters will endeavour to be on sufficiently close terms with neighbouring land occupiers that prior warning of any intended outdoor burning will be obtained.

Foresters will telephone information about actual or proposed burning operations by neighbours to the Fire Control Centre at Santon Downham by 10 a.m. or as soon after as possible, each day during the fire season.

(v) **Warning F. C. Staff.** Foresters, the Foreman Mechanist and the Estate Clerk of Works are responsible for reminding their own staff of the need to take care with cigarettes and matches and not to smoke in the forests except at authorised times and places.

Such warnings should be given at the onset of the fire season and again if fire danger becomes high or extreme.

(vi) **Railway Danger Zones**

(a) Whole 7 miles from Brandon to Thetford.

(b) From Roudham Junction for 2 miles towards Attleborough.

(c) From Roudham Junction for 4½ miles to Stow Bedon crossing.

(d) At Broom Covert, Swaffham, for ½ mile on the King's Lynn line.

Standard signs are placed at the entrances and exits to these zones to notify engine drivers.

The address of the Regional Officer of the British Transport Commission is Thorpe Road, Norwich.

Permits are required to enter onto Transport Commission property. The S.F.O. is responsible for obtaining these for all staff likely to have need.

PART III—ORGANISATION

14. Equipment and Water Supplies

(i) **Fire Brooms, Pumps and Hose.** For details see Appendix D.

Fire brooms will be of birch 7 ft. in overall length and distributed in twos in stands (made at Thetford Chase Creosoting Plant) at strategic points along roadsides and other public places, and singly at two chain intervals along each side of the railways, staggered so that they are one chain apart. Reserves will be held at Santon Downham Fire Station and at Beat Fire Depots.

Hand pumps to be carried one in each van. Reserves will be held at Santon Downham and at Beat Fire Depots.

Land-Rovers are equipped with Langdon pumps but these require improvement or replacement.

Firetenders have Hathaway Mk. III pumps with 1 inch delivery hose and instantaneous light alloy couplings.

(ii) Supplies of Spades and Cutting Tools. Small reserves will be held at Santon Downham Fire Station and at Beat Fire Depots. Extra supplies can be obtained from the Forest Stores at Santon Downham and from Beat tool stores. All vans and Land-Rovers will carry a slasher with which emergency fire brooms may be cut.

(iii) Transport. For details see Appendix D.

(a) Adequacy of existing holding. Holding of fire tenders, tanker, landrovers and lorries is adequate in number but replacement of the tanker and fire Land-Rover is urgently required. There is a shortage of transport for Foresters-in-charge.

(b) Future requirements. Unless there are large acquisitions of plantable land, future requirements are likely to be restricted to replacement of old vehicles, and provision of sufficient vans or other suitable vehicles to enable one to be allocated to each Forester-in-charge.

(c) Hired vehicles. The need is not likely to arise as the F. C. employs its own fleet of lorries for hauling produce.

(iv) Water Supplies. The rivers Lark, Little Ouse, Thet and Wissey cross the area but are an asset only very locally. The best river supply is from the Little Ouse at Santon Downham where a hard standing has been made near the former Downham nursery.

At Santon Downham a hydrant near the Fire Station may be used for filling tenders in an emergency and there are five other hydrants in the village.

Lakes at Didlington and Lynford are normally reliable, but the principal water supplies after initial supplies carried by F. C. tenders or the tanker have been used, are provided in static tanks of 3,000 to 5,000 gallons capacity. These are situated at intervals throughout the forests. (About one tank per 500 acres). Most of these tanks are constructed of concrete so that when filled the surface of the water is at ground level. Older types of static tanks will be replaced by this type and a small number of extra tanks will need to be constructed on newly acquired land.

Foresters are responsible for initiating action by the Clerk of Works at Santon Downham to ensure that all static tanks on their territory are kept full. All water supplies except hydrants will be demarcated on the ground by upright yellow posts 3 inch top diameter standing 5 ft. out of the ground with yellow finger boards 5 inches wide, if it is necessary to indicate direction. The position of hydrants on F. C. land will be marked by smaller posts showing the distance in feet of each hydrant from its post.

Standard warning notices with the words 'Danger Deep Water' will be maintained at all static tanks and Foresters will periodically inspect netting covers and arrange for defects to be repaired.

Access to water supplies is important and the surrounds of static tanks will be levelled and kept clear of rank vegetation by regular mowing if necessary.

The No. 1 and No. 2 fire tenders may not be used for any purpose without the approval of the Duty Fire Officer during the fire season or the S.F.O. out of the fire season.

The tanker is engaged during working hours in delivering drinking water to tenants. The Estate Clerk of Works at Santon Downham is responsible for supplying the Fire Control Centre with a note of its daily scheduled journeys so that its probable location at any time is known by the duty staff.

(v) **First Aid Equipment.** First Aid Boxes will be carried on fire tenders, the tanker and in the fire Land-Rover. A further box is held in the Fire Control Room and additional stocks are available from the Forest Stores.

15. Fire Control Centre

(i) **Location and Manning.** (See Appendix D for equipment in the Fire Control Centre).

A Fire Control Centre for the whole of the forests is situated in the District Offices at Santon Downham. In addition, Foresters' offices are Beat Control Centres. Arrangements for manning will be as follows:—

Fire Control Centre:—

	A. Fire Season	
Fire Danger Rating:	*Working Hours*	*Non-working Hours*
Nil, Low, or Moderate	Staff manning actual offices: Duty Fire Officer, at least one District Office Clerk or a Fire Warden	Staff on call at home: Duty Fire Officer, Duty Fire Warden
High, or Extreme	Duty Fire Officer, a District Officer or Head Forester, a Fire Warden if D.F.O. instructs. At least one D.O. clerk	Duty Fire Officer, a District Officer or Head Forester, Duty Fire Warden
	B. Non-Fire Season	
Fire Danger Rating:	*Working Hours*	*Non-Working Hours*
Nil, Low or Moderate	Staff manning actual offices: At least one District Office Clerk	Staff on call at home: Duty Fire Warden

Beat Control Centres:—

	A. Fire Season	
Fire Danger Rating:	*Working Hours*	*Non-Working Hours*
Nil	Staff manning actual offices: Nil	Staff on call: Nil
Low	Nil	Forester in charge or authorised relief
Moderate	Beat Clark or other responsible person	Forester in charge or authorised relief
High	Forester in charge or responsible assistant	Forester in charge or authorised relief
Extreme	Forester in charge	Forester in charge
	B. Non-Fire Season	
Fire Danger Rating:	*Working Hours*	*Non-Working Hours*
Nil	Nil	Nil

The fire season is the period from the date when the S.F.O. first requires tower look-outs to report for duty in the early spring until he finally stands them down in the late summer or autumn.

The S.F.O. will prepare a rota listing, for each week of the probable fire season, the Duty Fire Officer, the District Officer or Head Forester who will assist in the event of high or extreme danger and the Duty Fire Warden.

The Fire Control Centre is normally staffed during their working hours by two District Office clerks who are experienced in operating the telephone switchboard, receiving and transmitting radio messages, plotting smoke bearings and keeping the Control Centre Log Book. The District Office clerks, by staggering their lunch hours, ensure that the Control Centre is never unattended during the often critical period between noon and 2 p.m.

The Duty Fire Officer will be deemed to be manning the Control Centre provided that he can be called by radio or telephone. During working hours he should not, however, go away from the vicinity of the District Offices except on official business and in the fire Land-Rover, which should also be used for lunch-time travelling between home and office.

During the fire season it is particularly important that the S.F.O., the District Officers and Head Foresters keep the District Office clerks informed of their probable whereabouts.

An outbreak of fire automatically means that the District Officer (or Head Forester) listed as the assistant to the Duty Fire Officer, will be contacted if possible and asked to be ready to assist, whether or not fire danger had previously been regarded as high.

During working hours the Duty Fire Officer may call in one or both of the Fire Wardens to assist in the Control Centre at any time circumstances demand. In periods of very high or extreme fire danger this need may be anticipated by the S.F.O. who will arrange accordingly.

Outside normal working hours the Duty Fire Officer and Duty Fire Warden will be on call by telephone at their homes, but the Duty Fire Warden will man the Control Centre whenever the Duty Fire Officer is called out. He will also man the Control Centre on Saturday, Sunday, or other holiday afternoons when *all* the following conditions prevail:—

Relative humidity 40% or less.
Wind fresh or strong.
Number of days since last rainfall exceeds 3.

When Beat Control Centres are manned by Beat Clerks or persons other that the Forester i/c or his assistant it is important that the Forester, or his assistant, leaves a note of his whereabouts at the Beat Control Centre so that he may be contacted reasonably quickly.

After working hours, including week-ends, during the fire season, it will be normal for the Forester in charge of each Beat to be on stand-by fire duty, but the following reliefs may operate subject to approval by the District Officer of the Forester concerned, and notification of the Duty Fire Officer:—

	Beat	*Relief for Forester in charge*
	Brandon Depot	Either of the two Asst. Foresters
No. 4 District	Feltwell	The Forester i/c Mundford
	Croxton	*The Forester i/c Hockham
	Didlington	The Asst. Forester
	Hockham	The Forester i/c Roudham
	Lynford	The Forester i/c West Tofts
	Mundford	The Foreman or the Forester i/c Feltwell
	Santon	The Asst. Forester or the Forester i/c Downham
	Swaffham	The Asst. Forester
	West Tofts	The Forester i/c Lynford or Forester i/c Croxton
No. 5 District	Downham	The Foreman
	Elveden	Either the Asst. Forester or Foreman
	Harling	The Asst. Forester
	High Lodge	The Forester i/c Redneck
	The King's	The Asst. Forester
	Mildenhall	The Forester i/c The King's Forest
	Redneck	The Forester i/c High Lodge
	Roudham	The Asst. Forester or *the Forester i/c Hockham

* Indicates that the relief will be on duty for his own Beat as well, but never on duty for more than his own Beat and one other. District Officers will not withhold approval of these reliefs unless fire danger is very high or extreme, or there are other good reasons. Any alteration to the authorised reliefs requires approval of the S.F.O.

(ii) Rendezvous Points (i.e. Fire Routes). The whole of the area is served by a network of forest roads and motorable rides termed Fire Routes. These are numbered consecutively and indicated by 6-inch red numbers on rectangular white boards mounted on upright white posts 3 inch top diameter, standing 5 feet out of the ground. The posts are positioned at the junctions of Fire

Routes with Council roads, and the boards are fixed like signpost finger boards and point in the direction of the Fire Route. Fire Routes must be signposted inside the plantations where there are major ride junctions, or sharp changes of direction occur. These signposts will consist of white boards 5 inches wide bearing 4-inch red numbers and mounted on white posts standing 4 feet out of the ground. These boards will be pointed at the ends to indicate direction.

16. Communications and Alarm Methods

(i) **Public Roads.** There is a good system of public roads, but sections of some public highways (e.g. Harling Drove) which would be useful for forest traffic, are not developed by the County Councils and are even a disadvantage since their maintenance is uncertain. However, the fire risk would increase if these public roads were more suitable for motor traffic, and in improving access it is the policy to concentrate as far as possible on routes over which the F. C. has full control.

(ii) **Forest Roads.** It is particularly important that forest roads and rides designated as Fire Routes are maintained in good condition so that County Fire Service tenders can traverse them safely at reasonable speed.

In the few cases where it is necessary to have padlocked gates across roads or rides, a standard padlock will be used. A reserve of standard padlocks and keys is to be held at the Fire Control Centre.

In addition to Fire Routes, rides surrounding Compartments are kept mown to provide access for vehicles.

Compartments are divided into sections of about 5 acres by tracks 18 ft. wide, and again by numerous extraction tracks when thinning begins.

(iii) **Fire Towers.** Five 80 ft. and two 60 ft. fire towers enable observation of the whole area. These are named and situated as follows:—

Swaffham	map	reference	782060
High Ash	,,	,,	805975
Denton Hill	,,	,,	753919
Gallows Hill	,,	,,	864847
Roudham	,,	,,	950884
High Lodge	,,	,,	791853
The King's	,,	,,	805732

No further towers are definitely required during the period of this plan but acquisition of land in certain areas, e.g. Mildenhall or Hockham, would require the position to be reviewed.

Fire towers must be fenced and when not manned, padlocked against trespass. Nearby each tower there is to be a suitable shelter. Foresters are responsible for keeping the fire tower sites clear of rank vegetation. Each tower will be equipped as follows:—

G.P.O. telephone.

Log Book.

Clock.

Binoculars.

1 inch map of surrounding area with pointer and compass rose centred on position of the tower.

Seat.

Venetian blinds on south and west windows.

Oil Stove.

Foresters will provide spray to kill flies as may be necessary. Windows will be marked in degrees with white paint and a plumb-line from the roof will be positioned to enable accurate bearings to be taken.

(iv) **Telephones. (See Appendix B).** All telephones are G.P.O. At the Fire Control Centre there is a 3×20 switchboard.

(v) **Other Alarm Methods.** There are three sirens at Santon Downham which all operate simultaneously on the press of a button at the Fire Control Centre.

The following code of signals will be used:—

Sequence of short blasts (wailing). This means that an outbreak of fire has been reported to the Control Centre. The Duty Fire Officer and, when he is on stand-by duty, the District Officer or Head Forester detailed to assist him, will report to the Control Centre if not already mobilised. Possible fire tender crews will be on the alert, but only one either during or after working hours is expected to report to the Fire Station except on subsequent instructions or requests originating from the Duty Fire Officer.

Since personnel at the Creosoting Plant may not hear the sirens three long rings on the telephone (outside bell) will be used to signal that a fire tender will be calling to pick up a crew.

Prolonged long blast. This means that there is a fire at which the fire-fighters need reinforcements. It is a signal for assembly at the Fire Station of all persons able to fight fires. Persons answering this call quickly will receive appropriate payment whether or not they are sent into action, provided that on arrival at the Fire Station they are suitably clad and in a fit state to fight fires.

Testing of Sirens. It is the responsibility of the Fire Wardens to ensure that the sirens are in working order and they will test them either personally or by request to District Office clerks. The time for testing will be 9 a.m. on Fridays. A short call only will be made.

(vi) **Radio.** The equipment consists of a fixed station at Santon Downham operating from mains electricity, three sets in Land-Rovers, and four pack sets. The operating frequency is 86.475 Mc/s.

During the fire season one pack set will be carried in the fire Land-Rover for use at fires where it is necessary for communication over a distance to take place between the person (e.g. Beat Forester) immediately in charge of the fire-fighters and the Duty Fire Officer at the Fire Control Point.

Pack sets may be carried in other vehicles wherever a possible advantage is foreseen, but one will always remain in reserve at the Fire Control Centre.

All Foresters will be trained in radio communication. Arrangements for training are the responsibility of District Officers.

Set Call Signs:—

Fire Control Centre at Santon Downham	—	Sanfire	Control
Fire Land-Rover (Duty Fire Officer's Land-Rover)	—	,,	Able
No. 4 District Land-Rover	—	,,	Baker
No. 5 District Land-Rover	—	,,	Charlie
Pack Sets	—	,,	Mike
	—	,,	Nan
	—	,,	Oboe
	—	,,	Peter

Personal Call Signs:—

Conservator, Mr. Backhouse	*1*
Regional Forest Officer (East) Mr. Ballance	*2*
State Forest Officer (Thetford) Mr. Chard	*3*
District Officer No. 4 District, Mr. Small	*4*
District Officer No. 5 District, Mr. Tilney-Bassett	*5*
(No. *6* not allocated)	
Head Forester No. 4 District, Mr. Anderson	*7*
Head Forester No. 5 District, Mr. Redford	*8*

The use of the word 'Sanfire' is necessary at the beginning and ending of a series of transmissions only. Thus the normal call sign, for example, of H.F. No. 4 District transmitting from fire Land-Rover is *Able Seven*. Personal numbers are not used in transmitting from Control.

Maintenance. The Fire Wardens are responsible for keeping batteries of pack sets charged for testing these sets and reporting any defects to the Duty Fire Officer. All users of the main set, Land-Rover sets, or pack sets will report any defects to the Duty Fire Officer or, in emergency, direct to the maintenance engineers, Messrs. Barnetsons of Thetford.

17. Fire Tower Lookouts and Patrols

Lookouts. Each Forester on whose Beat a fire tower is situated is responsible for ensuring that it can be manned if necessary each day of the fire season. Fire towers will be manned whenever the Fire Danger Rating is Moderate, High, or Extreme, or is expected to increase to Moderate later the same day.

Prior to 10.30 a.m. each day the Duty Fire Officer will assess the probable degree of fire danger and leave instructions with the District Office clerks, or Duty Fire Warden at week-ends and other holiday times, as to which towers are to be manned, or whether lookouts are to report back later for further instructions. Tower lookouts will telephone the Fire Control Centre between 10.30 and 11.0 a.m. to receive instructions.

Normal duty times will be:—

From date of first reporting until the Thursday before Easter:—
11 a.m. to 5 p.m.

Good Friday until the Thursday before Whitsun:—
11 a.m. to 6 p.m.

Friday before Whitsun until 15th September:—
11 a.m. to 7 p.m.

16th September until stand-down:—11 a.m. to 6 p.m.

The Duty Fire Officer will lengthen or shorten the times if necessary on a day-to-day basis.

Tower lookouts will report all sightings of smoke or fire immediately to the Fire Control Centre at Santon Downham. Such reports will usually take the following form:—

Identity of Tower. Description of what has been seen. Bearing (to nearest 5°) e.g. "Gallows Hill Tower. White Smoke. Line 27½" means that Gallows Hill Tower lookout has sighted white smoke on a bearing of 275°.

It is essential that such messages are kept as brief as possible since in all probability other lookouts will be trying to telephone the Fire Control Centre at the same time and their bearings are needed to enable the location of the smoke to be plotted.

Lookouts must, however, be prepared to give further information if requested to do so from the Fire Control Centre. Information likely to be required is:—

(1) Estimated distance of smoke from the tower.

(2) Whether smoke is increasing or decreasing.

(3) Whether smoke has changed in colour (e.g. from white to black).

(4) Estimated wind strength (still, light, moderate, fresh, strong) and direction from which it is blowing.

Lookouts are responsible for maintaining a log of attendance and times and details of messages (e.g. bearings of smoke). These logs will be periodically inspected and initialled by Foresters in charge. Lookouts will keep the cabins of their towers tidy and clean. Fire tower equipment must be safeguarded and any losses or defects immediately reported to Foresters.

Lookouts must not leave their posts without instructions to do so from the Fire Control Centre, including the end of normal duty periods. Lookouts may descend from their cabins in the event of the approach of thunderstorms threatening lightning, but must first notify the Fire Control Centre.

Patrols. The numbers of men required for railway patrols are:—

Railway Line	*Moderate Danger*	*High and Extreme Danger*
Brandon-Thetford	3	5
Roudham Junction towards Attleborough	2	3
Roudham Junction to Wretham	1	2
Wretham to Stow Bedon	1	2
Swaffham to Kings Lynn at Broom Covert	1	1

At Roudham, patrols are necessary only when there is no work proceeding in the nursery. On the Roudham Junction-Wretham-Stow Bedon line steam trains are very limited and patrols may be of limited duration accordingly.

Patrols on roads and at other danger points, are required in limited numbers when there is extreme fire danger. Since extreme conditions may exist for a short period of a day only, such patrols have usually to be posted when high fire danger persists with the possibility of extreme conditions.

During working hours economy in such patrols should be effected by employing men near roadsides or other danger points when possible.

Responsibility for posting patrols and seeing that they are fully equipped and instructed, rests with each Beat Forester, but it is important that arrangements are co-ordinated by District Officers so that there is no unnecessary overlapping, e.g. where a public road is a boundary between two Beats.

The Fire Control Centre must be informed where and when patrols will be posted.

The duties of patrolmen are:—

(a) The immediate suppression of small fires.

(b) Raising the alarm if a fire cannot be suppressed quickly without assistance, first by firehorn to summon other patrolmen, secondly to Brandon 271.

(c) Preventing the public from lighting fires, or using stoves on Forestry Commission land.

(d) Preventing the public from blocking Fire Routes and other roads or rides with cars, etc.

(e) Noting the registration numbers of cars parked near areas of high hazard or otherwise likely to be a risk.

(f) Advising the public of the risk of starting fires when smoking.

Usually if fires are not immediately suppressed by patrolmen, the alarm will be raised by the fire tower lookouts, but action under (b) above should nevertheless be taken without delay as an extra safeguard.

As regards (d) and (e):—

(i) A motorist is not committing an offence under the Road Traffic Act of 1930 if he parks his car *within 15 yards* of either a public highway or a private F. C. road which the public are allowed to use.

(ii) F. C. staff are within their rights, however, in ordering a person to remove his vehicle from any F. C. land, including that adjoining any public or private road within a distance of 15 yards.

(iii) The rights under (ii) include the right to order a motorist off the road itself if this is a private F. C. road (although commonly used by the public by consent).

Each patrolman should be equipped with an armband, a duty book and firehorn. Railway patrolmen will require a permit card authorising them to enter on to British Transport Commission property.

18. Labour and Assistance

(i) Forestry Commission Personnel. Each Forester in charge is responsible for the arrangements for mustering his staff for fire-fighting both during and after working hours. The location of working gangs must be known at each Beat Control Centre.

It should be possible during working hours for the Duty Fire Officer to muster 50 or more men at any point within the Forest area in less than 45 minutes. Up to 200 men could be mustered within two hours by using Forestry Commission lorries for transport.

It is essential that all men shall be led by an adequate number of gangers, so that organised teams may be deployed at a fire.

(ii) Forestry Commission Fire Tenders. Each fire tender should be manned by a crew consisting of a driver, a pump man and a hoseman. If full crews cannot be obtained quickly at Santon Downham, tenders will be sent to the fire without delay and the crews will be completed from persons at the fire.

The tanker, if not on its rounds, will be manned by the first driver available.

During high fire danger when extreme conditions are possible, fire tender crews and a tanker driver may, at the discretion of the S.F.O., be employed near the fire station at Santon Downham.

(iii) Training of Fire Fighting Teams. Each Forester in charge is responsible for ensuring that his staff is trained in the use of fire brooms and other hand equipment.

The Foreman Mechanist under the general direction of the S.F.O. is responsible for training transport staff, and staff at the Creosoting Plant, to operate as effective fire tender crews.

Foresters will be familiarised with equipment on fire tenders so that they may more effectively take charge of tenders on their Beats if the need arises.

District Officers are responsible for arranging with the Foreman Mechanist for Foresters to visit the Fire Station and be given the opportunity to handle the equipment.

(iv) **Outside Assistance.** *The County Fire Services* whose statutory duty it is to suppress fires, provide the main and vital assistance. Fire stations exist at East Harling, Methwold, Thetford, Swaffham and Watton in Norfolk; and at Brandon, Bury and Mildenhall in Suffolk.

Predetermined first attendance at a Forestry Commission fire is two C.F.S. tenders; a progressive build-up to 12 appliances in an hour and a half is possible.

The Police will assist in investigating smoke reports and will control traffic The cause of a fire may also need their enquiries.

The Military have undertaken to provide troops on request to the H.Q. East Anglian District at Colchester or direct to Stanford P.T.A., with subsequent notification to H.Q. at Colchester.

The United States Air Force at Lakenheath will provide one fire tender and up to 25 men. Possibly earth-moving equipment (e.g. graders) also.

The Royal Air Force from a number of air stations in the area will provide men.

The Automobile Association and Royal Automobile Club will provide assistance in traffic control.

The Press should be notified whenever news can be given which will impress the public with the danger of heath and forest fires, or whenever it is desirable to give factual information in correction of misleading reports.

(v) **Liaison.** Actual fires and other incidents, usually provide sufficient occasions for maintaining liaision with the County Fire Services and other sources of assistance. The S.F.O. is primarily responsible for ensuring that good liaison is maintained and that contact is made before the onset of the fire season with Stanford P.T.A., U.S.A.F. Lakenheath and local R.A.F. stations.

Staff should be able to recognise County Fire Service badges of rank. Supervisory staff issued with yellow helmets should wear them at fires since their value is enabling wearers to be recognised as persons in authority has been proved.

19. Catering

The Pine Vista Cafe, Brandon, will supply tea, sandwiches etc. at short notice provided that they are collected. A supply of waxed cardboard cups will be stored at the Fire Control Centre.

20. Special Arrangements Not Covered in Sections 14 to 19 Above

Duty Fire Officers

Complement and Authority

The following will take it in turn to be Duty Fire Officer during the fire season:—

District Officer No. 4 District (N. Thetford Chase and Swaffham)
District Officer No. 5 District (S. Thetford Chase and The King's)
Head Forester No. 4 District.
Head Forester No. 5 District.

In the carrying out of their duties as Duty Fire Officers they will be directly responsible to the S.F.O. and will have authority over all Forestry Commission staff in the area except that District Officers have discretion to exercise authority over either Head Forester.

The Duty Fire Officer whether Head Forester or District Officer will, however, retain full leadership over Forestry Commission staff at a fire unless a more senior officer specifically states that he is taking charge.

The District Officer or Head Forester from the other District will be nominated to be available to assist the Duty Fire Officer during high or extreme fire danger.

Duration of Duties

The duty rota will be drawn up by the S.F.O. for the duration of the fire season. Each turn of duty will last from 8.30 a.m. on Thursday until 8.30 a.m. on the following Thursday. Deviations from the rota, which will be issued to Foresters for information, will not normally need approval of the S.F.O. provided that the person wishing to exchange duties makes all the necessary arrangements in agreement with his colleagues.

The Duty Fire Officer must be available at any time of the day or night.

Nature of Duties

(1) Assessment of probable and actual fire danger.

(2) Ensuring that Fire Control Centre staff and all Fire Control Centre and Fire Station equipment are in the required state of readiness. (The District Officer or Head Forester listed as assistant to the D.F.O. and one of the Fire Wardens may be required and if so must be notified).

(3) Deciding each day by 10.30 a.m. which fire towers will be manned and notifying the District Office clerks or Duty Fire Warden accordingly.

(4) Instructing staff manning the Control Room or the Duty Fire Warden at his house, on action to be taken in consequence of smoke reports or other incoming messages.

(5) Attendance at, and suppression of all fires likely to cause damage to Forestry Commission property.

(6) The noting of any defects in preventive measures equipment or organisation and their rectification if within his authority or reporting to the appropriate District Officer, S.F.O. or other person responsible.

(7) Ensuring each day that the Fire Control Centre Log is properly kept.

(8) Checking (or assisting with checking) reports of fires which occurred during his turn on duty.

Fire Wardens

Complement and Status

There will be two Fire Wardens of equal status. They will be graded as Gangers and appointed by the S.F.O. to whom they will be directly responsible for their general conduct and efficiency as Fire Wardens, and under whose general authority they will carry out their duties. For their particular actions when on fire duty during the Fire Season they will be responsible to the Duty Fire Officer, and it will be recognised by all staff that they act for the Duty Fire Officer. Thus a request from the Duty Fire Warden to a Forester to investigate a smoke report will be acted on as though it was an order from the Duty Fire Officer.

Duration of Duties

Normally the Fire Wardens will take it in turn to be on duty, and the duration of each turn of duty will be from 8.30 a.m. on Thursday round to the same time on the following Thursday, and when not on duty they will be entirely free of all responsibility connected with their duties as Fire Wardens.

During the Fire Season any daily or weekly variation in the turns of duty mutually convenient to the Fire Wardens must be approved by the Duty Fire Officer. Outside the Fire Season no such approval is required. The important condition is that one or other of the Fire Wardens must be available all the year round.

Exceptionally, for example during extreme fire danger, or when a fire is being fought, both Wardens may be required to be on duty.

Nature of Duties

(*a*) *Out of the Fire Season*

(1) *Communications.* At all times when the District Office is closed, the line Brandon 271 will be switched through to the extension in the Duty Fire Warden's house. He will be responsible for answering all calls to the best of his ability, taking messages, and initiating any action necessary as a result of such calls. It is his duty to ensure that confidence is retained in "Brandon 271" as the number which is always answered, and which always has the answer to any emergency call or business enquiry.

(2) *Maintenance of Equipment.* The Fire Wardens will periodically inspect all hand tools and hand equipment, including radio pack sets, which are stored in the Fire Station or Fire Control Centre, and must arrange for its maintenance, requesting the S.F.O. to provide renewals where necessary, or to organise tool maintenance by forest staff as required. All tools and equipment must be serviceable by the 1st February each year.

(3) *In the Event of Fire.* Fires may occur out of the "fire season" e.g. house fires, crashed aircraft. The Fire Warden on duty must mobilise assistance on his own initiative and endeavour to notify a District Officer or Head Forester.

(*b*) *During the Fire Season*

(1) *Communications.* When the District Office is staffed, communications are taken care of by the clerical staff, acting on general instructions of the S.F.O. and particular instructions of the Duty Fire Officer. Only during high or extreme fire danger is it likely that the Duty Fire Warden will be required to report to the Fire Control Centre during normal working hours. Outside these hours Brandon 271 will be switched through to the extension in the Duty Fire Warden's house, but whenever it is necessary for the Duty Fire Officer to be called out to investigate smoke, or to an actual fire, the Duty Fire Warden will man the Fire Control Room. The Duty Fire Warden will also man the Fire Control Room outside normal District Office working hours when all the following conditions prevail:—

Relative humidity 40% or less.
Wind fresh or strong.
Number of days since last rain fell exceeds 3.

(2) *Maintenance of Equipment.* The Fire Wardens will inspect Fire Station and Fire Control Centre Equipment during the out of season months, but more frequently, and always after any of it has been in use.

(3) *Manning of Fire Towers.* Outside normal District Office working hours the Duty Fire Warden is responsible for ensuring that Fire Towers are manned or stood down in accordance with the Duty Fire Officer's instructions.

(4) *Fire or Smoke Reports.* Reports received by the Duty Fire Warden will be dealt with according to their category as follows:—

(*a*) *Uncontrolled fire definitely located on or near F. C. land.* Commence mobilisation on own initiative and inform Duty Fire Officer (and assistant Duty Fire Officer if possible).

(*b*) *Smoke definitely located and considered to be a threat of uncontrolled fire.* Inform Duty Fire Officer and commence mobilisation on own initiative.

(*c*) *Smoke definitely located, not known to be controlled burning, but not considered to be a fire threat.* Inform Duty Fire Officer and await his instructions.

(*d*) *Smoke or reported fire, not definitely located.* First endeavour to obtain cross-bearings from fire towers. If definite fix not obtained ask nearest Beat Forester or Police to investigate. Duty Fire Officer to be informed if this investigation cannot be quickly arranged and if doubt persists.

It is appreciated that judgment of the degree of fire hazard at and near the location of smoke will influence the precise action taken by the Duty Fire Warden. The quick decisions necessary cannot be entirely pre-determined by any set of rules, and because of this, and the vital importance of the initial decisions made on receipt of smoke reports, the post of Fire Warden carries special responsibility for the safety of the Forest.

(5) *Fire Control Centre Log Book.* The Duty Fire Warden will be responsible for keeping the Log outside normal District Office working hours, In addition to recording messages, smoke bearings and times, readings of relative humidity, temperature, and estimated wind strength and direction will be recorded at 2 p.m. G.M.T. or 3 p.m. B.S.T. since this is the most likely time for fires to occur.

Remuneration. The basis will be fixed fees appropriate to an average year, and paid additionally to wages for normal duties for each day of duty, wet or fine. (No payment will be made for non-duty days). The fees will cover all duties except actual manning of the Fire Control Room which, when this is necessary out of normal working hours, will be paid for at appropriate overtime rates. The fees will be greater for Saturdays, Sundays and other holidays than for weekdays, and greater for days during the fire season than out of the season.

District Office Clerks

Two clerks are employed as typists, telephonists, radio operators, receptionists and on general clerical work in the Control Room. They will at all times give priority to fire protection matters and will arrange their lunch hours so that there is always someone to operate the telephone switchboard.

Their fire protection duties include:—

(1) Transmitting and receiving all necessary messages by telephone or radio.

(2) Notifying lookouts of the Duty Fire Officer's instructions regarding the manning of fire towers.

(3) Assisting the Duty Fire Officer to keep the Fire Control Centre log book, the record of Duty Foresters, the record of burning operations by neighbours and other day-to-day information.

(4) Dealing with fire and smoke reports in the same way as defined for Fire Wardens.

(5) Reporting to the Duty Fire Officer any defects apparent in the telephones or radio.

The Duty Fire Officer is responsible for the actions of the District Office clerks in the carrying out of these duties. Whilst their training enables them, for example, to mobilise assistance on their own initiative, the District Office clerks are not expected to carry the same degree of responsibility as Fire Wardens or other supervisory staff.

Fire Control Centre Log Book

The following information will be recorded throughout the fire season:—

1 Date	2 No. of days since last rain	3 Condition of vegetation on roadsides (Green, G Half Green, HG Half Dead, HD Dead, D)		4 % Relative Humidity	5 Shade temp. °F	6 Wind		7 Fire Danger Rating (Low L Mod., M High, H Extreme, E) Nil	8 TIME
		Grass	Bracken			Direction (E., S.E., etc.)	Strength (Still, — Light, L Mod., M Fresh, F Strong, S)		

9 Names of Lookouts on duty and bearings of smoke							10 Record of messages and action taken	11 Initials of Duty Fire Officer or Fire Warden
Swaffham	High Ash	Denton Lodge	Gallows Hill	Roudham	High Lodge	Kings		

Entries will be made in columns 1 to 8 at the time that the Duty Fire Officer decides which towers, if any, will be manned. Further entries will be made in columns 4 to 8 if there are *marked* changes in conditions during the day, and on every day, as near as possible to 2 p.m. G.M.T. or 3 p.m. B.S.T.

It is appreciated that these entries describing fire hazard relate to conditions in the vicinity of Santon Downham (information on wind direction and strength should be checked with High Lodge lookout) and that variations are possible (e.g. thunder showers) within the region which may cause the Fire Danger Rating to be different in different places. Fire reports will attempt to give the conditions at the time and place of each fire, but since it is unlikely that, e.g. relative humidity will be known in this way, the Fire Control Centre Log will help to provide information for fire reports.

The Duty Fire Officer is responsible for ensuring that the log is properly kept. The Duty Fire Warden will collect the log book from the Control Room, and return it from his house after its use there outside normal office hours.

Assessment of the Degree of Fire Danger

All staff are expected to have an awareness of the degree of Fire Danger. Beat Foresters must make an assessment in order to decide on action necessary as regards the manning of Beat Control Centres and the posting of patrols. If in doubt they should check with the Fire Control Centre to obtain the Fire Danger Rating as assessed by the Duty Fire Officer.

The Duty Fire Officer will keep records of rainfall, maximum daily temperature, relative humidity, and wind force to enable him to calculate the Fire Danger Rating using Rouse's Tables (*Forestry*, Volume 32, No. 2, 1959), with Table V amended to show indices for extreme fire danger during the spring and holiday summer seasons. These tables have not yet been thoroughly tested in East England, but the decisions arrived at by their proper use will be recognised as correct, although Duty Fire Officers are free to make different decisions if for good reason they consider this advisable.

The Duty Fire Officer may obtain forecasts of minimum relative humidity and maximum wind speed to be expected by telephoning the meteorological forecasting office at Mildenhall.

PART IV—SUPPRESSION

21. Alarm Action

(i) **How Alarm is Raised.** Any outbreak of fire, except spot fires quickly suppressed by patrolmen, should *without exception* be reported as quickly as possible to the Fire Control Centre at Santon Downham, telephone number:—

BRANDON 271.

During normal office hours, if a reply cannot be obtained from this number, it means that both lines 271 and 272 are engaged. The third number BRANDON 312 should then be used.

After normal office hours, if Brandon 271 is engaged, Brandon 272 will automatically be called instead. This, after normal office hours, is switched through to either the District Officer or Head Forester of No. 4 District. If the call is not accepted by either of these, the procedure is to ring off, obtain the G.P.O. operator and request to be put through to Brandon 271 (the Duty Fire Warden). (If Brandon 312 is used after normal working hours, it may obtain either the District Officer or Head Forester of No. 5 District).

Any person wishing to telephone Brandon 271 from a private telephone or public call box in order to raise a fire alarm may ask for the charge to be reversed.

(ii) **Action at Fire Control Centre.** The result of a call to Brandon 271 giving the *definite location* of an uncontrolled *fire* on or near Forestry Commission land will be to *immediately* start mobilisation of assistance according to predetermined arrangements.

If the report is indefinite about location, further investigation will first be necessary.

The sequence of action by the Duty Fire Warden or District Office Clerks will be:—

(a) *Uncontrolled fire definitely located on or near F. C. Land.*
Commence mobilisation on own initiative and inform Duty Fire Officer (and Assistant Duty Fire Officer if possible).

(b) *Smoke definitely located, and considered to be a threat of uncontrolled fire.*
Inform Duty Fire Officer and commence mobilisation on own initiative.

(c) *Smoke definitely located, not known to be controlled burning, but not considered to be a fire threat.*
Inform Duty Fire Officer and await his instructions.

(d) *Smoke, or reported fire, not definitely located.*
First endeavour to obtain cross-bearings from fire towers. If definite fix not obtained, ask nearest Beat Forester or Police to investigate. Duty Fire Officer to be informed if this investigation cannot be quickly arranged and if doubt persists.

(iii) **Action at Beat Control Centres.** Beat Foresters are responsible for mobilising their own staff and equipment, and at the same time notifying the Fire Control Centre of the outbreak of fire if the alarm has not in fact been received from there.

22. Mobilisation

(a) **By Fire Warden or District Office Clerks.** (On own initiative if Duty Fire Officer not present and fire is definitely located).

(i) *Sound Siren:—*
Sequence of short wailing blasts. To be sounded if necessary to call Duty Fire Officers and if it is considered advisable to alert local staff, particularly the Foreman Mechanist and possible fire tender crews.

Long blast. To be sounded if it is known that the fire definitely requires to be fought by all available staff.

(ii) *Call the County Fire Service:—*
Fire in Norfolk — Norfolk C.F.S. H.Q. at Hethersett, Norwich.
Fire in Suffolk — Suffolk C.F.S. Divisional H.Q. at Bury.

(iii) *Establish radio communication* between Fire Control Centre and Duty Fire Officer in his Land-Rover.

(iv) *Inform the Beat Forester* on or near whose Beat the fire is.

(v) *Inform neighbouring Beat Foresters* to stand-by to mobilise.

(vi) *Inform Police* nearest to the fire for traffic control and investigation of cause.

(b) **Mobilisation by Fire Warden or District Office Clerks on Duty Fire Officer's instructions.** (This sequence may be varied according to circumstances).

(vii) *Muster tender and tanker crew(s) and despatch* tender(s) and tanker as may be required.

(viii) *Muster fire-fighters and transport* from depots or village.

(ix) *Inform S.F.O.* (In all cases where there is a threat of serious damage to F. C. Property).

(x) *Inform Conservator* (when fires are likely to result in the loss of 10 acres or more of plantations).

(xi) *Call out neighbouring Beat Foresters and transport* for their fire-fighters.

(xii) *Call out Military* if nearest to the fire, or in addition.

(xiii) *Call out R.A.F. or U.S.A.F.* if nearest to the fire, or in addition.

(xiv) *Call A.A. and R.A.C.* for extra traffic control.

(xv) *Inform local press.*

(xvi) *Arrange for catering supplies.*

The wording of the call to the County Fire Service will be:—
"FORESTRY COMMISSION FIRE. —— TO —— ROAD, FIRE ROUTE NUMBER———". The appropriate council roads between well-known places will be quoted in place of the first two dashes, and the number of the nearest fire route to the fire given in place of the last dash. This form of identification of the location of the fire will also be used in calling out other assistance.

The policy in mobilising will be to err, if anything, on the side of safety. No one will be criticised for calling out, with good intent, assistance which in the event does not prove necessary. The Duty Fire Officer must, however, ensure that demobilisation is not delayed longer than is prudent.

The equipment in the Control Room is arranged to enable all of it to be operated as speedily as possible by one person, e.g. the Duty Fire Warden. During normal office hours, however, there are usually two District Office Clerks, and there may in addition be a Fire Warden and the District Officer or

Head Forester listed as assistant to the Duty Fire Officer in the event of high or extreme fire danger. It is important that all these persons know in advance what their main functions will be:—

The Duty Fire Officer proceeds with all speed to the fire, satisfying himself either immediately prior to his departure or by means of radio during his journey that he has the most accurate information available on the location of the fire, and that mobilisation is continuing to his orders.

The District Officer or Head Forester *assisting the Duty Fire Officer* is primarily to be available to go to the fire if the D.F.O. requires him, or to go to a second fire if one occurs before the first is under control. His secondary function is to observe in the Control Room the progress of mobilisation, to take responsibility for any decisions which require the authority of his rank and cannot be obtained from the Duty Fire Officer, and to act as radio operator if the District Office Clerks or Fire Warden are otherwise engaged.

The Fire Warden will operate all equipment if necessary, but if the District Office Clerks are present they will relieve him firstly of transmitting and receiving radio messages and secondly of operating the telephone switchboard. He will then be freer to take stock of the situation and to mobilise tender crews if required (this may entail his temporary absence from the Control Room).

The District Office Clerks will, during office hours, be the normal operators of the radio and the telephone switchboard since the higher pitch of the female voice gives them an advantage in audibility over men. If both are present they will decide beforehand which of them will be radio operator, and which telephone operator.

Other Persons entering the Control Room during mobilisation are expected to remain quiet and to assist (e.g. with the mustering of tender crews) only if requested.

23. Action at Scene of Fire

The County Fire Services are the Statutory Authorities responsible for extinguishing fires, and their senior officer is legally in charge of fire-fighting operations.

Until the arrival of the County Fire Service the senior Forestry Commission person present, whether Ganger, Forester, or Duty Fire Officer will be responsible for making a *planned* attack on the fire with the men and equipment available.

After the arrival of the County Fire Service the senior Forestry Commission person, normally the Duty Fire Officer, will take the first opportunity of consulting with the senior officer of the County Fire Service so that the attack is properly co-ordinated.

Fire Control Point. The Duty Fire Officer on arrival at the scene of the fire will establish a Fire Control Point for Forestry Commission staff and equipment. This will be indicated by a red and white chequered flag, or by the flashing red light on the fire Land-Rover, since this will normally be stationed at the Fire Control Point.

The Beat Forester or other person in charge of Forestry Commission staff already engaged in directing fire-fighting before the arrival of the Duty Fire Officer, will report to the Fire Control Point as soon as he is free to do so. Otherwise the Duty Fire Officer will endeavour to make early contact with him to hand over a radio pack set, to confer, and to issue any necessary instructions.

All persons in charge of Forestry Commission staff or equipment arriving after the Duty Fire Officer, will go to the Fire Control Point for instructions.

Initially the Fire Control Point may merely serve as a check point at which Forestry Commission fire tenders etc. will wait until the Duty Fire Officer has completed his initial reconnaissance and consultation with the County Fire Service senior officer, and is able to give instructions for deployment. Later the Fire Control Point may be moved to a position closer to the head of the fire, and more advantageous for observation of the progress of the fire-fighting.

If the Fire Control Point is not readily visible from the Fire Route along which assistance will arrive, the way to it from the Fire Route should be marked by the white arrows carried in the fire Land-Rover.

The location of the Fire Control Point should be notified to the Fire Control Centre.

If it is necessary to indicate the way from the Fire Control Point to the nearest water supply, the yellow arrows carried in the fire Land-Rover will be used.

Strategy. Whilst the whole purpose of the provisions of this plan is to prevent small fires developing into large ones, the possibility of large fires cannot be ruled out.

In that event the guiding principle should be to concentrate fire-fighters and equipment at the point or points where the fire, if unchecked, will do the most damage, rather than to disperse forces all along the front.

Tactics. Fire-fighting tactics aim to break the links between the three components of every fire—fuel, heat and oxygen. Water, if the form of a spray will be used as early in the attack as possible. Firebrooms will be used to deprive ground fuel of oxygen; water will assist with this and also cool the heat at the same time.

If, however, the initial attack is delayed, a fire may develop so much heat that it cannot be cooled with the water available, and may be too extensive to be deprived of oxygen by smothering with firebrooms. Removal of the fuel in front of the fire must then be considered.

It is in anticipation of such conditions that fire breaks are maintained. Retreat of fire-fighting forces to one of these *in time* to be ready for action before the fire reaches it, may be necessary. In conditions of extreme fire hazard the amount of fuel will be reduced by counter-firing from firebreaks. Duty Fire Officers have full authority to counter-fire in order to save greater damage. They will normally endeavour to get agreement with the County Fire Service before counter-firing.

In some circumstances it may be possible to remove fuel from in front of a fire by means of bulldozers or graders.

Refreshments and Reliefs for Forestry Commission Staff. The Duty Fire Officer must anticipate the need for these in good time and arrange accordingly. When night action is expected following an afternoon outbreak, arrangements for reliefs can be made more easily before other staff have gone home after normal work.

The Duty Fire Officer will not himself leave the scene of the fire until it is out or he is relieved by another Forestry Commission Officer.

24. Mopping Up

After the suppression of running flames, the Duty Fire Officer must see that the burnt area is damped down, an adequate fire line made round it, and arrangements made to patrol the perimeter.

A spare water tank is held in the Fire Station at Santon Downham to enable a water supply to be provided on the spot for use by patrolmen using bantam pumps.

The burnt area must not be left unattended until declared safe by the Duty Fire Officer or District Officer in whose territory it has occurred.

APPENDIX A

MAPS

The following maps are a necessary part of fire protection arrangements:—

Description	*Holder*	*Location during Fire Season*
2½ *inches to* 1 *mile wall maps:—*		
(a) Fire Location Map (showing fire routes, and equipped with pointers centred at the position of fire towers).	S.F.O.	Fire Control Centre
(b) Fire Suppression Map (showing location of water supplies, equipment depots, telephones, areas of difficult radio reception etc.).	S.F.O.	Fire Control Centre
6 *inches to* 1 *mile:—*		
Fire Plans (showing all relevant information for each Beat as per legend below).	D.O.'s., for use by Duty Fire Officer	Fire Land-Rover
	D.O.'s., for use by duty staff in Fire Control Centre	Fire Control Centre
	Foresters-in-charge	Beat Control Centres or in Foresters' own transport.
1 *inch to* 1 *mile:—*		
All showing fire routes, water supplies, fire towers, A.A. and R.A.C. boxes.		
(a) Master Set (Sheet Nos. 124, 125, 135, 136)	S.F.O.	Fire Control Centre
(b) Fire Location Maps (with pointers centred at the position of fire towers).	Duty Fire Officer	House
	Duty Fire Warden	House
	Foresters i/c Towers	Fire Towers
(c) In perspex cases.	Conservator	Car
	S.F.O.	Car
	D.O. No. 4 District	Car
	D.O. No. 5 District	Car
	H.F. No. 4 District	Own transport
	H.F. No. 5 District	Own transport
	H.F. Brandon Depot	Own transport
	S.F.O., for use by duty staff	Fire Land-Rover No. 1 Fire Tender No. 2 Fire Tender Tanker Fire Station for No. 3 Tender

(d) Complete Sets (Sheet Nos. 124, 125, 135, 136)	Norfolk and Suffolk County Fire Services S.F.O.	As required Fire Land-Rover

LEGENDS FOR MAPS

	2½" *to* 1 *mile*	6" *to* 1 *mile*	1" *to* 1 *mile*
Forest Boundary	Solid black line	Solid external yellow line	Black solid line
Beat Boundary	Black chain line	Broken external yellow line	Black broken line
Roads passable to all vehicles	—	Solid dark brown line	—
Roads passable to four-wheel drive vehicles	—	Broken dark brown line	—
Fire Routes	Broken black lines with numbers	Broken dark brown line with numbers	Black lines with numbers
Fire Breaks (cultivated)	—	Hatched Green	—
Hardwood Belts—Effective	—	Large green dots	—
—non-effective	—	Small green dots	—
Water supplies—over 1,000 galls.	½" solid blue circle	½" solid blue circle with numbers to indicate 000's galls.	⅛" solid black circle
Water Supplies—under 1,000 galls.	¼" solid blue circle	¼" solid blue circle	
Hydrants	¼" solid blue square	¼" solid blue square with H at side	—
Perennial Streams	—	Pale blue wash	—
Telephones	T in red in ¼" green circle	T in red in ¼" green circle	—
A.A. and R.A.C. Boxes	—	—	Red arrow
Fire Towers	Solid red triangle with ½" base	Solid red triangle with ½" base	Solid red triangle with ¼" base
Fire Control Centre	¾" solid red square	—	—
Beat Control Centre	½" solid red square	½" solid red square	—
Danger Areas	—	Orange wash	—
Equipment Depots	½" solid red circle	½" circle hatched purple	—
Railway Danger Zones—Entry	½" circle with black fir tree on yellow background	½" circle with black fir tree on yellow background	—
Railway Danger Zones—Exit	½" circle with ⅛" vertical black bar on yellow background	½" circle with ⅛" vertical black bar on yellow background	—
Level Crossing, manned	Red "gate" sign	—	—
Level Crossing, unmanned	Black "gate" sign	—	—
Publicity Boards	½" × ¼" yellow rectangle	½" × ¼" yellow rectangle	—
Areas of Difficult Radio Reception	Yellow wash	—	Yellow wash

APPENDIX B

LIST OF NAMES, ADDRESSES AND TELEPHONE NUMBERS IN SEQUENCE OF CALL-OUT

Name	*Address*	*Telephone Number* *Day*	*Night*
1. Fire Control Centre			
Fire Wardens:			
E. Whitta	District Office, Forestry Commission, Santon Downham, Brandon.	Brandon 271	Brandon 271
J. Marsh			,, 271
Duty Fire Officers:			
H. A. E. Tilney-Bassett			Brandon 312
D. Small			,, 272
C. W. Redford			,, 312
J. T. Anderson			,, 272

2. Fire Towers

Denton Lodge	Feltwell Beat	Methwold 247
Gallows Hill	Santon Beat	Thetford 3140
High Ash	Didlington Beat	Mundford 204
High Lodge	High Lodge Beat	Brandon 357
The King's	The King's Forest	Culford 263
Roudham	Roudham Beat	Thetford 3340
Swaffham	Swaffham Forest	Swaffham 340

3. County Fire Service

First call to C.F.S. in whose county the fire is.

Norfolk	Whitegates, Hethersett, Norwich.	Norwich 26161
Suffolk	Fornham Road, Bury St. Edmunds.	Bury St. Eds. 11

4. Beat Control Centres

	Adjoining Beats		
(a) Brandon Depot	p	Mundford Road, Brandon	Brandon 359
(b) Croxton	o, r, i	New Forest Lodge, Croxton.	Thetford 2163
(c) Didlington	f, k, q	Forest Lodge, High Ash, Hilborough	Mundford 205
(d) Downham	h, n, p	c/o District Office, Santon Downham	Brandon 271
(e) Elveden	h, n	Wood Cottage, Brandon Park, Brandon	Brandon 337
(f) Feltwell	c, m	Feltwell Heath Lodge, Feltwell	Methwold 247
(g) Harling	o	Forest Lodge, West Harling	East Harling 256
(h) High Lodge	d, e, n	High Lodge Camp, Brandon	Brandon 395 (c/o Brandon 271 after working hours)

	Name		*Address*	*Telephone No.*
(i)	Hockham	b, o	Forest Lodge, Gt. Hockham	Gt. Hockham 235
(j)	The King's	l	Forest Lodge, West Stow	Culford 237
(k)	Lynford	r, p, c, m	Squirrel Cottage, Lynford Cross, Mundford	Mundford 257
(l)	Mildenhall	j	Forest Lodge, Mildenhall	Mildenhall 2115
(m)	Mundford	f, k, p	Ickerbuildings, Mundford	Mundford 221
(n)	Redneck	d, e, h	c/o District Office, Santon Downham	Brandon 271
(o)	Roudham	b, g, i	Forestry Cottages, East Wretham	Gt. Hockham 257
(p)	Santon	d, k, m, r	c/o District Office, Santon Downham	Brandon 271
(q)	Swaffham	c	Drymere Lodge, Beechamwell	Swaffham 464
(r)	West Tofts	e, k, p	Forest Lodge, Lynford Cross, Mundford	Mundford 257

5. Police (according to area)

Barton Mills	Mildenhall 3222
Brandon	Brandon 211
Elveden	Elveden 32
Gt. Hockham	Gt. Hockham 222
Hockwold	Feltwell 223
Ingham	Culford 306
Methwold	Methwold 222
Mildenhall	Mildenhall 2222
Mundford	Mundford 211
Northwold	Methwold 233
Swaffham	Swaffham 222
Thetford	Thetford 2223
Weeting	Brandon 212

6. State Forest Officer (Thetford)

R. Chard	District Office, Santon Downham, or	Brandon 271
	93, Norwich Road, Thetford	c/o Thetford Police Thetford 2223

7. Conservator, East England

G. W. Backhouse	Forestry Commission, Brooklands Avenue, Cambridge	Cambridge 54495 Ext. 1466 or 1477
	After Working Hours	Cambridge 54977

8. Regional Forestry Officer (E)

G. F. Ballance	Forestry Commission, Brooklands Avenue, Cambridge	Cambridge 54495 Ext. 1462 or 1479
	After Working Hours	Histon 432

Name	*Address*		*Telephone No.*
9. Military			
H.Q. East Anglian District		(Day)	Colchester 5121 Ext. 405
		(Night)	Colchester 5121 Ask for Duty Officer
The Range Officer, Stanford P.T.A.	West Tofts, Thetford		Thetford 3224
10. U.S.A.F. Lakenheath			Mildenhall 2341 Ext. 95
R.A.F. Barnham			Thetford 2141
Feltwell			Feltwell 205
Honnington			Bury St. Eds. 2931
Marham			Narborough 261
Mildenhall			Mildenhall 2281
Watton			Watton 384
11. A.A. Norwich	2, Thorpe Road, Norwich		Norwich 26231
R.A.C. Norwich	40, Prince of Wales Road, Norwich		Norwich 28255
12. Press			
Eastern Daily Press	20, King Street, Thetford		Thetford 2233
Thetford and Watton	20, King Street, Thetford		Thetford 2233
Bury Free Press	Kings Road, Bury St. Edmunds		Bury St. Eds. 2881
13. Catering			
Pine Vista Cafe	Mundford Road, Brandon		Brandon 332
14. Other Telephones			
Quarry Cottage, North Stow	(The King's—Asst. Forester)		Elveden 85
Broomhouse	(Elveden Beat)		Brandon 336
New Buildings	(Croxton)		Thetford 2238
Brecklands	(Feltwell and Mundford — Foreman)		Mundford 261
Forest Lodge	(Swaffham—Asst. Forester)		Swaffham 280
R.A.C. Box	(Brandon/Mundford Road—Emilys)		Brandon 267
R.A.C. Box	Elveden Cross Roads		Elveden 26
R.A.C. Box	Harling Cross Roads		East Harling 216
A.A. Box	Barton Mill Five Ways		Mildenhall 2152
A.A. Box	Mundford Cross Roads		Mundford 239
A.A. Box	Harling Heath		East Harling 282
15. Meteorology			
The Senior Met. Officer, H.Q. 3 Group	R.A.F. Mildenhall, Bury St. Edmunds		Mildenhall 2274

APPENDIX C

Copy of warning letter sent to neighbouring land occupiers. The letters will be addressed and posted by Beat Foresters to all neighbours listed in Beat Fire Plans.

Dear Sir,

Once again as the season of fire danger approaches I must draw your attention to the need for precautions. The afforestations now proceeding have been embarked upon in order to restore the Nation's supply of growing timber, which has been so heavily depleted in the two Great Wars, and, in view of the grave risk to woods and plantations from fire, the Forestry Commissioners ask for the co-operation and help of all neighbours in the task of guarding young plantations and woodland against this very serious danger.

At most seasons of the year, especially in late winter and spring, and again in autumn, dry grasses, heather and gorse will burn fiercely, and fires lighted to improve grazings, or to burn rubbish, easily get out of hand and spread into plantations. Afforested areas are destroyed each year in this way and the costly losses are preventable if due care is exercised. A grass or heath fire should never be lighted on a windy day.

I venture to draw your attention to the provisions of the Heather and Grass Burning (England and Wales) Regulations 1949 which provide, inter alia, that between the 31st March and 1st November in any year no person shall burn heather or grass except in accordance with the conditions of a licence issued by the Minister of Agriculture and that *at all times* notice (as specified in the Regulations) is given to adjoining occupiers of a proposal to carry out burning. Further information concerning the Regulations (Statutory Instrument 1949 No. 386) is obtainable from the Agricultural Executive Committee.

Yours faithfully,

Signed **G. W. Backhouse,**
Conservator.

APPENDIX D

LIST OF EQUIPMENT AND TRANSPORT HELD AND LOCATION
Fire Control Centre, Santon Downham

1. **Fire Control Room.** All items will be periodically checked by the Fire Wardens.

Master Fire Plan — 1 copy.

3 × 20 Telephone Switchboard.

Remote control of V.H.F. main radio set.

3 radio pack sets.

4 spare batteries for pack sets.

Charger, voltmeter and distilled water for battery maintenance.

Loud Hailer — For use in passing instructions to tender crews.

Power amplifier — For use as required on any Land-Rover equipped with radio.

Fire Control Centre Log Book (for use by Duty Fire Officer).
Clock.

Fire Location Map	—	2½ inch to 1 mile wall map showing fire routes, and equipped with perspex pointers and compass roses centred on location of fire towers; lights (in pivots of pointers) for switching on to indicate which towers are manned, and indicators to show degree of fire danger and direction of wind.
Fire Suppression Map	—	2½ inch to 1 mile wall map showing location of water supplies, equipment depots, telephones, areas of difficult radio reception etc.
Fire Plans	—	6 inch to 1 mile for each Beat.
Fire Route Maps	—	1 inch to 1 mile master set.
Mobilisation Control Board	—	Lists sequence of mobilisation, with telephone numbers. Equipped with indicator panels to show action taken and whether the fire Land-Rover, tenders and tanker are ready for action, at a fire, or not ready for use. Contains siren button and panels for names of Duty Fire Officers and Duty Fire Wardens. Also blackboard on which to record information about burning operations by neighbours.
Duty Forester Board	—	Board for easy indication of which Foresters are manning Beat Control Centres and which Beats they are responsible for.
Key Board with issue book	—	Holds spare keys likely to be required in the event of fire. Also spare keys for fire towers.
Padlocks and keys	—	Spares for issue if new forest gates are erected which require locking.
Fire Control Point Flags	—	2 spare red and white chequered flags.
First Aid Box.		
Waxed cups	—	5 dozen (Pine Vista Cafe supplies tea in urns but no cups).
Torch.		

(2) Porch of District Offices

All mounted on shaded board	Hygrometer (dial type)	—	With surround marked to show probable fire danger according to percentage relative humidity.
	Thermometer	—	°F. Registering maximum and minimum.
	Rainless days recorder	—	Adjustable numerals (0 to 99) for setting each morning by Duty Fire Officer to record number of days since last rain.

The S.F.O. will arrange for hygrometers to be checked and adjusted to agree with wet and dry bulb readings as may be necessary.

On Open Ground Nearby. Rain gauge.

(3) Duty Fire Warden's House

Hygrometer Thermometer Rainless days recorder	Identical equipment to that in porch of District Offices.

Fire Location Map	—1 inch to 1 mile with pointers.
Fire Control Centre Log Book	—(For use by Duty Fire Warden at his house and in the Control Room).

(4) Duty Fire Officer's House

Fire Location Map	—1 inch to 1 mile with pointers.

Fire Station, Santon Downham

	Items for maintenance by Foreman Mechanist	*Items for checking or maintenance by Fire Wardens*
(5) Fire Land-Rover (with V.H.F. Radio)	Flashing red light. Langdon pump and water tank. Tool kit.	1 Radio pack set. 2 Red and white chequered flags. Metal arrows—6 white. —6 yellow Paraffin burner and matches (for counter-firing). 2 Torches. Slasher. Key to Forest gates. A.A. Box key. 1 inch fire route maps: (a) Complete set. (b) In perspex case. 6 inch fire plans for each Beat. Master Fire Plan — 1 copy. First Aid box.
(6) No. 1 Fire Tender (4-wheel drive Bedford) The pumping system of this tender is not drained in the winter. Electric heaters are provided, and should be attended to by the Fire Wardens.	Watertank 500 galls. Pump, Hathaway Mk. III 1 inch rubber hose on 2 live reels—60 ft. each. 1 inch Camelite rubber-lined canvas hose — 4 lengths of 75 ft. each. Suction hose, 20 ft. Vehicle Tool Kit. Pump Tool Kit.	6 Birch fire brooms. 2 Hand pumps. 4 Canvas buckets. 4 Spades. 1 Billhook. 1 Axe (3¼ lb.). 1 4-ft. crosscut. 1 2 ft. 6 in. bowsaw. 1 inch fire route map in perspex case. First aid box.
(7) No. 2 Fire Tender (4-wheel drive Bedford).	This carries a 600 gallon tank. Otherwise it is equipped and maintained the same as No. 1 Tender.	
(8) Equipment for loading on to first available lorry to make up No. 3 Tender Equipment stored on ramp at height of lorrydeck. Wooden rollers under tank.	Water tank, 500 gallons. Pump, Hathaway Mk. III 1 inch Camelite rubber-lined canvas hose — 5 lengths of 75 ft. each. Suction hose, 20 ft. Pump tool kit.	A third set of equipment the same as carried on No. 1 and No. 2 Tenders

(9) **Water Tanker** (Leyland rear wheel drive only).	Tank 1,200 gallons. Pump, Hathaway Mk. III Suction hose, 20 ft. $2\frac{3}{4}$ inch rubber-lined canvas hose—50 ft. Vehicle tool kit. Pump tool kit.	1 inch fire route map in perspex case. First Aid box.

Note: The fire Land-Rover, Nos. 1 and 2 tenders and the water tanker (which all have yellow paintwork) are maintained by the Foreman Mechanist who will also arrange for their petrol tanks to be filled whenever they return to the Fire Station after use.

During working hours the fire Land-Rover will either be in use by the Duty Fire Officer or parked ready for him outside the District Office, whilst the tanker will usually be delivering drinking water to tenants according to a routine schedule.

(10) **Standpipe and Key for Hydrants** — For checking and maintenance by Fire Wardens.

(11) **Water Tank** — Suitable galvanised iron tank for leaving at a burnt area to provide a water supply from which to fill hand pumps used by patrolmen.

(12) **Reserve Equipment** — For checking and maintenance by Fire Wardens.

Birch fire brooms	— 150 at start of fire season. This reserve to be kept up to a minimum of 50 through the season.
Canvas buckets	— 10.
Spades	— 10.
Billhooks	— 10.
Slashers	— 5.
Axes ($3\frac{1}{2}$ lb.)	— 5.
Saws, 4 ft. crosscuts	— 5.
Saws, 2 ft. 6 in. bow-saws	— 5.

(Other reserves of handtools are held in the Forest Stores at Santon Downham).

Santon Downham

(13) **Radio Hut** — Brick-built, specially insulated, ventilated and electrically heated hut containing the main set. Situated near the village water tower on which is the main aerial. To be inspected periodically by the S.F.O., or local staff on his behalf, to adjust heater and ventilators.

(14) **Other Vehicles and Equipment** — 2 Land-Rovers fitted with V.H.F. radio are used by the Head Foresters of No. 4 and 5 Districts and can be kept available for fire protection duties.
These vehicles are equipped with Langdon pumps.
The lorry fleet is parked by the District Offices when not working.
Forestry Commission bulldozers and graders are not permanently held in the Forests but may be available by arrangement with the Foreman Mechanist.

Beat Depots

(15) **Hand Tools and Hand Pumps** Each Beat holds reserves of equipment as specified in the Beat Fire Plans.

Record of Amendments

Amend-ment No.	*Date*	*Subject*	*Section and Paragraph*	*Amendments made*	
				Date	*Initials*
1	22.3.60	Manning of Control Centres and Fire Towers, and Assessment of the Degree of Fire Danger	Sections 15, 17, 20 Appendix B Appendix D	23.3.60	R.C.

Note: Illustrations of the Fire Control Room appear in Plates 2-5 in the central inset.—*Editor*.

CROW ABOUT RAILWAY FIRES

By K. W. WILSON
District Officer, South Scotland

The summer of 1959 will be remembered for its drought and sunny days. Many people will have been distressed to see the countryside spoiled by black, burned areas of moorland and plantations or grassland and trees in parks, hedgerows and on roadsides and railway embankments. When information has been collated, 1959 may well prove to have been a 'bad year' for fire incidence and there may be grounds (1) for believing that future outbreaks of fire will be less troublesome to foresters.

One can be certain that railway engines will again be the cause of the greatest number of fires. Recent figures (2) show that, since 1949, in the group of fire causes influenced by publicity, the number of fires per 10,000 acres at risk has fallen considerably whilst there has been an increase in the number of railway fires. In the 20 years from 1929, railways caused 54% of the 12,412 fires reported, whilst in the eight years to 1956, 63% of the 10,350 reported fires began on line-sides. The increase was spread fairly evenly over the three countries where railway fires occurred in the following proportions—England, 6; Scotland, 12; Wales, 4.

The report on '*Fire in State Forests*, 1929-52' (1) showed for the first 20-year period that railway fires burned 3,645 acres of planted land, or 14% of the total. Over the next 8 years the damage increased by 1,820 acres; over the 28 years, an increase to 17% of the total planted area burned. Though the average area of each fire was reduced to 0.4 acres from 0.6 acres, and though rail electrification and greater use of Diesel locomotives, particularly on main lines, should reduce the incidence of railway fires, foresters must for many years yet give high priority to the prevention and control of fires from that source. By the end of 1958 over 2,400 modern Diesel locomotives were in use (3) and it is expected another 2,000 units will be in operation by the end of 1961.

The aim in all fire control is the prevention of fires. In the case of railway fires there is a good and increasing measure of co-operation between the British Transport Commission, The Forestry Commission and other landowners towards reducing the incidence of fires and the costs of extinguishing and damage. These costs for the Forestry Commission alone totalled £129,000 in the period 1929-56. Of the £100,000 recovered by claims for damage, £64,000 have been in respect of railway fires.

In railway modernisation lies the chief hope for preventing railway fires. Railway operating rules (4) prohibit the ejection of hot ashes from engines and urge the exercise of care in the handling and firing of locomotives to prevent the emission of sparks. In 1949, J. T. Fitzherbert reported (5) on the fire prevention methods enforced on Canadian railways and asked why similar precautions should not be incorporated into the regulations of the British Railways. Such regulations have, in fact, been in force for many years though the provision of spark arresters has never been obligatory. It is interesting to note that since 1950, all new steam locomotives have been fitted with spark arresters probably similar in design to those on Canadian engines. Self-cleaning smoke boxes are fitted with a wire mesh which breaks up cinders before they reach the blast stage, so minimising the danger of sparks being ejected from the chimney. A number of older types of engine are fitted with draught plates in the smoke box. These have a similar effect but it is not possible to fit all old locomotives without impairing their efficiency. In any event, the oldest engines are going out of service and less trouble should arise from their use.

Under the Railway Fires Acts, 1905 and 1923, British Railways are liable for damage to plantations, orchards, market and nursery gardens, agricultural land and fences, or crops thereon, resulting from sparks from locomotives. Railway staff must exercise "the greatest vigilance at all times to prevent fires, and, where they occur to extinguish them". Instructions to that end are set out in the 'General Appendix to the Working Time Tables'. In addition to the prohibition mentioned above, they require permanent way men to cut down, burn or clear away all undergrowth which may be ignited by sparks on linesides, and in some cases, on adjoining property. All staff must keep a sharp lookout for any signs of fire on linesides and adjoining land. Drivers who see a fire which is not being attended to, must give *one crow, one long and one crow whistle* and repeat the signal when passing the next station, signal box or permanent way men. On hearing the signal, all available staff should attend the fire and extinguish it and, if necessary, make further arrangements for this to be done.

In co-operation with the Forestry Commission, sections of line where danger to woodlands may be acute have been designated and are described in the General Appendix. In England there are at present 107 danger zones covering 57 Forests; in Scotland, 55 zones at 40 Forests and in Wales, 65 zones at 32 Forests.

Fresh impetus was given to joint co-operation with British Railways following the disastrous fire at Leanachan on 3rd February, 1956 when 740 acres of plantations were burned as a result of a railway fire. As a result of subsequent discussions British Railways have provided water tanks in danger zones and supply water to these and F.C. tanks near linesides. In some areas, where practicable, mobile fire-fighting equipment is being provided and transported by B.R. vehicles, and portable pack pumps supplied to permanent way men. Joint action for burning linesides and adjoining firelines was approved and arrangements were made for direct communication between forester and signalman where signal boxes could act as observation and fire control points.

To assist engine crews to recognise fire danger zones, it was agreed to mark each end of a zone with signs. The signs consist of two yellow discs, 24 inches in diameter. The zone entry sign is a black conifer silhouette on one disc. On the other disc, the zone exit sign consists of a vertical black band across the middle. To help distinguish the band, a yellow band is painted on the post below the disc. A danger zone sign erected outside New Galloway station on the line adjoining Cairn Edward Forest is illustrated in our central pages. (Plate 6)

Other measures effected by the Forestry Commission will be familiar to most foresters. Three methods are generally adopted. First, lines are patrolled to put out small fires as they arise or to give warning should larger forces of men and equipment be needed. This operation can be carried out at lower cost by limiting, where possible, the time of patrol to the periods when trains are expected to run. The nearest station will provide the time-table. Where available, radio provides a speedy alarm and information service and can effectively cut down the number of patrolmen required, especially when forest roads have been constructed near and parallel to railways. Secondly, it is essential to place a beater at intervals along the railway fence for the use of F.C. and B.R. patrolmen. At water tanks and at useful nearby open drains a fire-sack and an open-ended old five-gallon oil drum are helpful accessories.

Thirdly, the provision of some form of protective strip along the railway is always necessary, the method of preparation usually depending upon the soil conditions. The fireline is often preferred about three chains wide and is maintained in a non-inflammable condition by the removal of vegetation by mechanical or even chemical means. Burning the dead vegetation on the fireline is generally effective, but in some cases a residue of unburned material may be left on the ground and this may carry a fire in the interval before regrowth of the fresh green grass reduces the hazard. Firelines can be improved considerably for control purposes if soil conditions allow their use by vehicles, or when a road is built on the plantation side of the fireline. Even more protection may be obtained if a firebelt of Japanese larch can be established along the plantation edge. Close planting the larch, say at 4 ft. by 4 ft., ensures an earlier benefit by the rapid suppression of ground vegetation. It is important that the later treatment of the firebelt should not encourage regrowth of ground cover. The use of chemical herbicides is still in an early stage of development, though extensive trials in South Scotland Conservancy of a variety of chemicals have indicated that firelines may be made and maintained at low cost by this means.

The maintenance of a green fireline by mechanical cutting is effective and with the use of a 'Dynabalance' cutter bar fitted to a tractor, this operation can be carried out with suitable ground conditions at about half the cost of using an 'Autoscythe'.

In recent years, cattle and horses have proved excellent 'mowing machines' on firelines. Whilst initial costs of fencing, draining, manuring and sowing may seem high, maintenance costs are low and income from grazing rents can recoup a good proportion of the total cost. Where grazed firelines have been developed at Greskine and Cairn Edward Forests most encouraging results have been obtained, even from the poorest peat areas. The initial manurial treatments have followed advice from the County Agricultural Adviser, the Macaulay Soil Institute and a local farmer with a long experience of the reclamation of hill grazing land. British Railways have helped by sharing the cost of establishment or, as the fireline was at first inaccessible by road, by delivering manures direct from the rail truck to each section of the fireline. At Cairn Edward a variety of seed mixtures have been sown for comparative test. The mixtures include wild white clover, ryegrass, highland bent, Yorkshire fog and red fescue. Two farmers have shown great interest in this development and though their early cooperation was tinged with doubts, they are now very willing to stock the fireline to the extent required to keep the vegetation eaten down. Grazing by Galloway and Ayrshire cattle extends from May to December. These trials hold much of both forest and agricultural interest and would form an excellent subject for a later article.

There is some satisfaction to be had from the progress made in protection of forests from railway fires, but if you should hear an engine's di-dah-dit crow—get busy!

Editor's note.—Taking entry and exit sign as a single unit, more than 300 such units had been erected by linesides in England, Scotland and Wales by 1959.

REFERENCES

(1) Forest Record No. 23. *Fires in State Forests*, 1929-52.

(2) *Fires in State Forests*, 1929-56 (in preparation for publication).

(3) *British Transport Commission, Annual Report*, 1958, Vol. I.

(4) *General Appendix to the Working Time Tables, British Railways.*

(5) Railway Fires and Preventive Measures, J. T. Fitzherbert. *Forestry Commission Journal*, No. 20, 1949.

OH FORESTER! WHERE IS THY BED?

(The Diary of a Wareham Forester in High Fire Danger)

By A. J. TACKNEY

Forester, South West England

Date	
30 9 59	9.20 p.m. Mr. Braine and myself (having been alerted by hearing the Wareham Fire Siren) went to investigate a fire in the direction of Chicks Hill.
	When nearly at the scene of the fire we saw another fire burning behind it on the other side of Wareham in the Sandford area. We contacted the Station Officer of Wareham and at once went to investigate the other fire. Found to be near Cpt. 50 of the Great Ovens area.
	Fire Service called for at 9.45 p.m. by radio to Control. R.L. and *Q.L. tenders and men brought in by 10.5 p.m.
	At 10.40 p.m. I spotted another fire in the direction of Carey Camp. Contacted Head Forester at Control, who confirmed area of fire and asked for Q.L. tender to be released with men to proceed to new outbreak with Mr. Braine.
	Myself and remainder of men and †R.L. tender called for, ten minutes later. Proceeded to Carey leaving Hamworthy Fire Service to deal with fire. Returned in an hour when Carey fire was under control and patrolled area until 4 a.m. of the 1st October, 1959.
1 10 59	8.15 p.m. Fire Service report fire on Stokeford Heath. Mr. Braine and myself investigate but no danger to Forestry Commission property.
4 10 59	2.18 p.m. Fire at Highwood. Dealt with by Fire Service and Head Forester Parsons.
	At 4.30 p.m. I arrived back in Wareham having been on a week-end leave in North Devon.
	At 5.45 p.m. was on my way to Snelling Dairy at Moreton where a fire had occurred at 3.55 p.m.
	9.30 p.m. troops called for to assist Fire Service and Forestry Commission personnel as fire was once more getting out of hand. Constant patrol of the fire area by Forestry Commission and Fire Service until relieved at 8.30 a.m. of the 5th.
	In bed at 10.0 a.m. Informed at 2 p.m. that there was a fire at Bloxworth Corner, so got up and staggered once more up to the office. Fire under control and very little damage.
6 10 59	8 p.m. Heard Wareham Siren and saw glow in sky in direction of Chicks Hill. Mr. Braine and myself went to look at it. Fire actually at Bunkers Hill on War Department land which has been afforested. No immediate danger to Forestry Commission property, and no help required by War Department personnel.
	10.15 p.m. in bed.

* "Q.L." is a 5-ton Bedford Lorry specially adapted for fire-fighting purposes—equipment consists of Water Tank, Pump and Ancillary equipment.

† "R.L." is a 7-ton Bedford Lorry—adaptation as for a 5-ton.

"Q.L." and "R.L." being the Bedford Code Numbers for the two types of vehicles.

10.45 p.m. phone message from Head Forester Parsons. Fire Service wants an all-night patrol on fire at Bunkers Hill.

Rang Fire Service Headquarters and told them to contact the Army at Lulworth Camp. Back to bed.

11.20 p.m. Raked out of bed again by relief fire crew who were just proceeding to the Snelling Dairy area to take over for the rest of the night. This fire was still being watched by Forestry Commission and Fire Service.

The fire crew pointed out to me, large glow in the sky, which appeared to be behind Gore Heath plantations. I ordered them to get out to the scene as fast as they could.

Called Fire Service, Messrs. Braine and Howe and informed Head Forester Parsons, whose only comment was that he would have to get his trousers on!

Turned out men in Carey Road and had them on fire area by 11.35 p.m. Fire actually in plantations . . . Very suspicious . . . Suspect arson. All-night watch maintained and continued until 5 p.m. on the 7th.

7 10 59 6.45 p.m. Informed by Head Forester Parsons of fire in Cpt. 50 and that R.L. tender was already on the job, having been put on patrol as there now seemed to be very grave suspicions that a fire bug was operating in the area. 13 men and Fire Service on the scene by 6.57 p.m. Fire soon under control. As R.L. tender was bearing down on the fire, a figure was outlined against the fire running away in Northerly direction.

Police dogs were at once called for, but could not pick up a scent. An all-night patrol was maintained by R.L. tender and Police.

8 10 59 11.0 a.m. Saw smoke rising in Keysworth area but on investigating found to be controlled burning.

11.30 a.m. Mr. Fancy investigates fire in Hyde area. Farmer controlling burning of rough grazing.

1.0 p.m. Reported to me by radio, fire in Hyde Gravel Pits area. Found to be controlled burning of gorse in the pits.

8.30 p.m. Informed by Head Forester Parsons that Police had apprehended a youth in connection with the fires in the Gore Heath and Sandford areas.

9 10 59 10.55 a.m. Reported by Mr. Walton over the radio, fire in Chicks Hill area. Mr. Braine investigates and finds War Department plantations at Bunkers Hill on fire figain. Fire Service and troops in attendance.

12.55 p.m. Heard Wareham Siren go. Visibility bad, so checked with Fire Service Headquarters. Fire in Burngate area at Lulworth. On arriving found about 3 acres of a stubble field on fire right on boundary of Cpt. 144. Dealt with by Fire Service and farm hands.

10 10 59 12.20 a.m. Raked out of bed once more by the incessant ringing of the phone. Head Forester Parsons informs me that the Fire Service had reported a fire in the Snelling Dairy area again. Informed Mr. Braine and Mr. Howe and proceeded to scene of fire. Found to be on the edge of Moreton track adjacent to Cpt. 129. Troops and Fire Service on the job. Joined later by Mr. Howe and we maintained watch with the troops until 4.30 a.m. when rain started to fall. Blessed rain! Crawled into bed at 5.15 a.m.

LANDSLIDE DAMAGE TO PLANTATION AT MOCCAS, HEREFORDSHIRE

By B. R. HAMMOND
Forester, South-West England

The Moccas beat of Hereford Forest, comprises several blocks of old woodland formerly managed by Guy's Hospital, but now leased to the Forestry Commission. Most of the blocks consist of long, somewhat narrow but steep hillsides. The range of elevation varies from 300 to 850 feet and generally as the slopes are narrow, the gradient is very steep.

The soil is typical of the locality, being rich clay loam of the characteristic red colour, overlying a somewhat heavy marl, which in turn gives way to the Old Red Sandstone, outcrops of which occur throughout, but are noticeable as caps at the top of the slopes.

Rainfall in the vicinity averages from 30 to 40 inches per year. An interesting point concerning the majority of the hillsides is the abundance of natural springs, which occur at all elevations, and many can be found on the tops of the slopes.

In early May, 1959, a torrential storm occurred, and the following morning, the Blakemere block of the Forest was seen to be rent with numerous large gashes, and as the whole area was under plantations, established P.54 to P.56, an immediate investigation was made.

It was found that five major landslips had occurred, and it was estimated that approximately 6½ acres of young plantations had been destroyed or very severely damaged.

Apparently the porous fertile soil, saturated by the exceptional rainfall, had slid over the less porous and marly soil beneath, carrying all the vegetation, including the trees, with it and had slid over the trees planted below, bending them flat, stripping off the branches and leaves, finally ending in a congealed mass at the base of the slopes.

Immediately following the slips, it was found that water was running down the scarred slopes, but this ceased to run some three days later.

On examination of the exposed soil it was found to contain a considerable amount of powdered mica, which it has been suggested may have accelerated the slipping of the top soil.

The damage can be assessed as twofold, and a short description of the crop may be of interest.

Briefly, the top of the ridge had a plantation of Scots pine extending down the hill some two chains, beneath this a belt of beech also some two chains in width, and below this, pure European larch, with some oak and Norway spruce in line mixture on the flatter portion of the lower slope.

The first and most serious damage was to the Scots pine and beech, which had been carried in some cases rather like large "islands" down the slopes. These had met the higher European larch and bent them down but not buried them deeply, and finally ended up in a heap at the base of the slope.

The damage therefore is: first, complete burying and destruction of portions of the Scots pine and beech, and second, the bending flat and stripping of the European larch, oak, and Norway spruce.

There is little that can be done to salvage the first damage, but it has been suggested that coppicing of the stripped and damaged oak may succeed in preventing the necessity for replanting this. The difficulty here will be the fact that in places piles of soil have wedged on the slopes and buried the oak, thus the coppiced remainder will necessarily include large gaps in places.

The European larch, which were averaging 12 to 15 feet in height, have been flattened to the surface, and denuded of their needles. It is feared most cannot be salvaged, although possibly setting upright and staking might save a small number.

To sum up, the slips have caused severe damage. They are of interest as they have indicated the danger to future plantations on similar sites. Their prevention appears to lie in careful control of future fellings, and a retention of anchorage trees from the mature crop. This may be difficult where the disposal of the crop is not in the hands of those who have to plant up later, but certainly will have to be taken into consideration in years to come.

Note by M. Penistan, Divisional Officer

Certainly these steep slopes are very unstable and their form shows that many slips have occurred in the past. At the middle of the slopes the gradient eases where former land slides have come to rest. The last thing we must do in future is to clear-fell these slopes—there are no recent slips in adjoining older oak woods. The new scars will be planted closely, in lines across them, with alder. We shall salve what we can elsewhere, remembering that any deep-going tree root, whether the stem is vertical or not, is on our side. Blanks will again be planted with tap-rooters, and as this is one of the best regions for fine sessile oak in England, that species will be used in mixture. The cause of the slips is geological rather than surface drainage, but drains will be carefully maintained.

SCOTS PINE DEFOLIATION ON THE WEST COAST

By J. H. THOMSON

Forester, Research Branch

In certain coastal areas along the West of Scotland and the North-West of England, Scots pine has failed to flourish even at low elevations. The sites used for Scots pine here are usually shallow soils over rock or stony drift, sometimes with a covering of peat. The Scots pine grows up to three to ten feet, and then suffers from a browning of the needles, followed by needle fall. This browning is very noticeable in early summer; later, when the new needles grow, it is not quite so obvious. This casting of the previous year's needles is repeated year after year, with the result that growth is seriously retarded or stopped. In some cases it may result in the death of the tree. Examples of this have been found in Carradale Forest (Kintyre) and Salen (Mull).

There is some doubt as to the cause of this defoliation. One theory is that flying salt spray is responsible. At Inverliever during a south-westerly gale it has been recorded that the air was full of flying salt spray, even on the higher parts of the forest, at a distance of ten-and-a-half miles from the sea. If salt spray is the cause, this indicates that its effects may be found a considerable distance from the sea. (Forestry Commission Journal No. 1—1922, P.35 and 36. A. Graham).

It has also been suggested that the browning and fall of the needles may not be caused by sea spray, but may be the result of a cold north-east wind on plant tissues which are not completely dormant. Following the severe winter and spring of 1947 damage was observed further inland, even into Speyside. At this time even heather was killed by the severe winter.

In Tardree Forest (Co. Antrim, N. Ireland) it has been noted that defoliation by "blasting" in Scots pine does not necessarily imply highly exposed conditions, as fully sheltered trees are affected almost as badly as those which are exposed. In this case "climatic defoliation" might be a better description. (J. Redmond, 27.9.48 in correspondence).

Other factors than situation and climate have been suggested as the cause of the defoliation. Briefly, they are:—(a) The lack of ground preparation, since the trouble usually occurs with direct notching without ploughing or turfing; (b) Poverty of the soil, for which manuring might be a cure. This was demonstrated in Experiment 22.P.36 at Achnashellach, where the effect of slag on the growth of Scots pine of the local Glen Uig provenance was phenomenal: 15.3 ft. for the slag treatment as compared with 5.0 ft. for the control at 20 years. The site was, however, poor *Trichophorum* ground, and much poorer than in typical cases of the defoliaton.

After consideration of all available information, it was considered worth while to test the effect of careful ground preparation plus manuring, and compare this with direct notching, on several provenances of Scots pine.

In selecting sites for the experiment the usual difficulties of uniformity were encountered, but eventually satisfactory sites at Salen, Asknish and Strathlachlan were selected.

Adjoining the experimental site at Salen there is a twenty-five year old plantation of Scots pine which has failed. The provenance used was one from East Scotland. Many of the trees are dead and others are only two to six feet in height. Exposure on the experiment site is severe all round and the elevation is 300 to 500 feet.

The sites at Asknish and Strathlachlan are on opposite sides of Loch Fyne and have, therefore, easterly and westerly exposures, each ranging from moderate to severe. The elevation at Asknish is 250 to 400 ft. and at Strathlachlan 450 to 500 ft. Complementary experiments were decided upon for the two sites, covering sufficient combinations of aspect, elevation, ground preparation and manuring, and provenance.

All three sites were planted in March, 1952. The design of the experiment was limited to a certain extent by the number of plants available in certain provenances. At Salen nine provenances were used and at Asknish and Strathlachlan, six each. The provenances at Salen include three from West Scotland, three from East Scotland—or East England—and three from Norway. At Asknish and Strathlachlan two from West Scotland, two from East Scotland—or East England—and two from Norway were used. As further details of provenance may be of interest, the complete list of plants used is as follows:—

50/421 Raasay, Western Isles—at Salen.
48/516 Java Estate, Island of Mull—at Salen.
48/252 Baranlongart Estate, Argyll—at all three sites.
47/136 Carradale, Argyll—at Asknish and Strathlachlan.

48/188 Altyre, Morayshire—at all three sites.
50/63 Candacraig, Aberdeenshire—at Salen.
50/135 Lynford Point, Thetford, Norfolk—at all three sites.

50/82 Amla—Sogndal, Norway (West)—at Salen.
50/83 Svanoy, Norway (West)—at all three sites.
50/183 Hedmark, Norway (East)—at all three sites.

Unfortunately, the plants were not all of the same age and type, the Norwegian provenances in particular being rather small but sturdy 1+1's, while the Thetford plants (also 1+1) were twice as big.

The design of the Salen experiment consists of five randomised blocks. One half of each block was planted without fertilizer and with minimum ground preparation, while in the other half thorough ground preparation and application of 1½ oz. of Ground Mineral Phosphate per plant were carried out. There is a 36-plant plot of each provenance in both halves of each block. There are no gaps between plots and the whole block of 18 plots is surrounded by two rows of a standard provenance, so that edge effects are minimised. The blocks vary slightly as regards vegetation, elevation, aspect, and exposure, but are as uniform as possible within themselves.

At Asknish and Strathlachlan the design is similar. There are four blocks in each case, split as at Salen, but including only the six provenances. Methods of ground preparation varied from place to place according to site and conditions. At Salen three blocks were ploughed at 5 ft. with plants on the bottom and close to the side of the furrow. The other two blocks, on steeper unploughable slopes, were turfed. At Asknish a large screef with pit planting was the method adopted, and at Strathlachlan turfs were spread from plough furrows twenty-seven feet apart. Soil from Salen was analysed by the Macaulay Institute, Aberdeen, who suggested that phosphate application would be beneficial. The half blocks without ground preparation or fertilizer were planted using an "L" notch after slight screefing.

Results of the experiment after six growing seasons are as follows:—

HEIGHT GROWTH

(Mean for each Provenance in Feet)

		Salen		*Asknish*		*Strathlachlan*	
Id. No.	*Origin*	*Prep. and Fert.*	*Nil*	*Prep. and Fert.*	*Nil*	*Prep. and Fert.*	*Nil*
50/421	Raasay, Western Isles	3.4	1.9	—	—	—	—
48/516	Java Estate, Isle of Mull	2.8	2.6	—	—	—	—
48/252	Baranlongart Estate, Argyll	3.0	2.3	3.8	3.5	1.5	1.4
47/136	Carradale, Argyll	—	—	3.4	3.3	1.4	1.9
48/188	Altyre, Morayshire	3.3	2.9	4.2	3.8	1.7	2.0
50/63	Candacraig, Aberdeenshire	2.3	1.8	—	—	—	—
50/135	Thetford, Norfolk	3.1	2.6	4.0	3.6	1.5	1.7
50/82	Amla—Sogndal, Norway (W.)	2.3	1.6	—	—	—	—
50/83	Svanoy, Norway (W.)	2.1	1.7	2.8	2.5	1.1	1.1
50/183	Hedmark, Norway (E.)	2.6	2.1	2.7	2.7	1.3	1.0
	Mean	2.8	2.2	3.5	3.2	1.4	1.5

At Strathlachlan the results have been confused by hare damage, which was more severe in the Prepared and Fertilized sections because these plots were planted on turfs and stood out above the snow. The damage occurred during the first and second winters. Vole damage occurred at both Salen and Strathlachlan. There was some damage by deer at Asknish in the earlier years, but, more recently, severe damage has occurred at Salen. The three best provenances for height growth are Thetford, Altyre and Baranlongart in that order, but on the prepared and fertilized ground at Salen, Raasay is better than any of these three. There are no Raasay plots at Asknish and Strathlachlan.

DEFOLIATION AND NEEDLE BROWNING

Salen

After six growing seasons, Hedmark, East Norway, has had much less defoliation than the other eight provenances. The percentage of trees recorded as having browning of needles in each provenance in December 1957 after the sixth growing season are as follows:—

		Prep. and Fert.	*Nil*	*Mean*
50/421	Raasay, Western Isles	36%	35%	36%
48/516	Java, Isle of Mull	48%	20%	34%
48/252	Baranlongart, Argyll	47%	17%	32%
48/188	Altyre, Moray	63%	22%	42%
50/63	Candacraig, Strathdon	41%	19%	30%
50/135	Thetford	60%	65%	62%
50/82	Amla, West Norway	45%	29%	37%
50/83	Svanoy, West Norway	53%	23%	38%
50/183	Hedmark, East Norway	9%	5%	7%
	Mean	45%	26%	36%

It is difficult to say to what extent these figures are comparable because of the variations in height growth between provenances, but the difference between Hedmark and the others is very great indeed, and the height growth table shows that there are three provenances which are smaller and, therefore, less liable to defoliation than Hedmark. Hedmark was also recorded as having noticeably less brown needles than the others, in April 1957 at the beginning of the 6th growing season, and in March 1955 at the beginning of the 4th growing season. No inspection was made at the beginning of the 5th growing season, spring, 1956.

It will be interesting to see how the various provenances react during the next few years as the trees become taller and get more into the wind. The Prepared and Fertilized sections, which are taller at the moment, have had more needle blasting than the other sections, presumably because they present more foliage to the winds which cause browning of the needles.

Asknish

So far, Hedmark, East Norway, has had less defoliation than any of the other five provenances. It is also one of the two smallest provenances for mean height. The other provenance with small plants, Svanoy, West Norway, has as much defoliation as the other provenances. Defoliation appears to be most severe on the tall Thetford provenance. The Hedmark plants are much more bushy than the other five provenances and seem to have needles of a darker green.

Strathlachlan

Very little defoliation has been recorded for this site, but in May 1955, at the beginning of the 4th year, the Hedmark origin appeared to have less brown needles than the other five provenances.

DISCUSSION

The results so far do not indicate any clear superiority of West Coast provenances over those from East Scotland or East England either in resistance to defoliation or in height growth, but they can only be regarded as preliminary and it will be interesting to see what happens during the next few vital years. Will the vigour of Thetford (which is probably of Scottish origin) and Altyre continue as the trees get taller, or will the apparent ability of Hedmark to hold its needles continue and make it the only successful provenance? We shall have to wait for quite a few years yet before we have the answers to these questions.

DAMAGE TO YOUNG BEECH (FAGUS SYLVATICA) BY THE COMMON RAT (RATTUS NORVEGICUS) IN MICHELDEVER FOREST, HAMPSHIRE

By D. A. DRUMMOND and A. REDFERN
Infestation Control Division, Ministry of Agriculture,

and A. G. PYMAN, *Forester, South-East England*

The only published record known to us of damage by common rat to forest trees is that of Udagawa (1954). While investigating the cause of the complete destruction in Japan of almost 20 acres of young *Chamaecyparis obtusa*, he found signs of gnawing 10 to 20 cms. from the ground on the bark of 10-year-old *Abies firma*, 15-year-old *Tsuga sieboldii*, and 20-year-old *Pinus pentaphylla*. The marks were larger than those of the field vole, *Apodemus*, and Udagawa had no doubt that they were made by the common rat, *Rattus norvegicus*, which he had shown, by trapping, to be present in the area.

Damage in the present case occurred in Hampshire and was confined to most of an 11 acre plot (Fig. 34) of derelict hazel coppice planted in 1955 with alternate strips (each with three rows of trees) of beech (*Fagus sylvatica*) (aged 2+2 years) and Douglas fir (*Pseudotsuga taxifolia*) (1+1, and 1+2 years). To the north the plot was bordered by a ride and a further plantation of beech and Douglas fir of similar age but with no overhead cover. Along the western edge was derelict hazel coppice, not under-planted, and to the east the same but under-planted with oak (*Quercus robur*) and Norway spruce (*Picea abies*). To the south a hedge separated the plot from a field of corn stubble. Perhaps grain in this field first attracted rats to the area and probably formed their main food during the autumn, for about half the rat holes lay close to the field. The rest were further into the wood but mainly along the western edge (towards undisturbed woodland and human habitation) and a central path (where grain was put down periodically for game birds).

A survey of the damage was made on 29th January 1958, nine weeks after control of the rats had begun and ten weeks after damage had first been seen. The Douglas fir were not examined systematically for damage, but the bark of some of them had been gnawed or stripped off near the base of the tree. Probably most of this gnawing was done by field mice or voles. for only in one or two cases were the teeth marks big enough for rats. Mice and voles may also have done some of the superficial gnawing of the beech. Much of the damage to this tree however was more severe. We counted 264 beech that had been completely gnawed through at the base and in many cases the roots of these felled trees had been dug out and gnawed away to a depth of about 4 inches. All the teeth marks examined on the gnawed surfaces were of rat size, but rats were also convicted on the following counts:—

(1) Distribution of the damaged beeches was roughly correlated with the distribution of rat holes (Fig. 34) in that damage tended to diminish from south to north leaving two completely undamaged strips of beech along the northern edge of the plot and no rat holes occurred beyond the last traces of damage.

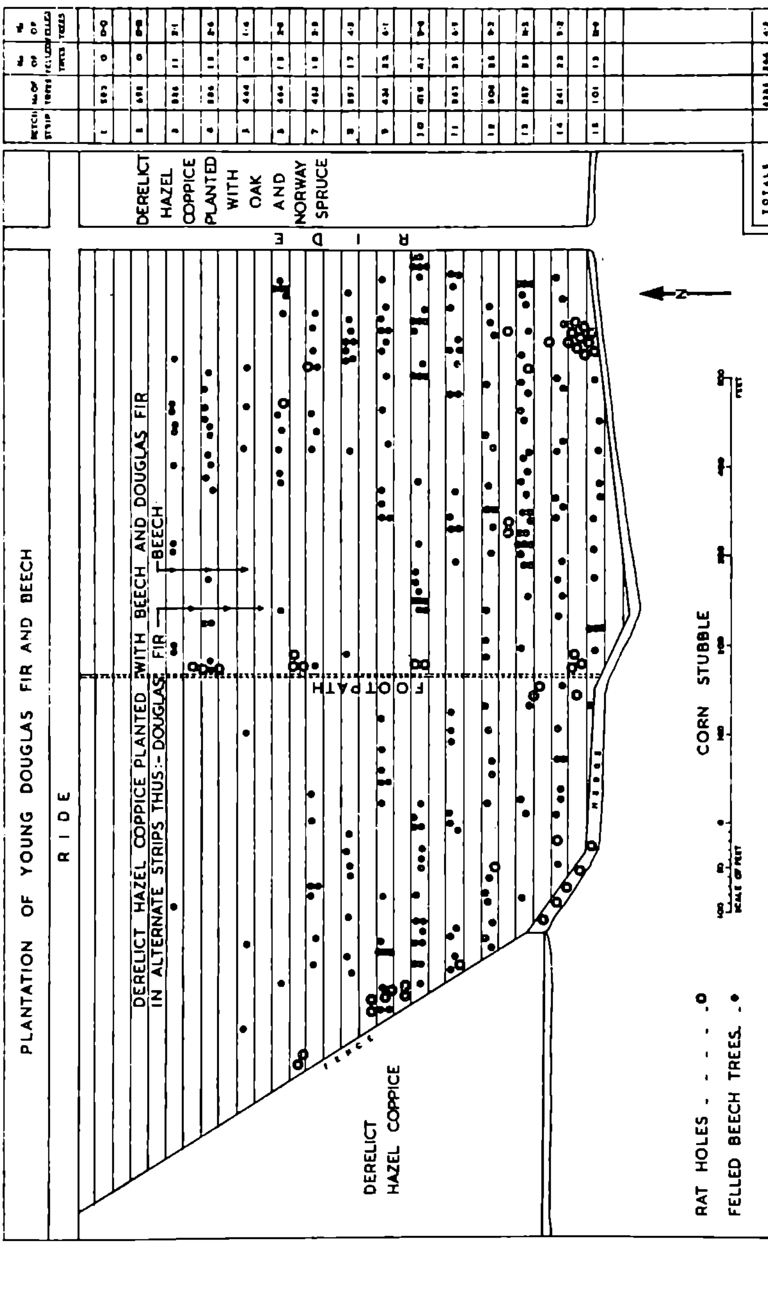

Fig. 34. Diagram of damaged plot, showing distribution of rat holes and felled beech trees.

(2) Where the root of a felled beech had been gnawed away, the hole made was 3 to 4 inches in diameter, and had every appearance of the entrance to a rat burrow.

(3) Rat droppings were found associated with damaged trees and some actually in the holes where the roots had been gnawed away. Thirteen fresh droppings were collected. Eleven contained woody tissue from which was separated one small fragment of beech bark. The rest of this woody material was not identified, but some of it may have been the roots of wild parsnip (*Pastinaca sativa*) which rats had been gnawing close to the damaged plot. In addition, earthworm chaetae were found in 9 droppings, leaves of grass in 7, and insect fragments and a slug shell each in one. With the exception of a few pieces of worm, the stomach of a rat killed on the same day as the droppings were collected, was entirely filled with grass leaves. Thus, while the stems and roots of the young beeches almost certainly served as a source of food for the rats it was by no means the only one.

The numbers of felled trees counted in each of the 15 strips of beech are given in Fig. 34. The numbers of felled trees and gnawed (but unfelled) trees in strips 12, 13, and 14, were 80 and 216 respectively. If this ratio holds good for other damaged strips, roughly 700 trees in the whole plot suffered less severe damage than the 264 "felled" trees. It is impossible from this rather superficial survey to estimate the monetary loss due to rats. Its seems likely, however, from the scattered nature of the damage that relatively few of the trees destroyed will need to be replaced, thus making the loss much less than appears at first sight.

The rats were controlled by a combination of live trapping, gassing and poison baiting; 23 rats are known to have been killed and no traces of rats or recent damage were found when the plot was inspected on 2nd May, 1958.

Acknowledgments

We are indebted to Mr. A. G. Jenson for drawing Figure 34.

Reference

Udagawa, T. (1954): '*Rattus norvegicus* does harm to the woods'. *J. Jap. For. Soc.*, XXXVI, 92-95. (Only the English résumé has been read).

See also Plate 7. *Editor.*

THE FASCINATION OF BADGER WATCHING

By JOHN M. FRENCH

Forest Worker, South-East England

A June day was fading into twilight as my brother and I made our way to the woods. From the depths of the woods a fox barked and we knew that with the creatures of the night, activities were afoot. Our intended destination was a badger sett in the middle of the woods. It has been home to many badgers and its enormous entrance, with side tunnels branching off here and there, represented the excavations of many generations of badgers.

At the time of writing a family of five badgers resided there, three of these being cubs. By the time we reached the middle of the woods, the twilight had deepened into dusk. We approached the sett cautiously and reached our hiding place behind an old oak tree only a few minutes before a large white-striped face appeared at the entrance of the sett; it was the old boar badger; he paused on the threshold and carefully scented the air, first in this direction then in that. Fortunately, what wind there was blew towards us and did not betray our presence. Apparently satisfied, the badger sat down and started to scratch in various positions. We envied the old gentleman because we were being eaten alive by midges, but were afraid to scratch in case the slight noise might have sent him underground.

The scratching ceased at last and the badger turned towards the sett entrance and looked expectantly down. Almost immediately, another white-striped face appeared, this time it was the sow. She sniffed the air, but the wind told her of no dangers and out she came. She was closely followed by three cubs, who started to play. They started chasing each others' tails, then all puffed out their fur, stiffened their short legs and bounced around one another like big india-rubber balls, twisting and turning their heads in all directions. The adult badgers in the meantime had left the vicinity of the sett to begin the night's foraging, and the cubs, suddenly realising they were alone, followed in a mad rush, the sounds gradually receding into the night.

This is an account of many such scenes that my brother and I have witnessed, but the fascination of watching badgers never fails to thrill us.

Badgers are more common in urban localities than many people imagine. The belief that they are not, is because badgers are nocturnal in their habits and are very rarely seen abroad. In daylight there is little to catch the eye of the casual observer save the enormous mounds of earth outside setts. The badger's home, which is called a sett, is found mostly on hilly ground, in a bank or under the roots of a tree. Setts are regularly cleared out and fresh bedding is brought in to line it. Badgers are scrupulously clean and never soil their setts but use specially dug pits for excrement.

In the above paragraph, I referred to the close proximity of setts to urban surroundings. Several striking examples come to my mind, most of them within 15 miles of the centre of London and many situated not more than a few hundred yards from heavily populated areas. In the urban district in which I live, I know of twenty occupied setts, some being extremely large and of a great age. One in a wood in Sanderstead, Surrey, covers an area of ground approximately an acre in extent. The soil is soft sand and badger tunnels are everywhere. At the present moment the sett is occupied by a thriving colony of six badgers, four of which are shown in the photograph. This photograph and the other illustration are only two of many which we have obtained by flashlight, using an inexpensive camera (see Plate 14).

Badgers, although mainly carnivorous, will eat many varieties of food, a considerable amount of vegetable matter is consumed, and wasps nests are considered a delicacy by them. It is fair to say that their feeding habits are generally harmless, but badgers are sometimes accused of killing poultry and game birds. After several years of observations, I have not come across any such cases and would condemn any man who killed a badger unless he had first-hand proof of rogue behaviour. However, one poor chap I have just met, whose house adjoins woodland, has found that his newly-laid lawn is marked with badger holes and we cannot number him amongst the admirers of the species.

In the Forestry Commission, we often find evidence of Brock the badger although we rarely see him. He is not an enemy of the forester because he does next to no damage, except occasionally disturbing rabbit-proof netting which interferes with his old established runs.

Badgers have a peculiar attraction for students of natural history but their study requires considerable patience. It is advisable to visit the sett in daylight and select a vantage point such as a convenient tree from which a good view of the sett can be obtained. It is essential to stand to the leeward of the sett as badgers depend largely on scent as a danger signal, their eyesight not being highly developed, although any sudden movement will alarm them and cause a rapid retreat underground.

To the patient student, however, the arrival of sunset can bring that most gratifying sight—a large striped face cautiously sniffing from the entrance to the sett, the jolly good scratch and then the disappearance into the undergrowth in search of food.

A VISIT TO THE ORDNANCE SURVEY RECORD ROOM AND MUSEUM, CHESSINGTON, SURREY

By H. C. CRAWFORD

Clerical Officer, Finance Branch

The aim of the following article is to give an account of the history and methods of Ordnance Survey in this country, but it must be borne in mind that the science of map-making is very complicated and comprehensive, and that the article can only treat the subject in very broad and general terms. Before relating the history of Ordnance Survey I must first explain the factors that have to be decided when mapping a country.

Planning a Survey

When objects surveyed and measured on the curved surface of the earth are represented on a flat piece of paper, it is not possible to place the symbols representing those objects on the paper in the same relative positions which they occupy on the surface of the earth, so some conventional method of making the representation must be used and this method is known as a projection. So the *projection to be used* is one of the factors to be considered. The one used for the re-survey of Great Britain is the Transverse Mercator Projection.

Next must be the *limits of permissable error.* These must be worked out so that the extremities of the survey will not contain any plottable error on the largest scale to be used.

For plotting the various controlling points (or stations) a *point of origin* is chosen on the projection. This is the intersection of a Meridian of Longitude and a Parallel of Latitude on which a Projection is based. In the case of the re-survey of Great Britain it is 2° West and 49° North, a point which lies in the English Channel.

Triangulation. For very many years the method used for establishing the relative (absolute positions are determined by astronomical observations) positions of points on the earth's surface has been that of "triangulation". These points are known as Triangulation Stations and they must be sited so that each point is intervisible with several other surrounding trig. stations, thus enabling triangles to be formed between them. Triangulation depends on the principle, that "if the length of *one* side and the angles in a triangle are known, the lengths of the remaining sides can be found". In practice, one side of the initial triangle is accurately measured and from the terminals of this "base", triangles covering the whole area to be surveyed are built up and their angles are measured with a theodolite. (See Fig. 35, westernmost point is St. Kilda).

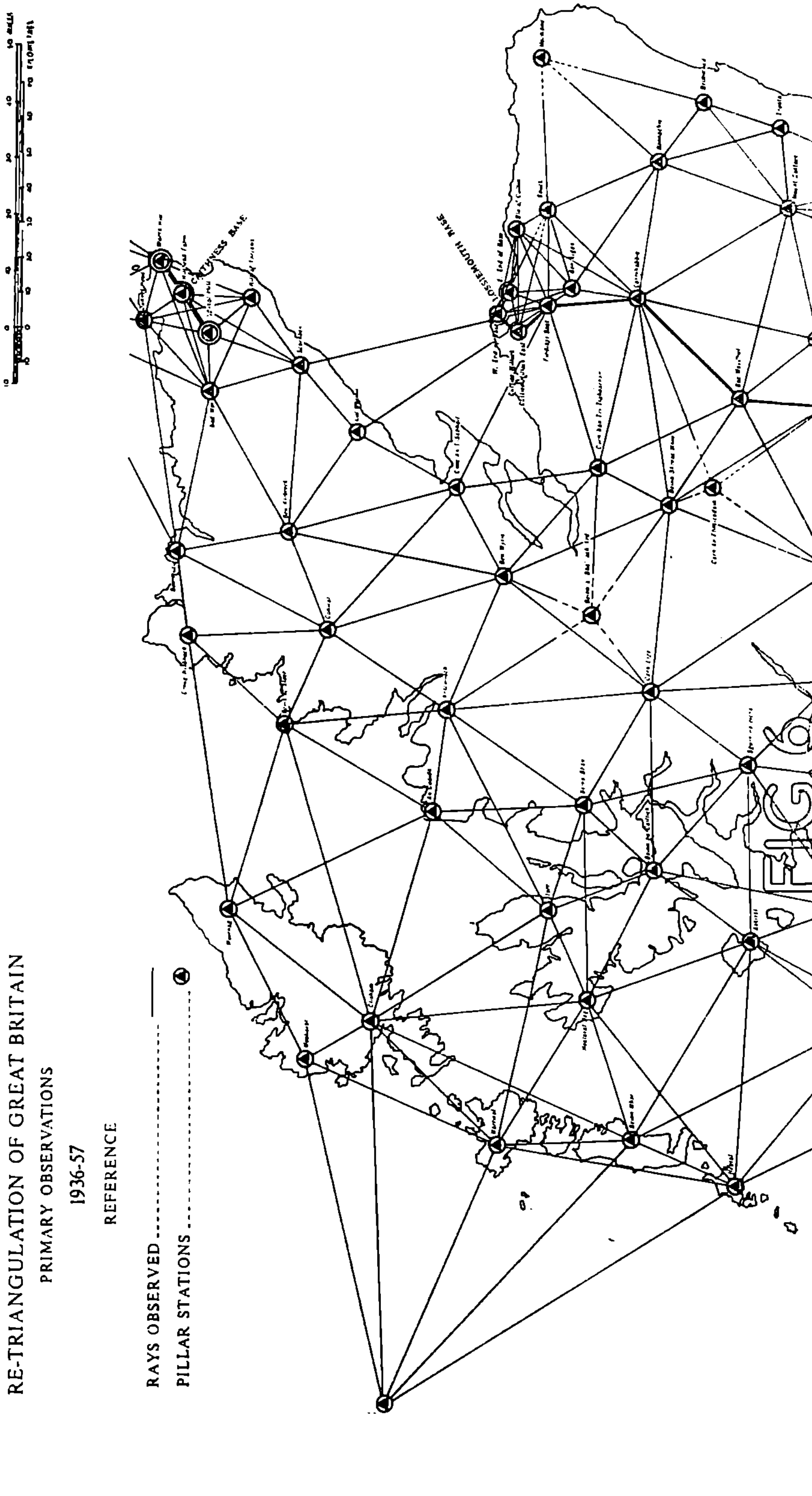

Fig. 35. Ordnance Survey Triangulation.

There are three main classes of triangulation, Primary, Secondary and Tertiary. Primary triangulation uses very large triangles and is carried out using every possible refinement in instruments, field procedure, and calculation to ensure the highest degree of accuracy for the positions of the stations. It thus establishes a network of control points on which a Secondary triangulation using triangles of smaller size can be based. Tertiary triangulation breaks down the Secondary network into still smaller triangles where required. Primary, Secondary and Tertiary are sometimes referred to as 1st, 2nd and 3rd order triangulation.

The trig. stations are selected by reconnaissance. Their selection is largely governed by the "order of triangulation", topography of the country, stability of the ground and intervisibility between stations. In the case of Primary triangulation, the sites for bases are also selected, usually from a separate reconnaissance. The bases, other than the one which starts the whole system of triangulation, are normally referred to as "check bases" and by comparing their measured lengths with the calculated lengths derived from the triangulation, a check on the accuracy of the triangulation can be maintained as the work proceeds.

Scale. In Great Britain the scale of survey is decided by the extent of built-up areas and density of population. A large town will generally warrant a large-scale survey, and many since the last war have been surveyed on the 1 : 1250 (approx. fifty inches to one mile) scale. Except for moorland and mountainous areas, the whole country is covered by a 1 : 2500 (approx. twenty-five inches to one mile) scale. The larger scales are technically known as plans, and the smaller scales as maps.

History

The Jacobite rebellion of 1745 emphasised the need for reliable maps. It was found that military operations were considerably handicapped by lack of good maps, and it was the need for good maps that eventually led to a survey of Great Britain and Ireland. In 1747 the Government authorised the mapping of the Highlands of Scotland to be carried out by the Army. The survey was placed under the supervision of William Roy, later to become General Roy. These first maps, one of which can be seen in the Museum, were on a scale of about 1,000 yards to one inch and can be regarded only as magnificent military sketches as they were not based on a triangulation. In 1755 this work came to a stop when the country became involved in war. After the American and European wars the military authorities began a systematic survey. The first triangulation commenced in 1783 with the object of obtaining a relationship between the observatories at Greenwich and Paris, the work again being controlled by General Roy.

The base of the first triangle was between a point on Hounslow Heath which is now part of London Airport, and a point at Twickenham. The points were marked by guns sunk into the ground about four and a half miles apart. From there triangulation was gradually extended to cover the whole of the British Isles. While the triangulation for the connection between the two observatories was in progress, the Government authorised the survey of the country on the one inch to one mile scale. The staff employed in this survey were placed by the Duke of Richmond under the Board of Ordnance in 1791, hence the name of "Ordnance Survey". By 1801 a one inch map of Kent had been produced. Work progressed on the one inch scale until 1825 when it was suspended in order to take up the survey of Ireland on a larger scale for valuation purposes; the one inch being too small to show sufficient ground features. A scale of six inches to one mile was, therefore, authorised. It was later decided to map the still unsurveyed parts of Great Britain on this scale. This involved the six northern counties of England and all of Scotland. Work commenced in 1840, and was subsequently extended to cover the part of England and Wales previously surveyed at one inch to one mile scale.

In the meantime, there was a demand for large scale plans by some Local Authorities and in 1855 permission was granted for surveying urban and cultivated districts, on the 1 : 2500 scale. From this time onwards, the two basic scales of survey were 1 : 2500 for urban and cultivated areas and six inches to one mile for the rest of the country. Nothing was done during the 1914-18 war, and after the war the staff of the Ordnance Survey was so depleted because of Government economies that it became virtually impossible to bring the plans of the country up to date. As a result of this difficulty, the Government set up a Departmental Committee to investigate the state of the National Survey and to make recommendations for rectifying the position. In 1935 the "Davidson Committee" reviewed the situation and found that a new survey was necessary in many places. In view of this finding, it was decided that a re-triangulation was essential because many of the triangulation stations had disappeared and there was also an element of doubt as to the stability of a large number of those which remained, particularly those in mining areas.

The re-triangulation commenced in 1935 and the Primary work was completed in 1957 when connections were made to Ireland, France and St. Kilda. The average length of the sides is about 30 miles, the longest being from Prescelly in Pembrokeshire to Ballycreen in Wicklow, about 95 miles. Two bases were measured, one in Berkshire (Ridge Way) about 7 miles long and one in Caithness (Caithness) approximately 15 miles long. The Ridge Way base was measured twice; in 1938 and in 1951, the difference between the two measurements being six millimetres. The Caithness base was measured in 1952. The Secondary Triangulation breaks down the Primary framework into triangles with sides about five to seven miles long. This task is expected to be completed by the end of 1962. Tertiary triangulation, or 3rd order, is carried out in all areas except mountainous districts. The sides of this order are about four to five miles in length.

Methods of Measurement

In order to obtain large triangles, primary stations were selected on mountain tops, prominent hills and, in some cases, the tops of tall structures with flat roofs, church towers, water towers, etc. were found to be very convenient. In flat or wooded areas, e.g. East Anglia, specially constructed steel towers (Bilby Towers) were used to get the necessary height to clear obstacles. (See photo). These towers can be erected to heights of about 30, 60 and 103 feet. Flat roofs and Bilby Towers are also used in Secondary and Tertiary work when necessary.

When the sites for triangulation stations have been selected, ground points are marked by concrete or stone pillars. Roof tops are marked by special metal bolts fixed to the roofs. A geodetic theodolite, specially designed for precision work is used for measuring angles at each first, second and third order Trig. Station. The theodolite is trained on to a point of light coming from a beacon lamp on the target station. (See photo). For the Primary work each angle was measured thirty-two times, but for second order work only sixteen measurements were taken and eight measurements were normally sufficient for third order work. In general the means of the measurements are accepted as the angles to be used in calculating and determining the positions of the points on the earth's surface. The calculations are done by computers at Headquarters.

Base Measurement. The equipment used for measuring bases has improved considerably with the advance of science. Prior to 1827 the bases for the old Primary Triangulation were mostly measured with steel chains along the surface of the ground, but for measuring the base for the re-triangulation "Catenary" equipment was used. This equipment enables measurements to be taken through the air by suspending the measuring wire of twenty-four metres in length between tripods. It also enables bases to be measured over undulating and comparatively rough country so giving more scope in the selection of sites.

In 1957, a new type of equipment called a Tellurometer, was used over the bases and other measured distances, and the comparisions between the original and Tellurometer measurements of these lines proved that the order of accuracy was as expected. The Tellurometer measures distances by electronic means and is comprised of two instruments; one sends out radio waves and the other reflects them back. The time interval is measured, and from this, the distance between the two points is calculated. When the equipment was used over the Ridge Way Base, approximately seven miles, the resulting measurement was about three centimetres shorter than the Catenary method. Still more remarkable, was the fact that the Tellurometer equipment needed only four men to handle it over a period of two days, whereas the Catenary measurement took forty men twenty-four days to complete. The Tellurometer takes direct readings between the two terminal stations, thus enabling measurements to be taken over country where it would not be possible to use Catenary tripods. It is now being used to provide control points in a number of places for the large scale and six inch re-surveys.

Minor Control Points. The trig. stations established by Triangulation are normally too far apart to provide adequate control for large scale survey. Where this is the case, a fourth order triangulation is carried out to increase the density of control points to about two kilometre intervals for 1 : 1250 scale and about three kilometre intervals for 1 : 2500 scale work. In built-up areas it is necessary to increase the density of control points so a system of "minor control points" is established. Their density will depend on the scale and method of survey to be used. The three main methods are:—

Air Survey which provides detail by means of air photographs. To control the survey by air photography about ten pairs of points (Air Points) per kilometre are selected. These must be points on the ground which can be identified on the air photographs.

Tacheometric Survey, in which angular and linear measurements are made by the tacheometer (see photo). A tacheometer is an instrument which measures angles and distances. The distances are obtained by taking readings on to a graduated horizontal staff mounted on a tripod. For tacheometer survey control points must not be more than 1,200 metres apart.

Chain Survey which needs an average of forty pairs of minor control points (Revision Points) per kilometere square. The positions of these points are established by traverse or triangulation methods (see photo).

Armed with descriptions of these points, reconnaissance surveyors go out and prepare a diagram showing the methods to be employed to survey the points. The most economical method which ensures the standard of accuracy required is used. In general this means that in rural areas triangulation is used but in built-up areas the normal method is traversing. A traverse is a series of connected straight lines starting from, and closing on, previously established points. The angular direction and length of each line in a traverse are measured, the former with a theodolite and the latter with a steel tape. The terminal point of each successive line is normally marked by driving a "pipenail" or wooden peg into the ground according to the nature of the surface. These points are called traverse stations. Where permanent objects are in suitable positions they can be used as traverse stations. The actual point to be used is marked by making a cross-cut on the object with a cold chisel. Each traverse is allotted a unique number. In many instances it is not possible to start the traverse and sight to the next station because of the intervention of buildings. The "revision points" are therefore in pairs, so that a line can be made between the two and create along that line a suitable spot to start the traverse.

In the case of tacheometer survey, permanent objects on the ground are chosen to provide the control for tacheometric survey. They may be such objects as the centres of circular manhole covers, corners of the frames of manhole covers, storm drains, etc. In rural areas, where permanent objects are not available, small concrete blocks are let into the ground with their tops level with the surface. A small brass rivet is set in each concrete block to mark the exact position of the station. Angular and linear measurements are recorded in special books, which are sent to the Computing Staff at Headquarters who are responsible for calculating the co-ordinates of all stations. These co-ordinates are then passed to the Plotting section which is responsible for plotting the points on the documents to be used by air and ground field surveyors.

Detail Surveying

The complete survey of all features is not attempted by any of the three methods briefly described in the previous sections. Air survey provides as much as possible from the photographs. In "open" areas up to ninety per cent of such features can be drawn in at this stage, when photographs are good, whereas in tacheometric and chain survey, the effort is confined to surveying sufficient detail to form a good foundation, upon which the remaining unsurveyed features can be built. The material now in use for plotting the actual survey is aluminium because its liability to contract or expand is small, easily determined, and the same in all directions. It is in the form of small square plates, four of which, when placed together, make a quarter of a kilometre square (one plan) for 1 : 1250 scale, and one kilometre square (one plan) for 1 : 2500 scale. By using aluminium plates the accuracy of the field surveyors work is preserved.

These plates are called Butt Joint Plates because each plate butts on to its neighbour. Each plate is identified by its kilometre plan number which is entered on the reverse side of it at the plotting stage. The detail surveyed by air, tacheometric or chain method is plotted on to Butt Joint Plates in the office and drawn in red ink. This becomes the "red control" from which the unsurveyed features are supplied by surveyors on the ground. These surveyors also have to show the different types of vegetation encountered, and collect names, house numbers, etc. The completed survey is sent to Headquarters where it is critically examined, drawn and finally printed.

Revision

In order to maintain plans in an up-to-date state, a system of continuous revision is carried out. A number of surveyors are appointed to areas where survey has been completed and their task is to keep all the plans in their areas up-to-date by surveying all development as soon after it occurs as possible and cancelling all old detail that has disappeared since the current plans were published. Modern photography plays a large part in revision work. By reproduction methods the smaller scales can be derived from the larger scales, so making unnecessary a re-survey of the area for conversion.

In revising, Ordnance Survey have taken the opportunity to bring more colour into map-making. The first "Ordnance Survey Maps" were uncoloured, but gradually colours were added, conventional signs adapted and in the latest one-inch "Tourist Series" for special mountainous areas relief is depicted by a combination of layer tints and hill shading. In the "One-inch Seventh Series Maps" as many as ten colours are used. A separate printing plate is made for each colour and each colour must register exactly on the first black and white print. For example, the colour for roads must fit exactly between the outline showing the width of the road. Some other maps produced by the Ordnance Survey are the ½-inch to one mile and ¼-inch to one mile series, both derived from the 1-inch maps. A series at 1 : 25,000 scale (approx. 2½ inches to one mile) is derived from the 6-inch scale maps.

The map and photographs accompanying this article are reproduced by kind permission of the Director-General, Ordnance Survey, and the Controller, H.M. Stationery Office.

VALUING YOUNG PLANTATIONS

By HALDANE CHARTERS
Chief Executive Officer, Headquarters

Valuations of very young trees which contain no marketable timber and cannot be valued on a fair commercial basis are required by the Commission for a variety of purposes. The most important of these are:—

Claims for compensation.
Statistics.
Accounts.
Estimates.
Purchases and sales.
Investigations.

People outside the Commission have expressed surprise that the assessing is done by staff in a London office who never see what they are valuing; and there are people inside the Commission who wonder how these backroom boys do it. This article explains why and how.

There is no universally accepted method of assessment, but over the years the Commission has evolved a process which, although not adopted everywhere, is probably the most frequently used. It has been explained to judges, solicitors, surveyors, insurance experts, accountants and foresters. Most of them have, in effect, said "The method isn't altogether satisfactory, but I can't think of a better substitute". And that, really, is what those who use it at Headquarters also feel about it. If there does exist a better method they would be very glad to know. This article explains the process and adaptations of it, and also tells of objections that have been made to it and of steps taken to counter them.

When the Forestry Commission was created some forty years ago there were very few young plantations alongside the railways, consequently there were few forest fires started by sparks from locomotives and the Railway Companies paid out little as compensation for damage caused. As the Commission's operations expanded and more and larger plantations were formed beside the lines, there were, as a result, more and larger fires and consequently bigger compensation payments by the Railways. To arrive at an amount of compensation the Commission's District Officer would meet the Company's Surveyor on the site of the fire and endeavour to reach an agreement.

At that period it was common practice to assess immature plantations on the basis of expectation value. One estimated the further net expenditure that would be incurred on the plantation up to the age of maturity, and the sum that would be realised by selling at maturity. These amounts were discounted back to the current year, and their difference was regarded as the present value of the plantation. No account was thus taken of the cost of the plantation to date, the assessment being based entirely on what was thought likely to happen in the future. As very few woodland owners kept any costings the future expenditure was decided largely by crystal gazing. Nevertheless, the method was reasonably satisfactory when applied to, say, a forty-year-old plantation and one had to look ahead only twenty years; but it was far from satisfactory when applied to a five-year-old plantation and one had to predict the total expenditure, and the volume and quality and selling price of the timber fifty-five years ahead. The District Officer and the Surveyor inevitably spent much time arguing and bargaining. If the figures each had in mind were much alike, they would split the difference or possibly toss a coin. If the difference was considerable they referred the matter to their respective headquarters and the fight continued at a higher level.

In 1925 an exceptionally large number of fires was started. The District Officers and Railway Surveyors were kept so busy that they had great difficulty in arranging meetings. The Commission could not afford to let its land lie idle indefinitely and in many cases it replanted the sites before they had been inspected by the Surveyors. Both the Commission and the Companies realised that as the forest area continued to expand the problems of evaluating would become more complex. They therefore arranged that representatives of both sides should meet and try to devise some standard simple basis of assessing compensation which could be applied centrally and which required from local officers only a statement of the extent and age of the plantation affected and the degree of damage done.

The meeting was attended by highly placed officers from all the bodies concerned. For the Commissioners it was said their duty was to create a reserve of timber by forming plantations. They had been voted money to do this by Parliament and if any of their work were destroyed by the Railways it was only right that they should be reimbursed the sum they had expended in order that they might do the work over again. They required no more than this, but on the other hand, no less. They knew the costs at each of their forests although they did not, of course, know the outlay on rearing individual trees and thus the exact expenditure on any particular area that might be burnt.

For the Companies it was said that they would be quite happy to pay on the basis of average costs for Great Britain since their locomotives were likely to start fires in all parts of the realm and if, as a result of using this average, they sometimes paid too much, they would in other cases pay too little.

A formula, based on the Commission's then sylvicultural practice was an outcome of the meeting. It subsequently became, and still is, the Commission's standard basic method of assessment for all purposes, though it has through the years undergone some slight revision that it might continue to reflect current practice and accord with changes in the accounting system. The formula in its present form is described below.

As very young trees contain no marketable timber and cannot be valued on a fair commercial basis their value is assessed on the cost of producing, planting and tending them, this cost being calculated by a standard formula.

The elements comprised in the cost are:—

(a) Direct Expenditure (cultural operations)
  Preparation of ground.
  Drainage—new and upkeep.
  Fencing—new and upkeep.
  Planting—plants, labour, etc.
  Beating-up—plants, labour, etc.
  Weeding.
  Protection—fire and other.

(b) Indirect Expenditure
  Vehicles and machinery.
  Forest overheads—covering tools, national insurance, holidays, sick pay, wet time, pensions, transport of workers, travelling time and the salaries and expenses of foresters and foremen.
  District, Conservancy, Directorate and Headquarters overheads—a proportion of the salaries and expenses of staff in these offices.
  Annual value of land—derived from the net cost of acquiring and maintaining land, houses, farms, roads, etc.

(c) Interest on Expenditure.

A plantation is regarded as taking five years to form, the cultural operations being carried out in the following order:—

1st year (Year 0)—Preparation of ground, drainage (new), and fencing (new).
2nd ,, (,, 1)—Planting, protection and 25% of weeding.
3rd ,, (,, 2)—Protection, 75% of beating-up, and 25% of weeding.
4th ,, (,, 3)—Protection, 25% of beating-up and 25% of weeding.
5th ,, (,, 4)—Protection and 25% of weeding.

A plantation is regarded as being maintained in the sixth and subsequent years, the operations in them being protection, drainage (upkeep) and fencing (upkeep). About the tenth year a charge is included for cleaning and before the first thinning a charge for brashing. The cost of the first thinning is incorporated; that of the second thinning is excluded on the assumption that receipts from sales would offset the expenditure; the net income from subsequent thinnings reduces the outlay on maintenance.

To the direct expenditure in each year is added an appropriate allocation of overheads and also compound interest on the total outlay to date calculated at a rate used in the Commission's accounts and purporting to be the rate at which the Commission borrowed the funds used.

In Tables 1 and 2 the formula is shown, in shortened form, with imaginary costs applied to it and pence omitted. Unit costs are derived from the Commission's financial Account of Forestry Operations and the tables of silvicultural operations in the Annual Report. How it is done is another story.

A schedule of average costs similar to Tables (1) and (2) is prepared annually for each country: it shows the current average cost of creating a plantation if every one of the cultural operations (plus appropriate overheads) were to be carried out at the cost in that particular year. By means of the annual schedules for Great Britain, a cumulative cost record is maintained for each age of plantation. An example is given in Table (3). The plantation having been planted in 1953 the record shows for Year (1) the cost of planting given by the schedule of average costs for 1953 (Col. (1) of Table (1)). The cost of the preparatory work in Year 0 (i.e. in 1952) derives from the schedule of costs for 1952 (Col. 0); and the cost of the operations in Year 2 (1954) originates from the corresponding column of the schedule of costs for 1954, and so on for each year to date (vide Year 6 (1958) and Col. 6 of Table (2)). For the current year the costs are estimates based on the best information available: they are substituted by actual costs as soon as these are known.

Depending on its purpose a valuation may be based on (a) original cost, (b) current, or future cost, or (c) replacement cost.

Original cost is the total expenditure on the plantation plus compound interest, at the rate ruling in the year of planting.

Current or future cost is the estimated total expenditure (based on the latest schedule of costs) necessary to create a plantation plus compound interest on the expenditure, at the latest rate.

Replacement cost is the estimated total expenditure (based on the latest schedule of costs) necessary to create a plantation similar to the one lost, plus the compound interest on the expenditure incurred on the original plantation at the rate ruling in the year it was planted.

Original cost is normally used in accounting and for claims against British Railways for fire damage; current cost is adopted for estimates; replacement cost for compensation claims against parties other than the Railways. Valuations on any of the bases may be made for statistics, in special investigations and as guides in the purchasing and selling of plantations. It is the Commission's normal practice to apply cost to plantations under forty feet in height and market value in other cases.

Below are given simple examples of the use of the tables in the valuing as at 30th September, 1958 of one acre of fully stocked plantation six years old (P.53) in normal condition.

		£	s.	£	s.
(a)	*Original cost*				
	Total Expenditure to date (Tab. (3) Cols. 0–6)	55	6		
	Interest on the Expenditure „ „ „	11	18		
				67	4
(b)	*Current cost*				
	Estimated Total Expenditure (Tab. 2 Cols. 0–6)	85	8		
	Interest on the Expenditure „ „ „	30	2		
				115	10
(c)	*Replacement cost*				
	Estimated Total Expenditure (Tab. 2 Cols. 0–6)	85	8		
	Interest on the Original Expenditure to date (Tab. 3 Cols. 0–6)	11	18		
				97	6

The values are appreciably different, (a) being the Commission's past actual outlay, (b) the estimated future outlay were the plantation to be formed at current (1958) costs, and (c) the sum that would compensate the Commission if the plantation were to be completely destroyed and had to be replaced.

Assessments are rarely quite as simple as the three examples given above: frequently, certain deductions fall to be made. It is possible, for instance, that

(a) part of the preparatory work (i.e. preparation of ground, drainage and fencing) carried out in Year 0 will not have to be repeated for the replanting. This work is valued and deducted.

(b) the plantation was understocked. Normally, 80% of the original planting and beating-up is regarded as a full stocking: any allowance given is proportional.

(c) some trees survived. Usually some allowance is made but sometimes survivors are of no value.

Below is a typical example of a calculation associated with a claim for damage against a neighbour for negligently setting fire to a Commission plantation.

> The burnt area was 8 acres in extent, planted in 1953 and burnt over on 30th June, 1958. It consisted of 60% of the original planting, but half of the trees suffered no damage and no preparatory work is needed for replanting.

The Commission requires as compensation (a) the amount of cash that it is estimated will have to be spent on forming a new plantation similar to the one damaged, and (b) the sum needed to extinguish the debt for interest on the money which was borrowed in earlier years and spent on creating the original plantation. Only if the Commission has these two amounts will it be financially in the same position after the loss of the plantations as it was before. The latest cost schedule shows how much per acre has to be spent; the age-class record shows how much is owing in interest on the original expenditure.

Calculation

	£	s.	£	s.
Expenditure (Estimate—1958 costs)				
Tab. 2, Cols. 0–5	83	5		
Tab. 2, ¾ of Col. 6	1	12		
	84	17		
Deductions—				
Preparatory work undamaged (Year 0)	30	12		
	54	5		
Understocking 25%	13	11		
(60% of original planting=75% stocking)				
	40	14		
Survivals 50%	20	7		
			20	7
Interest (on original outlay)				
Tab. 3, Cols. 0–5 (1952 to 1957)	9	7		
Tab. 3, ¾ of Col. 6 (1958 to 30th June)	1	18		
	11	5		
Deductions (see above)—				
Preparatory work		7		
	10	18		
Understocking	2	15		
	8	3		
Survivals	4	1		
			4	2
Compensation per acre			24	9
Compensation for 8 acres		(say)	195	0

With public bodies whose activities continually cause loss of plantations the Commission has made agreements respecting the basis of valuation. Some shortened extracts from the agreements are given below: each has some feature not common to all.

(a) *British Railways*

"With a view to avoiding disputes as to the compensation to be paid in the case of each fire the damage is to be computed by a standard method". (This has already been described). "The figures to be applied shall be the costing data for the Commission's forests regarded as a whole.

"There shall be deducted any saving in subsequent outlay on the operations of preparation of ground, drainage and fencing and the associated charges.

"Where there are special circumstances, e.g. owing to disease a plantation has partially failed, these must be taken into account".

The loss suffered by the Commission is estimated at the original cost of forming and maintaining the plantation up to the date of damage. This basis was reasonable so long as costs remained stable, but there has been a very steep rise in recent years and a destroyed plantation has to be replaced at present-day cost. An outstanding example of the change that has taken place is the agricultural wage which has risen from about 38/- in 1938 to 159/6 in 1958.

(b) *Service and other Government Departments*

Claims are based on replacement cost.

"The bases of compensating the Commission for damage to its property whether during temporary or permanent occupation should be as follows:

(i) in the case of plantations of mature trees, which may reasonably be defined as being those over 40 feet in height, the compensation paid should be the current market price of the timber less the value of salvaged timber if any:

(ii) in the case of plantations of immature trees, which cannot be valued on a fair commercial basis, the compensation paid should cover the estimated cost of creating a new plantation of similar age, extent and condition to that taken over or destroyed plus interest on initial capital expenditure and interest on maintenance expenditure on the old plantation to the date of settlement, at the rates notionally charged on these sums in the Commission's accounts. Allowance should be made for the value of the salvaged timber, if any".

(c) *Certain other Public Bodies*

The Electricity Boards have agreed to pay "(i) in any case in which the trees felled from part of a plantation and are of an average height of less than 40 feet, the current average cost of creating a plantation of the same height and acreage as the one felled, and in any other case, the market value of the trees. (ii) the amount of any damage caused to plantations by windblow due to the cutting of a clearance area and occuring at any time within five years of such cutting".

The Coal Board and other authorities have also paid compensation assessed on this basis.

Claims against the Railways, Service Departments and the Electricity Authority are by agreement based on average costs for Great Britain and a height limit of forty feet. This arrangement is fair enough as damage may be caused by these bodies almost anywhere in Great Britain and the overpayments of value which will occur sometimes are sure to be offset by underpayments at others.

With individuals, the position is rather different. They are almost invariably concerned with one plantation only, and they request an individualistic assessment reflecting the species affected, the region and other factors. In their cases the assessments have to stand up to considerable criticism. The Commission endeavours to reach an agreement as to the value of the damage: if necessary, the matter is put to arbitration: reluctantly, cases are taken to Court.

It is not known what basis an arbitrator or a judge will favour. There are many opinions: here are some. They relate to losses by fire but no doubt could apply equally to loss from any other cause.

Opinion A

A fire was lit negligently by a farmer and it caused damage to one of our young plantations. The Commissioners did not want to be too hard on the farmer so the claim was restricted to the original cost of the plantation notwithstanding that wages had risen considerably since it was planted.

The judge said:

"I am not altogether satisfied that Mr. Charters' assessment of damages proceeds on the right principle. I am inclined to think that the proper measure of damages is the actual cost of replanting this plantation that was destroyed, plus compensation for the loss that the Forestry Commissioners have sustained by reason of the fact that the capital labour and time sunk in the original plantation and expended on the original plantation up to the date of the fire have been wasted. Mr. Charters started off with the actual cost of starting the original plantation. I am sorry to say I think the method of calculation perhaps is not quite accurate in point of law, but it does not matter, because the figure which Mr. Charters arrived at is a lower figure than the figure I am inclined to think is the correct figure, and worked out on the correct basis".

Opinion B

Later, this was said by another lawyer.

"I do not think it is possible to simplify the valuation of a plantation . . . by taking as a basis of calculation the cost of establishing the plantation or the cost of replacement. The recent judgment certainly suggests that the replacement basis can and should be adopted, but more often than not unliquidated damages are arrived at by a rough and ready process which produces a reasonably correct result.

"The measure of damage, is strictly the diminution in the value of the land on which the fire occurred.

"Land with trees has a certain value to a prospective purchaser. The principal factors which go to make up that value are the value of the land itself as a site, and the value of the timber on it, the latter being compounded of such factors as the character of the trees, the state of the market for that type of timber, its proximity to maturity and generally the quantity and quality of the timber itself. The damage is arrived at by deducting the value of the site immediately after the fire from the value of the land with the growing timber as between a willing buyer and a willing seller immediately before the fire.

"The problem is to arrive at these two values.

"The amount of the damage depends primarily on the expert opinion of a surveyor or a timber merchant who clearly understands the legal principle explained above. It is important to show how the expert's valuation was arrived at: in the ordinary way a valuer supports his opinion with evidence of comparable purchases.

"Costs incurred in establishing and maintaining the plantation are not in themselves factors which go to make up the value of timber, since there may have been other factors which have resulted in those costs not producing timber of the quantity and quality which they might have been expected to produce— Consequently neither cost originally incurred nor current replacement cost is in itself a correct basis of calculation of a claim, although both may be useful as a check on the expert's opinion, the cost of replacement being the more important of the two".

Opinion C

"Value must be as at date of fire, and the Commission are entitled to value as between a willing buyer and a willing seller.

"The claim might be based on current costs, that is in effect replacement, on the assumption that the price which a purchaser would pay would probably be related to such costs rather than to those prevailing some years previously. Claims might be based on average costs for the country, adjusted up or down according to condition of the particular forest, stocking and accessibility".

Opinion D

"I am not happy about the method of working in averages which is apparently the Commission's system. We are concerned here with a particular piece of ground, the costs in relation to which may be greater or less than or the same as the average, but it is the value of the timber, destroyed on that area with which we are concerned. Can nothing be done to give particular figures?"

Opinion E

"The claim is based on average costs worked out from overall costs for all the Commission activities throughout the whole of Britain. For the purpose of compilation I prefer the evidence of people with general experience of forestry work in the part of the country concerned.

"The pursuer claims by a standard formula. I am dealing not with a speculation as to what might be appropriate procedure in some future contingency but with what in fact took place.

"The assessment of damage may be tabulated as

cost of plants
cost of beating-up
a general charge.

"The pursuer claimed recompense in respect of expenditure on weeding operations but no weeding was required in this plantation during the period and accordingly the pursuer must forego this item of claim.

"Beating-up over a period of two years is claimed. I am dealing not with a speculation as to what might be the appropriate procedure in some future contingency but with what in fact must have taken place. In the absence of proof that beating-up took place over two years the pursuer must bear the consequences.

"The pursuer claims an allocation of overhead charges but is unable to present any substantial or reliable basis for it . . . He ought to be able to point to some evidence which would entitle me to proceed on a basis of fact and not on a basis of speculation and arbitrary decision".

Opinion F

"The use of average costs in a specific case is unsound. The method of assessment must vary according to circumstances. Generally, the younger the crop the more appropriate it is to adopt a cost valuation. Averages should be adjusted to suit specific case. Age and condition of crop are the two main determining factors. There should be outside witnesses to confirm the figures. A detailed cost of the specific part of a plantation can never be available however perfect the accounting system. But data upon which a fair estimate can be made should always be forthcoming".

Opinion G

"Criticism was made by the defender of the lack of specification of damage. I do not think that the criticism is well founded. What the pursuer has done is to set out the acreage destroyed: to state that of that acreage the larger amount was planted in 1947 and the smaller in 1948, and then he sets out the sum per acre representing the estimated value of the trees and fencing destroyed. I do not see how the pursuer can do more than give an estimate of the Commissioners' loss and the data on which the estimate is based. None of the trees had reached a stage when they were marketable as timber, and, therefore, ruling market prices for timber have no application. It seems to me that the pursuer has given to the defenders fair notice of how the sum claimed in the action is arrived at and there are well recognised steps open to the defencders for checking the pursuer's figures".

Opinion H

"The local estimate is the most important".

Opinion I

"The lowest estimate is the most important".

Because of the many and varied legal opinions Headquarters endeavours when making a claim to arrive at a figure which in its opinion is not only reasonable but is one that a claimee could not prove to be unreasonable. The present practice is to make assessments on several bases and to claim a round sum approximating to the average or the mean. All the bases have good and bad points: none is completely satisfactory. The claimee is told what has been done and that the reasonableness or otherwise of the claim may be gauged by comparing it with the various assessments made; further, that if he will suggest values founded on any other reasonable bases they will be considered along with our own. In this way several possible objections to our figures are anticipated and forestalled.

Normally, the assessments which are averaged are based on the following:—

(1) the costs of the Commission's forests regarded as a whole (i.e. average costs in Great Britain)

(2) the costs of the Commission's forests in the country concerned regarded as a whole (i.e. the average for the country)

(3) the Conservator's estimate of cost of replacement.

(4) the average costs of certain private woodlands in the country concerned (from Survey by University).

(5) the estimated compensation payable by a certain insurance company (from its proposal form).

The Commission's standard formula is used for (1), (2) and (4), is believed to be used for (5), and is adapted for (3). In the case of the latter, operations which will not have to be carried out are deleted from the formula and any which will have to be performed but have not been included are added by the Conservator.

Exception has been taken in some quarters to the use of average costs (vide especially Opinions D, E and F); below are some arguments that have been used in support of their use.

The replacement cost of some finished goods, such as new cars, can be ascertained exactly since identical articles can be readily obtained in the market; of other property, such as a partly constructed house, it can be computed fairly accurately; but of an immature plantation it can be only a very rough estimate because of the vagaries of weather. For the assessment of compensation a young plantation ought not to be regarded simply as "x" acres of trees "y" years old. but rather as a certain numbers of tree stems of certain dimensions. Acreage and age alone are not stricly the measurements although, like a child's age, they usually give a reasonable indication of stage of development. If a plantation was fifteen years old but had the growth only normally expected from one five years old, a defendant would feel justifiably aggrieved if he had to pay compensation for it amounting to the expense of repeating all the cultural operations carried out on the original plantation.

On the other hand, if a plantation destroyed was five years old but had the development normally expected of one fifteen years old its owner would feel justifiably aggrieved if he were awarded compensation which was only equal to the cost of the actual operations performed in the five years.

One can fairly accurately estimate the cost of carrying out specified operations in a certain manner, but no one can accurately estimate the cost of producing a specified number of stems of a specified size and quality in a specified number of years. Growth depends largely on weather conditions which vary from year to year and cannot be forecast with any certainty. In 1956, for example, beating-up was exceptionally heavy because of drought in 1955: in 1957, because of excessive rain, twice the normal weeding was required in many districts: in 1959 there were four times as many fires as in 1958. Weather conditions at and following the first planting of a particular plantation are not necessarily going to be, in fact, are rather unlikely to be, the same at and following replanting. It is by the use of averages that abnormalities are ironed out and this may operate as much to the advantage of a defendant as it does to a plaintiff.

Not only are the effects of different weather conditions evened out but fortuitous variations in expenditure also. A fall in the local supervision overhead at a forest may be due solely to first formation having been supervised by a forester at the maximum of his salary scale, while replanting was controlled by one at the minimum of the scale: the change in this element of cost could be, on this account, as much as sixty per cent. Incidentally, the Commission's overheads are often criticised and it has to be pointed out that an appreciable proportion of the Commission's total expenditure is indirect owing to its nature and the administrative set-up and that some charges are of necessity allocations: further, that whether a certain element of cost should be treated as overhead or basic is sometimes only a matter of domestic convenience and does not affect total outlay. The criterion is not whether the ratio of the indirect expenditure to the direct is reasonable but whether the total (all-in) cost is reasonable.

The Commission is not, of course, alone in using average costs to arrive at price or value. The practice is widespread. A tobacco company does not say a packet of its cigarettes manufactured at one factory is worth 3s. 6d., but the same brand made at another factory is worth 4s. 4d. because costs of production are higher there. The price it charges is one based on the average costs of all its factories and is not varied on account of any local differences in demand, retail overheads or transport costs: the price is the same in London as in John o'Groats. Again, British Railways apply the same passenger rate per mile to a little-used line in the Highlands of Scotland as they do to a busy section in the suburbs of London. An insurance company has rates of compensation which are applied universally; and the Commission has planting grants for private woodland owners which are given without regard to locality or costs of planting.

It has been said that cost valuations ought to be supported with evidence of comparable purchases. In practice this is seldom possible. Sales in the open market between willing seller and willing buyer of very young plantations as a single commodity are exceedingly rare. Immature plantations containing no marketable timber are almost invariably sold unseparated from land, or connected with estate duty or bankruptcy. To a private owner their value is probably the total of cash, income tax avoided, Commission planting grant and amenity benefit. The prices realised by private owners cannot therefore be appropriately applied to Commission plantations. The Commission does not plant in order to avoid taxation, or purely for amenity and it does not receive a planting grant: it grows trees for commerce and in effect its mature plantations are its stock in trade and its very young trees are its unfinished goods of which it is rarely a willing seller. Besides, as foresters well know, there is little consistency in the prices of timber: trees which may fetch a handsome sum one year may be almost unsaleable the next.

The standard formula, while being reasonably satisfactory in its existing form, might now be needing some revision to keep it in line with modern silvicultural practice and it is about to be re-examined with this in view. The method of assessment is not ideal but it is possibly the best that can be devised at present with the limited costing and other data available. It might be improved some time in the future by the use of costings relating to conservancies, regions, or types of forests, and to hardwoods and softwoods; adjustments might be made for plantations which are much below or well above normal condition, and an addition might be made to overheads to cover the cost of normal failures of plantations resulting from disease or other cause.

It is the Commission's practice in compensation cases to make a real and honest attempt to arrive at a valuation which is fair to both parties. No officer of the Commission would benefit by the obtaining of any sum larger than that needed to replace the plantations destroyed, and there are no shareholders to appease for the loss of a chance to secure a profit. The Commission claims only that sum which in its opinion is a reasonably realistic forecast of what will be needed to reinstate the plantations lost; to claim more with a view to a subsequent compromise it would regard as unbecoming the public service.

Table 1. SCHEDULE OF AVERAGE COSTS PER ACRE IN 1953 (GREAT BRITAIN)

Element	Year (to 30th September)							
	Formation					*Maintenance*		
	0	1	2	3	4	5	6	etc.
	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.
Direct Expenditure:								
Preparation of ground	4 16							
Drainage	3 1					– 5	– 5	
Fencing	3 13					– 3	– 3	
Planting		11 2						
Beating-up			1 10	– 10				
Weeding		1 5	1 5	1 5	1 5			
Protection		– 8	– 8	– 8	– 8	– 8	– 8	
Indirect Expenditure:								
Vehicles, machinery	2 4	– 12	– 6	– 5	– 4	– 2	– 2	
Forest overheads	3 16	2 4	– 19	– 16	– 14	– 6	– 6	
District overheads, Conservancy overheads, Directorate overheads, Headquarters overheads	1 8	– 12	– 6	– 5	– 4	– 2	– 2	
Annual value of land	– 14	– 14	– 14	– 14	– 14	– 14	– 14	
Total Expenditure	19 12	16 17	5 8	4 3	3 9	2 –	2 –	
Interest on Expenditure	– 8	1 3	1 12	1 17	2 1	2 6	2 9	
TOTAL COST....	20 –	18 –	7 –	6 –	5 10	4 6	4 9	
Cumulative Totals	20 –	38 –	45 –	51 –	56 10	60 16	65 5	

Interest has been charged at 4%

Table 2. SCHEDULE OF AVERAGE COSTS PER ACRE IN 1958 (GREAT BRITAIN)

Element	Year (to 30th September)															
	Formation										*Maintenance*					
	0		1		2		3		4		5		6		etc.	
	£	s.	£	s.	£	s.	£	s.	£	s.	£	s.	£	s.	£	s.
Direct Expenditure																
Preparation of ground	7	7														
Drainage	3	14									–	4	–	4		
Fencing	4	15									–	2	–	2		
Planting			14	13												
Beating-up					3	7	1	2								
Weeding			2	6	2	6	2	6	2	6						
Protection			–	7	–	7	–	7	–	7	–	7	–	7		
Indirect Expenditure:																
Vehicles, machinery	2	13	–	5	–	2	–	1	–	1	–	1	–	1		
Forest overheads	9	2	5	13	3	2	2	8	2	2	–	9	–	9		
District overheads																
Conservancy overheads	2	2	1	18	–	13	–	8	–	7	–	1	–	1		
Directorate overheads																
Headquarters overheads																
Annual value of land	–	19	–	19	–	19	–	19	–	19	–	19	–	19		
Total Expenditure	30	12	26	1	10	16	7	11	6	2	2	3	2	3		
Interest on Expenditure	–	18	2	14	3	19	4	14	5	8	6	–	6	9		
TOTAL COST....	31	10	28	15	14	15	12	5	11	10	8	3	8	12		
Cumulative Totals	31	10	60	5	75	–	87	5	98	15	106	18	115	10		

Interest has been charged at 6%

Table 3. RECORD OF CUMULATIVE AVERAGE COST PER ACRE OF PLANTATIONS PLANTED IN 1953

Element	Year (to 30th September)							
	Formation					*Maintenance*		
	1952	1953	1954	1955	1956	1957	1958	etc.
	0	1	2	3	4	5	6	etc.
	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.
Direct Expenditure:								
Preparation of ground	4 7							
Drainage	2 16					– 4	– 4	
Fencing	3 16					– 2	– 2	
Planting		11 2						
Beating-up			1 15	– 12				
Weeding		1 5	1 8	1 12	1 14			
Protection		– 8	– 8	– 7	– 7	– 7	– 7	
Indirect Expenditure:								
Vehicles, machinery	2 –	– 12	– 6	– 2	– 2	– 1	– 1	
Forest overheads	3 7	2 4	1 2	1 9	1 8	– 9	– 9	
District overheads, Conservancy overheads, Directorate overheads, Headquarters overheads	1 6	– 12	– 6	– 5	– 4	– 1	– 1	
Annual value of land	– 16	– 14	– 14	– 17	– 18	– 18	– 19	
Total Expenditure	18 8	16 17	5 19	5 4	4 13	2 2	2 3	
Interest on Expenditure	– 7	1 2	1 11	1 17	2 3	2 7	2 11	
TOTAL COST....	18 15	17 19	7 10	7 1	6 16	4 9	4 14	
Cumulative Totals	18 15	36 14	44 4	51 5	58 1	62 10	67 4	

Interest has been charged at 4%

NOTABLE ARBORETA MEASURED SINCE 1950

By A. F. MITCHELL
District Officer, Research Branch

All estates are PRIVATE unless marked:—
‡—National Trust.
*—Opened on certain days.
†—Public Gardens.

Arboretum	*Owner and Entry*	*Remarks*
Abbotsbury, Dorset	‡ Lady Ilchester	Mixed; some rare hardwoods, *Idesia*, etc. Big *Picea spinulosa*
Abercairny, Crieff, Perthshire	Major J. Drummond Moray	Big *Abies*, Douglas fir, *Tsuga* etc. planted mainly 1864.
Adhurst St. Mary, Petersfield, Hants.	* Major A. Lubbock	Big conifers, notably Corsican Pine and both *Sequoia* spp. *Abies magnifica*
Albury Park, Surrey	* Helen, Duchess of Northumberland	Large general collection. Notable Cedars, Corsican pine, planes and Tulip trees
Arlington Court, Nr. Barnstaple, N. Devon	‡ National Trust	Fine *Araucarias*, Tulip trees and a notable *Sequois sempervirens*
Bedgebury National Pinetum, Kent	† Royal Botanic Gardens, Kew and Forestry Commission	Some older trees among the younger, most comprehensive collection of conifers in Britain
Benmore, Argyll	† Forestry Commission	Very big *Abies*, and Douglas fir with good range of other species growing fast in heavy rainfall area. Tallest *Tsuga heterophylla*, notable *Abies concolor*, *nobilis*, Douglas etc.
Bicton, Budleigh, Devon	* The Rolle Estates, Ltd.	Most remarkable collection of conifers with at least 30 species bigger than anywhere else. Wide range rare specimens
Blackmoor, Liss, Hants.	The Selborne Estates	Wide range of conifers, some rare, especially *Pinus* spp.
Blair Atholl, Perthshire	* Atholl Estates	Very big larches of 1737. Diana's Grove and St. Bride's Churchyard are remarkable concentrations of big *Abies* and other spp. Biggest and tallest *Abies magnifica*
Blair Drummond, Perthshire	Sir John Muir	Very big larches of 1734. Some big conifers and notable oak
Blairquhan, Straiton, Ayrshire	Sir James Hunter Blair	Wide range of species, many big conifers, notable *Araucaria*, tallest *Abies veitchii*
Boconnoc, Lostwithiel, Cornwall	C. G. Fortescue, Esq.	Compact group of conifers. Biggest *Tsuga dumosa*. Notable *Abies nordmanniana*, *Picea sitchensis*, *Picea smithiana*

Arboretum	*Owner and Entry*	*Remarks*
Bodnant, Denbighshire	‡ Lord Aberconway	Very extensive collection in ideal conditions. Notable *Abies cephalonica*, *venusta*, *Sciadopitys*, etc., etc., Tallest *Nothofagus obliqua* recorded
Bolderwood, New Forest, Hants.	† Forestry Commission	Some very big conifers, notable *Abies nobilis*, *Thuja*
Borde Hill, Haywards Heath, Sussex	* Col. Sir Ralph Clarke	Among the most comprehensive collections in Britain. Notable specimens of innumerable rarities.
Bowood, Calne, Wilts.	The Earl Lansdowne	Wide range of big conifers. Tallest Atlas and Lebanon Cedars and *Pinus ponderosa*, yet found. Notable *Picea smithiana*, *Sequoia sempervirens*, etc.
Bradfield House, Nr. Taunton, Somerset	(A School)	Very big *Abies grandis*, notable *Sequoias* and a few rarer species
Brahan Castle, Conon, Ross and Cromarty	Lady Seaforth	Some very big old conifers. Compact collection pl. 1901, growing fast. Notable Japanese larch, etc.
Brinkburn Priory, Longframlington, Northumberland	Captain Fenwick	Fine specimens along deep valley by Priory. Notable *Abies cephalonica*, *Abies lasiocarpa*; fine *Sequoiadendron giganteum*
Brocklesby Park, Limber, Lincolnshire	The Earl of Yarborough	Compact collection of wide range of conifers; many rarities. Good size for East Coast, dry area. Notable *Larix sibirica*, *Pinus flexilis*
Broxwood Court, Hereford	Col. Sned-Cox	Tallest recorded Nootka cypress. Notable *Deodars* and *Sequoias*
Buchanan Castle, Drymen, Stirlingshire	Buchanan Castle Golf Club	Small area of big conifers, many of remarkable girth. Notable *Araucaria; Picea sitchensis*
Burnside, Forfar	Col. Maitland	Notable small collection of rare Chinese *Abies* species
Bury Hill, Dorking, Surrey	Styles, Esq.	Many big conifers remain, notably an original *Deodar*, big *Pinus ponderosa*, *Sequoias*, etc.
Capenoch, Penpont, Dumfriesshire	J. Gladstone, T.D., J.P.	Small group of big conifers; notable *Deodars*, small collection planted 1922-6 growing fast
Cardross, Menteith, Stirlingshire	I. Orr-Ewing, Esq.	Big larches of 1765. Big *Sequoias*, *Libocedrus* and *Pinus strobus*
Chiltlee Place, Liphook	(Sold recently). Private	Good specimens of unusual trees. Unrivalled *Arbutus menziesii*

Arboretum	*Owner and Entry*	*Remarks*
Claremont, Esher, Surrey	‡ National Trust	Big cedars of Lebanon, *Cunninghamia*, *Sequoia sempervirens*, etc.
Coldrenick, Menheniot, Cornwall	R. M. Sneyd, Esq.	Medium sized collection of fine specimens of rare trees. Notable *Larix griffithii*, etc.
Cragside, Rothbury, Northumberland	* The Lord Armstrong	Large area with groups of very big conifers and a more compact area of rarer specimens. Biggest *Abies concolor* recorded. Notable *Abies magnifica*; many Douglas firs and *Tsuga*
Crarae, Furnace, Argyll	† Sir G. Campbell and Forestry Commission	Very comprehensive collection of conifers; many in plots; growing in ideal conditions
Cuffnells, Lyndhurst, Hants.	(Private)	Small hollow crowded with vast conifers. Tallest known *Pinus radiata*; very tall Corsican pines, and both species of *Sequoia*
Culzean Castle, Ayrshire	‡ The Marquess of Ailsa	Wide range of less hardy species. Notable pair of very big *Picea sitchensis*
Dawyck, Peeblesshire	A. N. Balfour, Esq.	Very comprehensive collection at high altitude. Notable very big conifers of many species, and plots of rare species, especially spruces
Dropmore, Burnham, Bucks.	* The Lord Kemsley	Almost continuously planted from 1792 and much recorded, a big collection of very wide range. Outstanding Corsican pines, *Deodar*, *Sequoias*, *Taxodium*, etc.
Dunans, Glendaruel, Argyll	I. Fletcher, Esq.	Remarkably tall *Abies procera*, Larches, *Picea sitchensis* and Douglas fir along deep valley. Notable *Abies nordmanniana* and *Araucaria*.
Dunkeld House, Perthshire	Dunkeld House Hotel	Famous European larches of 1737 and 1750, and Japanese of 1886. Big *Abies alba*-line along river; *A. magnifica* on lawn; notably *Sequoiadendron giganteum*. Small pinetum of very big trees by Cathedral, biggest girthed Douglas fir.
Dupplin Castle, Forteviot, Perthshire	The Lord Forteviot	Mainly planted 1865; wide range of big conifers. Notable larches, *Cham. nootkatensis*, *Abies spectabilis brevifolia*, etc.
Durris House, Kincardineshire	Mrs. R. J. Baird	Tallest *A. lowiana* recorded. Very big *Abies* spp. *Picea*, Douglas fir, *Sequoia*, *Tsuga*.

Arboretum	*Owner and Entry*	*Remarks*
Eastnor Castle, Ledbury, Herefordshire	Lady Hervey-Bathurst	Very large, varied collection. Biggest *A. venusta, C. atlantica.* Many big *Cedrus* spp., *Pinus* spp., etc. etc.
Edinburgh, Royal Botanic Gardens	† Ministry of Works	Wide range of small specimens of rare trees.
Elvetham Hall, Hartley Wintney, Hants.	Calthorpe Estates Co.	Notable *Araucaria* and avenue of very early *Sequoiadendron giganteum.*
Endsleigh, Tavistock, Devon	(Hotel)	Very big collection including many rarities and several biggest trees recorded.
Eridge Castle, Nr. Tunbridge Wells, Kent	The Marquess of Abergavenny	Compact group from 1868. Huge *A. grandis* (planted by Disraeli). *Ch. nootkatensis, Sequoias.*
Exbury House, Exbury, Hants.	* Lord Rothschild	Widespread collection including many rare, tender species, growing among *Azaleas*, etc.
Filleigh Estates, Devon	Lord Fortescue (?)	Very big Douglas fir; *Thuja* and biggest girthed *Picea sitchensis.*
Foxley, Hereford	J. L. Davenport, Esq.	Big *A. magnificas, Cedrus, Sequoia* etc.
Fulmodestone, Norfolk	The Earl of Leicester	Large area of all ages from 1850 of wide variety of conifer. Very big *Sequoias* and *Tsugas.*
Glamis Castle, Angus	* The Earl of Strathmore	Wide range, especially big *Abies* spp., etc.
Glenapp, Ballantrae, Ayrshire	* The Earl of Inchcape	Young but large conifers growing fast in small valley.
Glendurgan, Mawnan Smith, Falmouth, Cornwall	C. U. Fox, F.I.C.S.	Fine garden in sheltered valley. Many rare, tender species. Notable, *Quercus phellos, Liriodendrons, Araucaria bidwillii, Taxodium*, etc.
Glenlee Park, New Galloway, Kirkcudbrightshire	Agnew	Avenue of huge Douglas firs. Tallest *Sequoiadendron giganteum* in Scotland. Notable *A. grandis.*
Gordon Castle, Fochabers, Moray	Forestry Commission	Probable 1737 European larch and very fine *Pinus jeffreyi* survive.
Grayswood Hill, Haslemere, Surrey	* G. A. Pilkington, Esq.	Fine collection of wide range of trees, many rare. Notable *Pinus montezumae, P. muricata, Cercidiphyllum*, birches and *Nothofagus* spp.

Arboretum	*Owner and Entry*	*Remarks*
Heligan, St. Ewe, Cornwall	* Comm. H. H. Thomas	Valley (not open to public) of outstanding trees, mostly rare. Biggest *Podocarpus totara*, *Cedrela sinensis* and *Populus lasiocarpa.*
Hewell Grange, Worcestershire		Large collection of a wide range of conifers. Notable *Cham. nootkatensis*, etc.
Highclere Park, Hants.	The Earl of Caernarvon	Widespread area of a very big conifers. Notable huge Lebanon cedars and *Sequoiadendron giganteum* and *Abies cephalonica.* Small pinetum with notable *A. lasiocarpa arizonica.*
Highnam, Gloucestershire	T. M. Gambier-Parry, Esq.	Compact collection with many notable species of pine.
Hinton House, Hinton St. George, Somerset	The Rt. Hon. the Earl Poulett	Fine 1712 Lebanon cedars, big *Araucaria*, *Pinus radiata*, etc.
Howick, Craster, Northumberland	* The Rt. Hon. the Earl Grey	Group of big *Araucarias*, another of other conifers. In gardens notable *Abies forestii* and *Quercus mirbeckii.*
Inchmarlo, Banchory, Kincardineshire	A. Bowhill, Esq.	Many fine Douglas firs; notable very big *Abies nobilis.*
Inveraray Castle, Argyll	* Argyll Estates, Ltd.	Lime Kilns—compact group of huge conifers. Gardens — Notable *Araucaria*, *Abies grandis*, 1740 larch, etc. Estate and Plantations — Vast trees abound, especially *Abies* spp. and Douglas firs.
Keir Estate, Dunblane, Perthshire	Keir and Cawdor Estates, Ltd.	Group of large less-common conifers. Notable *Cupressus torulosa. Juniperus recurva*, 1760 larches, Hybrid larch, *Abies spectabilis.*
Kew Gardens, London	† Ministry of Agriculture, Fisheries and Food	Extremely comprehensive—conifers and hardwoods. Notable collection larch spp., pines, oaks, elms and rarer hardwoods. Immense *Q. castaneifolia.*
Killerton House, Tiverton, Devon	‡ National Trust	Large collection in two parts. Many notable for size and rarity, especially tender conifers.
Kilravock Castle, Nairnshire	Mrs. Rose	Notable *Araucaria*, immense *Picea sitchensis*, big *Sequoiadendron giganteum.*
Killiow, St. Kea, Cornwall	Commander Penrose	Small collection with some big and some rare trees.

Arboretum	*Owner and Entry*	*Remarks*
Kinloch House, Meigle, Angus	Mitchell, Esq.	Two 1737 larches. Very big *Sequoia; Thuja* and *Tsuga.* Fine line of *Carya* sp.
Kirkennan, Dalbeattie, Kirkcudbrightshire	Maj.-Gen. Aymer Maxwell	Outstanding *Abies nobilis* and Douglas fir in woods, *Sequoia* etc. in garden.
Knightshayes, Tiverton, Devon	* Sir John Amery	Remarkable specimens of oaks, *Picea sitchensis,* Douglas fir and *Sequoia*
Leaton, Knolls, Berwick, Salop.	The Earl of Bradford	Large collection; notable *Pinus n. calabrica* and *S. sempervirens* in narrow valley and *Cedrus libani, Tsuga canadensis, Populus Lloydii.*
Leonardslee, Horsham, Sussex	* Sir Giles Rolls-Loder, Bt.	Wide collection of big trees in garden, many rare. Very wide collection of conifers in Pinetum planted about 1900. Many outstanding specimens.
Linton Park, Maidstone, Kent	The Rt. Hon. Lord Cornwallis	Wide range of large conifers, especially notable *Abies* and *Sequoia.* Biggest girthed *A. Lowiana.*
Longleat, Warminster, Wilts.	* The Marquis of Bath	Main Drive and Paradise Walk contain many very large conifers. Notable *Deodar,* Douglas fir, *Sequoia sempervirens* and *Thuja plicata.*
Melbury, Dorset	*	Wide areas of very big and rare trees. Notable *Abies nobilis* (greatest girth), *C. macrocarpa, Ginkgo, P. smithiana, P. spinulosa, Sequoias* and *Pterocarya.*
Methven Castle, Perthshire	Messrs. Morgan, Crieff (in part)	Numerous very large conifers esp. *Sequoia* and *Tsuga.*
Moncrieffe House, Bridge of Earn, Perthshire	Heirs of Sir David Moncrieffe, Bt.	Mostly conifers, notable *Sequoias,* but also very big *Aesculus.*
Monk Coniston, Lancashire	‡ Holiday Fellowship	Big old larches and choice specimens; notable *Abies pindrow, Cryptomeria, Picea sitchensis, Tsuga.*
Montacute House, Somerset	‡ National Trust	Outstanding *Cupressus macrocarpa.* Fine *Deodars.*
Muncaster Castle, Ravenglass, Cumberland	* Major G. W. Pennington	Some unusual conifers; notable collection of *Nothofagus* spp.
Munches, Dalbeattie, Kirkcudbrightshire	Commander Herries Maxwell	Many large conifers, notable *Larix leptolepis, Sequoia gigantea, Thuja* and *Tsuga.*

Arboretum	*Owner and Entry*	*Remarks*
Murthly Castle, Perthshire	W. S. Fotheringham, Esq.	Largest Pinetum in Scotland. Many of the biggest trees recorded for height and for girth, *Picea glehnii*, *P. omorika*, *P. sitchensis*, *Tsuga mertensiana*. Numerous superb Douglas firs and *Tsuga*. Very big *Sequoias;* noted line of over 200 *Thujas* about 100 ft. tall.
Nettlecombe Court, Williton, Somerset	Garnet Wolseley, Esq.	Very unusual collection of big specimens. Notable rarer *cupressus* spp. and magnificent *Quercus sessiliflora* group.
Northerwood House, Lyndhurst, Hants.	Forestry Commission	Small group of big conifers; notable *Cryptomeria* and *Cupressus macrocarpa.*
Nymans, Handcross, Sussex	‡ National Trust	Wide range of species, especially rare and tender conifers, growing well in beautiful garden.
Ochtertyre, Crieff, Perthshire	Sir W. Keith Murray	Very big less usual *Abies* spp. and *Pinus* spp.
Pampisford, Cambridgeshire	J. Binny, Esq.	Very wide range of species, some rare and tender, growing over chalk in very low rainfall area.
Patshull House, Nr. Wolverhampton, Staffordshire	(Heirs of) The Earl of Dartmouth. (Partly a Hospital)	Wide range of conifers, especially rare *Pinus* spp.
Pencarrow, Bodmin, Cornwall	Sir J. Molesworth, St. Aubyn	Wide range of old specimens (many 1842) especially rare conifers. Notable *A. firma*, *A. spectabilis*, *Araucaria*, *Cunninghamia*, etc.
Penjerrick, Falmouth, Cornwall	Mrs. J. M. K. Fox	Outstanding collection of big conifers, many rarities. Notable *Podocarpus*, *Sequoia sempervirens* and vast Weeping beech.
Penrhyn Castle, Bangor, Caerns.	‡ J. C. Douglas-Pennant and National Trust	Old established specimens of conifer of great size; notable *Sequoias.*
Poltimore, Exeter, Devon		Many huge conifers; notable *Sequoias* and Lucombe oaks.
Redleaf House, Penshurst, Kent	(Recently sold)	General collection with some very large specimens esp. *Cedrus deodara*, *Pinus ponderosa.*
Rhinefield House, New Forest, Hants.	(Private)	Many big *Sequoias* of both species and *Thuja* within a small area.
Rhinefield Terrace, New Forest, Hants. (Ornamental Drive)	† Forestry Commission	Avenue bordered by a mixture of very large specimen conifers; notable *Picea glauca*, *P. rubens*, *Abies pinsapo.*

Arboretum	*Owner and Entry*	*Remarks*
Rossdhu, Luss, Dunbartonshire	Lt. Col. Sir I. Colquhoun, Bt.	Big conifers in drive and policies. Notable *Abies magnifica; Pinus muricara.*
Scorrier House, Redruth, Corwall	Mrs. M. Williams	Outstanding collection especially of rare conifers. Biggest *Athrotaxis laxifolia*, notable *Fitzroya*, *Pseudolarix*, *Araucaria*, *Chamaecyparis* spp. and Vars. *Podocarpus* spp. *Torreya*, etc.
Scotney Castle, Lamberhurst, Kent	* Christopher Hussey, Esq.	Many very big trees; notable *Pinus ponderosa*, etc.
Sidbury Manor, Sidbury, Devon	Sir Charles Cave	Wide range of rare species growing very well. Notable *Picea spinulosa*, *Pinus montezumae*, *Carya tomentosa*, *Cedrela*, *Eucalyptus* spp.
Sindlesham, Nr. Wokingham, Berks.	(Merchant Service School)	Large collection with some very big trees, especially *Cedrus deodara*, *Sciadopitys*, *Sequoia sempervirens;* avenue of old *S. giganteum*. Notable *Quercus borealis.*
Speech House, Forest of Dean, Glos.	† Forestry Commission	Compact collection of dated, labelled conifers.
Stanage Park, Knighton, Radnor	G. C. Rogers, Esq.	Mainly 1845 and 1916 plantings of conifers. Former include many remarkable specimens; latter superb group of rare Chinese *Abies* and *Picea.*
Stourhead, Warminster, Wilts.	‡ National Trust	One of the largest collections of conifers in the country. Wide range of outstanding specimens.
St. Clere, Kemsing, Kent	Brigadier Norman	Planted 1910-1915 at 750 feet on top of chalk Downs, a remarkably well-grown, compact, collection of rarer conifers.
Stratfield Saye, Hants.	The Duke of Wellington	Large collection of big trees; notable *Cedrus libani* (many), *Picea orientalis*, *Pinus ponderosa*, *Sequoias* (including avenue of *S. giganteum*), *Liquidambar*, etc.
Strete Ralegh, Devon	(Private) (part) Forestry Commission (part)	Small collection with huge *Cupressus macrocarpa* (3), *Pinus montezumae hartwegii* and fine *Quercus lucombeana* (in a wood). Others, mainly rare conifers on F.C. land.
Syon House, Isleworth, Middx.	* The Duke of Northumberland	Large collection of very rare broadleaved trees with many outstanding specimens. Noted *Taxodiums.*

Arboretum	*Owner and Entry*	*Remarks*
Studley Royal, Ripon, Yorks.		Large old conifers around lakes and in Pinetum; notable *Picea abies*, etc. Fine hardwoods.
Taymouth Castle Gardens, Perthshire	Perthshire County Council? (Golf Club)	Woodland walk along shore of Loch Tay. Conifers of extraordinary size, several unequalled elsewhere. Notable *A. spectabilis*, *Cedrus deodara*, spp. *Sequoia* and *Sequoiadendron*.
Tetton House, Nr. Taunton, Somerset	M. Herbert, Esq.	Some big trees along drive and near house. Notable *Pinus nigra caramanica*, *P. pinea*, *Araucarias*.
Titness Park, Ascot, Berks.	L. Riggall, Esq.	Notable *Cham. nootkatensis*, *Picea orientalis*.
Trebah, Mawnan Smith, Cornwall	J. L. Ford, Esq.	Sheltered, south-facing valley. Huge *Cupressus macrocarpa* and *Podocarpus andinus*. Notable *Cunninghamia*, two *Pinus radiata*, *Thujas*, *Eucalyptus*.
Tregrehan, Par, Cornwall	Miss G. Carlyon	Large, but compact collection among the most comprehensive in Britain. Numerous biggest recorded specimens, especially tender spp. (*Athrotaxus* spp., *P. montezumae*, *Pocodarpus* spp.). Rare hardwoods.
Tregullow, Redruth, Cornwall	Mrs. M. Williams	Adjoins Scorrier. Small group of big trees. Notable *Abies forrestii* and *Saxegothaea*.
Trent College, Long Eaton, Notts.	(School)	Wide range of species, many rare. Notable *Prunus* collection.
Trevarrick Hall, St. Austell, Cornwall	W. H. Mallett, Esq.	Small but choice collection. Notable *Araucarias*, *Cryptomeria* and *Athrotaxis*.
Trewidden, Penzance, Cornwall	Mrs. C. Williams	Mainly rare, tender spp. spread through beautiful garden. Notable *Athrotaxis* and *Guevinia*.
Vivod, Llangollen, Denbigh	F. C. Best, Esq.	Exceptionally tall conifers, especially Douglas fir. Notable *Abies nordmanniana*.
Wakehurst Place, Ardingly, Sussex	* Sir Harry Price	Big trees through famous gardens. Pinetum of remarkable variety, planted 1914-1916, and well-grown. Notable *Cupressus* spp., rare *Pinus* spp.
Walcot Park, Lydbury North, (Salop.).	M. W. Parish, Esq.	Large group of big conifers. Notable *Abies magnifica*, *Cedrus deodara*, Douglas firs, etc.
Wansfell, Ambleside	R.A.F. and National Trust	Garden of big trees especially *Abies nobilis*. *Cedrus* spp., *Chamaecyparis* spp.

Arboretum	*Owner and Entry*	*Rèmarks*
Warnham Court, Horsham, Sussex	L.C.C. Parks Department	Wide range big and rare species, especially *Larix* and *Picea*, including several of biggest specimens of Wilson's 1916 introductions.
West Dean, Singleton, Sussex	* E. F. W. James, Esq.	Large collection with some very big trees; on thin soil over chalk. Notable *Pinus muricata;* many Douglas firs and *Thuja.*
Westonbirt, Gloucestershire	† Forestry Commission	Probably the most comprehensive collection of conifers, after Bedgebury, in Britain. Some very big trees, many very rare. Many rare hardwoods.
Whittingehame, East Lothian	† Forestry Commission (in part)	Famous *Eucalyptus;* fine *Araucarias*, etc. in F.C. part. Some big *Abies* spp., etc. in pinetum by House.
Woodhouse, Uplyme, Devon	Mrs. A. Cartwright	Small area of very big conifers; smaller and rare trees in garden. Tallest *Abies nordmanniana*, *Cryptomeria* and *Picea smithiana.*
Wootton House, Wootton Fitzpaine, Dorset	Colonel Pass	Very big *Taxodiums*, *Fraxinus monophylla* and *Quercus cerris* and *Q. lucombeana.*

FORESTRY COMMISSION STAFF

At 1st January, 1960

Notes: The stations of individual officers are shown only where they are different to that of their main office. This list should not be read as a seniority list; it has been compiled from returns submitted by the various offices to the Establishment Section.

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	Turner, A. S. (Glenbranter)	,,	,,
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DIRECTORATE FOR ENGLAND

Office of Director: 1 Princes Gate,
London, S.W.7.
Telephone: Kensington 9691

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ENGLAND, NORTH-EAST CONSERVANCY

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York.

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FOREMEN

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ENGLAND, EAST CONSERVANCY

Brooklands Avenue,
Cambridge
Telephone: Cambridge 54495

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ENGLAND, SOUTH-EAST CONSERVANCY

"Danesfield",
Grange Road,
Woking.

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Butcher, H. G. (Crawley).

ENGLAND, SOUTH-WEST CONSERVANCY

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Brislington,
Bristol, 4
Telephone: Bristol 78041-5

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Telephone: Lyndhurst 300

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Telephone: Inverness 223, 608-9

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HIGHER EXECUTIVE OFFICERS:	MacBeath, T. S. B.; Stewart, W.

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SCOTLAND, EAST CONSERVANCY

6 Queen's Gate,
Aberdeen.
Telephone: Aberdeen 33361

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CONSERVANCY ENGINEER:	Blenkinsop, Col. R. I. C.
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Aitken, D. A.; Albiston, I. A.; Angus, J. (Estate); Dunford, J. A.; Furneaux, D.; Hendry, D. L.

HEAD FORESTERS

Allison, R. A. (Speymouth); Anderson, D. (Clashindarroch); Fraser, E. D. (Craigvinean); Gilbert, G. (Durris); McDonald, W. (Drumtochty); Milne, W. G. (Culbin); Murray, G. J. A. M. (Glenlivet); Urquhart, D. J. (Bin); Watt, D. M. (Monaughty).

FORESTERS

Aitkin, R. G. (Culbin); Allan, J. (Edensmuir); Anderson, F. (Benachie); Anderson, W. B. (Newton); Biggar, A. W. (Elchies); Christie, J. H. (Aultmore); Douglas, W. S. (Whitehaugh); Ellen, R. M. (Blairadam); Ewen, B. A. (Kemney); Fraser, J. R. (Clashindarroch); Garrow, P. J. (Rannoch); Grigor, E. (Glenisla); Grubb, J. A. (Newton); Guild, J. (Montreathmont); Harwood, A. E. (Forest of Deer); Hyslop, R. M. (Kirkhill); Hepburn, N. R. (Hallyburton); Innes, G. C. (Midmar); McBain, G. L. (Fetteresso); McDowall, C. (Pitfichie); McIntosh, W. J. (Tornashean); Mackintosh, C. O. (Speymouth); McLeod, E. (Roseisle); McRae, J. (Scootmore); Marnoch, D. (Alltcailleach); Masson, V. (Blackcraig); Maxtone, J. R. (Rosarie); Mitchell, F. M. (Carden); Murray, G. M. W. (Drummond Hill); Pennet, H. (Rosarie); Reid, J. K. (Fonab); Reid, J. (Drummond Hill); Reid, J. G. M. (P.W. Fochabers); Rose, A. (Ledmore); Russel, J. C. (Kinfauns); Scaife, C. L. (Lossie); Seaton, J. A. (Teindland); Skene, W. F. (Delgaty); Stewart, G. (Speymouth); Stewart, S. W. R. (Keillour); Stuart, P. (Newtyle); Thomson, R. B. (Tentsmuir); Thow, G. B. (Inglismaldie); Thow, J. B. (Forest of Deer); Watt, W. J. (Allean); Webster, J. O. (Blackhall); Wilson, J. F. (Pitmedden).

ASSISTANT FORESTERS

Adam, R. (Hallyburton); Armstrong, P. (Bin); Bain, J. (Drumtochty); Bowie, A. G. (Bin); Davidson, A. L. (Monaughty); Elliott, D. M. (Rannoch); Gordon, W. J. (Blackhall); Greenless, C. V. (Drummond Hill); Johnston, W. (Glendoll); Jolly, J. McC. (Glenerrochty); Kemp, W. T. (Cushnie); Kingham, H. A. (Clashindarroch); McCallum, L. C. (Glenlivet); McConnachie, K. (Glenlivet); McLean, J. P. (Ledmore); Macmillan, T. W. (Drumtochty); MacPhee, H. A. (Fetteresso); Menzies, J. A. (Rannoch); Rose, J. (Alltcailleach); Thirde, G. S. (Glenisla); Tracy, C. R. (Craigvinean).

FOREMEN

Anderson, R. M. (Tentsmuir); Anderson, S. C. (Keillour); Brown, R. (Craigvinean); Grant, A. M. (Elchies); McCann, W. G. (Drummond Hill); McDonald, J. (Culbin); Salmean, C. (Glendevon); Soppit, J. (Montreathmont).

SCOTLAND, SOUTH CONSERVANCY

Greystone Park,
Moffat Road,
Dumfries.

Telephone: Dumfries 2425-6-7

CONSERVATOR:	J. A. B. Macdonald.
DIVISIONAL OFFICERS:	Fossey, R. E.; Gibson, W. N.; Donald, R. R.
DISTRICT OFFICERS I:	Brown, N. M. (Peebles); Golding, R. A. (Barr); Johnson, W. A. J. (Dumfries, Estate); Long, M., M.C. (Moffat); MacNab, J. D. (Newton Stewart); Stirling, J. (Moffat); Williams, M. R. W. (Jedburgh); Wilson, K. W. (Dalry).
DISTRICT OFFICERS II:	Aaron, J. R. (Peebles); Fergusson, W. S. (Dalbeattie); Findlay, T. S. L. (Newton Stewart, Estate); Neustein, S. A. (Moffat); Robertson, S. U. (Gatehouse of Fleet) Steel, R. P. (Longniddry).
CONSERVANCY ENGINEER:	Walker, P. H. F.
ASSISTANT ENGINEERS:	Clarkson, W. H.; McNulty, E. P. (Jedburgh); Ruthven, G. (Newton Stewart).
CLERKS OF WORKS:	Carmichael, J. H. (Bonchester Bridge); Fergusson, J. M. (Kirkcudbright); Johnston, F. (Estate); Meek, I. G. N. (Newton Stewart).
SURVEYORS:	MacMillan, J. G. (Dumfries); Shearer, R. B. (Newton Stewart).
SENIOR EXECUTIVE OFFICER:	Farmer, T., M.B.E.
HIGHER EXECUTIVE OFFICERS:	Burnett, A. G.; Cowan, A. A.

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Byth, J. G.; Halliday, Miss A.; Jackson, G. K.; Laidlaw, J. C.; Morley, G. J.; Roberts, E. G.

HEAD FORESTERS

Graham, A. (Mabie); Mackay, W. H. (Fleet); MacMillan, H. (Kirroughtree); McNichol, F. (Wauchope); MacRae, A. D. (Glentrool); Parley, C. W. (Cairn Edward); Reid, J. M., M.B.E. (Ae); Watson, J. (Dalbeattie); Cameron, D. M. (Dundeugh).

FORESTERS

Anderson, M. (Wauchope); Armstrong, H. O. (Bareagle); Broll, J. L. (Yair Hill); Campbell, D. (Cairn Edward); Carruthers, J. (Fleet); Carruthers, M. F. (Elibank); Chisholm, M. R. (Carrick); Cochrane, A. S. (Dalmacallan); Davidson, J. R. (Duns); Drysdale, N. (Carrick); Duncan, D. (Wauchope); Edward, R. M. (Brownmoor); Gallacher, J. M. (Upper Nithsdale); Gallacher, P. (Glentrool); Goodlet, G. A. (Newcastleton); Gutch, J. H. M. (Stenton); Harvey, T. S. (Ae); Harkness, J. R. (Castle O'er); Hunter, J. (Greskine); Jamieson, R. A. (Newcastleton); Kirk, D. M. (Kirroughtree); Leishman, A. (Changue); Lloyd, S. (Laurieston); Liddell, A. T. (Eddleston); McGeorge, R. (Ae); McGivern, W. (Edgarhope); McLaren, A. R. (Dreva); McNaught, D. J. (Arecleoch); Melville, J. (Selm Muir); Murray, D. M. (Bareagle); Murray, W. (Glengap); Park, H. C. B. (Glentrool); Parker, J. (Glentrool); Parkinson, J. W. (Auchenroddan); Patterson, B. (Garcrogo); Peddie, A. S. (Cardrona); Rae, W. R. (Mabie); Robertson, D. (Kilsture); Robertson, W. J. (Clydesdale); Semple, W. K. L. (The Garraries); Scott, J. F. (Craik); Slater, J. (Saltoun); Swan, R. (Watermeetings); Thomson, A. (Dalbeattie); Thomson, J. (Penninghame); Towns, K. W. (Cairn Edward); Urquhart, G. (Glentress); Wood, R. A. L. (Kirroughtree).

ASSISTANT FORESTERS

Bagnall, J. A. (Ae); Bagot, W. (Changue); Beaton, J. (Bareagle); Brooks, C. (Penninghame); Bryson, J. L. (Dundeugh); Burgess, W. (Mabie); Burgon, F. W. (Glentrool); Cooper, H. (Ae); Cooper, J. A. M. (Glentrool); Dinsdale, E. (Ae); Edwards, O. N. (The Garraries); Fligg, P. (Carrick); Fraser, J. McD. (Edgarhope); Graham, P. (Carrick); Grieve, W. J. (Fleet); Hogg, J. L. (Kirroughtree); Hope, T. C. (Fleet); Jordan, R. D. (Cairn Edward); McArthur, A. (Carrick); McBurnie, A. (Ae); McIntyre, C. (Dalbeattie); McClelland, P. W. (Glentrool); Mackenzie, P. (Corriedoo); Macneill, J. B. (Elibank); Mowat, P. (Newcastleton); Murray, T. M. (Cairn Edward); Nelson, T. (Kilgrammie); O'Brian, G. D. (Carrick); O'Mara, J. P. (Greskine); Paterson, W. G. (Castle O'er); Pearce, J. S. (Kirroughtree); Pickthall, H. (Cairn Edward); Priestley, P. E. B. (Wauchope); Ramsay, K. J. (Castle O'er); Reid, J. M. (Glentrool); Robson, A. (Dalbeattie); Taylor, J. W. (Wauchope); Thomas, A. F. (Cairn Edward); Thomson, J. A. (Cairn Edward); Veitch, T. H. (Newcastleton); Walsham, J. A. (Laurieston); Watson, A. (Glentrool); Waugh, D. E. (Craik); Waugh, G. (Glentress).

FOREMEN

Harris, R. C. (Glengap); Maxwell, N. (Cairn Edward); Wilbur, G. (Dalbeattie).

SCOTLAND, WEST CONSERVANCY

20 Renfrew Street,
Glasgow, C.2.
Telephone: Douglas 7261-2-3-4

CONSERVATOR:	J. E. James.
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CONSERVANCY ENGINEER:	Chapman, F. G.
MECHANICAL ENGINEER:	Atkins, F. C.
ASSISTANT ENGINEERS:	Bennett, D. (Benmore); Gibson, W. (Aberfoyle); Nisbet, J. D. (Cairnbaan).
CLERKS OF WORKS:	Dalgleish, T. (Benmore); Miller, R. (Aberfoyle); Robertson, J. R. (Barcaldine); Stark, W. (Cairnbaan).
SURVEYORS:	Connor, P. T. (Aberfoyle); McLachlan, R. W. (Benmore); Sturrock, W. G. (Cairnbaan).
SENIOR EXECUTIVE OFFICER:	Kinnaird, B.
HIGHER EXECUTIVE OFFICERS:	Hogarth, J.; McMillan, W.

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Brunton, I. A.; Clelland, Mrs. I. M.; Griffin, J.; Liddell, A.; Macniven, Miss B. B.; Sifton, J. G.

HEAD FORESTERS

Calder, J. M. (Carron Valley); Cameron, A. (Strathyre); Crozier, R. (Loch Ard); Fairbairn, W. (Devilla); Jackson, J. (Benmore); Kennedy, J. (Minard); Murray, R. G. (Glenbranter); Mackay, A. (Barcaldine); Mackinnon, H. (Knapdale).

FORESTERS

Allan, J. S. (Strathyre); Angus, R. S. (Glenfinart); Beaton, K. A. (Torrie); Campbell, W. M. (Loch Ard); Cramb, J. (Glenduror); Cunningham, A. J. (Leapmoor); Dye, W. E. (Ardfin); Francey, G. S. (Ardgartan); Fraser, T. S. (Rowardennan); Gillies, A. (Glenbranter); Gilmour, W. (Inverliever); Hamilton, J. (Lennox); Harland, J. (Benmore); Henderson, W. (Loch Ard); Irving, R. H. (Aberfoyle); Johnston, C. R. (Garelochhead); Keiller, W. (Carron Valley); Lawson, D. W. (Tulliallan); Martin, W. C. (Creran); Morrison, A. (Carradale); Morrison, N. (Corlarach); Munro, D. (Carradale); MacCallum, D. (Achaglachgach); MacCaskill, D. A. (Inverinan); MacFadyen, D. (Inverliever); McGeachy, R. (Glenrickard); MacGregor, D. R. (Ardgartan); Mackay, D. J. (Asknish); McKeand, J. W. (Inverliever); MacKenzie, I. (Inverliever); McLarty, H. C. (St. Fillans); MacLean, A. (Kilmichael); McMillan, A. (Devilla); McMillan, J. (Minard); McLean, R. (Kilmory); McNicol, I. (Barcaldine); McNicol, P. (Inverinan); MacPhee, C. J. (Fearnoch); MacRae, D. J. (Ardgartan); McRorie, J. P. (Glenrickard); Polwart, A. (Glendaruel); Proudfoot, L. O. (Devilla); Rattray, W. D. (Garadhban); Robertson, D. A. (Strathyre); Robertson, N. (Tighnabruaich); Rodger, J. H. (Inverinan); Ross, D. H. (Loch Ard); Ross, I. (Kilmichael); Simpson, A. A. C. (Carradale); Sinclair, L. (Glenduror); Stout, H. C. (Knapdale); Stuart, A. M. (Loch Eck); Young, A. (Strathlachlan).

ASSISTANT FORESTERS

Beaton, J. (Loch Ard); Blake, G. W. (Glenduror); Boyd, R. D. (Glenfinart); Calder, A. M. (Loch Ard); Campbell, M. M. (Loch Ard); Cairns, J. M. (Loch Ard); Cruickshank, A. (Strathyre); Cowie, F. R. (Ardgartan); Elgar, W. (Garelochhead); Fergusson, P. D. (Glenbranter); Fraser, J. M. (Devilla); Fryer, K. (Glenbranter); Gelder, J. S. (Benmore); Graham, A. W. (Loch Eck); Graham, H. (Knapdale); Harvey, R. (Benmore); Hart, C. W. (Inverliever); Irvin, D. C. (Strathyre); Lyon, J. H. M. (Tulliallan); Main, D. (Inverinan); Maule, S. G. (Glenbranter); Morrison, I. (Inverliever); Murray, J. T. H. (Saddell); McCallum, D. (Kilmichael); MacDuff, R. J. A. (Barcaldine); McKenzie, J. S. (Benmore); McGavin, J. M. (Garadhban); McDonald, W. (Inverliever); McIntosh, A. (Strathyre); McLaughlin, R. S. (Loch Ard); McLeod, N. (Loch Eck); McNair, J. (Knapdale); MacRae, D. J. (St. Fillans) Oliphant, R. (Glenfinart); Proctor, W. A. (Asknish); Queen, T. S. (Glenduror); Rawlinson, A. S. (Knapdale); Robertson, J. S. (Loch Ard); Ross, D. A. (Kilmichael); Sallie, J. L. T. (Achaglachgach); Sanders, P. R. W. (Strathyre); Shaw, M. (Rowardennan); Sinclair, D. (Dalmally); Smellie, A. (Cumbernauld); Smith, A. K. (Loch Ard); Solway, D. F. (Glenfinart); Stewart, W. B. (Achaglachgach).

FOREMEN

McEachern, J. (Achaglachgach); Rose, W. (Strathyre).

DIRECTORATE FOR WALES

Office of Director: Victoria House,
Marine Terrace,
Aberystwyth

Telephone: Aberystwyth 367

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HIGHER EXECUTIVE OFFICERS:	Barcham, F. C.; Pope, H. J.

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WALES, NORTH CONSERVANCY

15 Belmont,
Shrewsbury
Telephone: Shrewsbury 4071-2

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CONSERVANCY ENGINEER:	Philbrick, Col. G. E. H. (Shrewsbury).
MECHANICAL ENGINEER:	Low, W. L. (Shrewsbury).
ASSISTANT ENGINEERS:	Baylis, D. O. (Aberystwyth); Egerton, F. C. (Gwydyr); Yates, Col. R. W. P. (Cemmaes).
CLERKS OF WORKS:	Bollans, L. (Gwydyr); Dummett, E. J. (Gwydyr); Ellis, T. (Hafren); Griffiths, W. E. (Dovey Corris); Redford, H. (Hafren); Vincent, P. E. (Dovey Corris).
SURVEYOR:	Williams, L. V. (Llangurig).
SENIOR EXECUTIVE OFFICER:	Mayhew, K.
HIGHER EXECUTIVE OFFICERS:	Bowers, G. H.; Henderson, F. S.

EXECUTIVE OFFICERS

Clay, J.; Frost, H. S.; Hamilton, B. A.; Smith, H. G. (Estate); Tudor, Miss M. C.; Winter, K. W.

HEAD FORESTERS

Davies, A. I. (Clocaenog); Evans, J. E. (Taliesin); Griffiths, I. L. (Gwydyr); Hughes, A. (Coed y Brenin); Jones, A. (Beddgelert); Jones, E. T. (Ystwyth); Jones, J. T. (Hafren); Yapp, P. W. C. (Radnor).

FORESTERS

Bell, H. C. (Dovey Valley); Bowen, J. F. (Elwy); Butterworth, P. (Radnor); Carter, T. A. (Taliesin); Claydon, G. W. (Breidden); Daniel, C. E. (Gwydyr); Davies, P. G. (Halcyn); Davies, R. D. (Dovey Twymyn); Edwards, R. (Coed y Brenin); Evans, A. C. W. (Kerry); Evans, J. F. (Lleyn); Farrelly, F. (Clwyd); Gardner, E. C. C. (Coed y Brenin); Griffiths, E. (Myherin); Griffiths, O. G. (Coed y Brenin); Griffiths, R. W. (Mon Newborough); Harrison, P. G. (Penllyn and Glanllyn); Hopkins, C. J. (Carno and Bechan); Hughes, J. W. (Dovey Corris); Hughes, L. E. (Gwydyr); Hytch, F. A. L. (Gwydyr); James, J. E. (Goror and Tanat); Jenkins, H. M. (Dovey Corris); Jones, A. (Dovey Corris); Jones, D. M. (Ystwyth); Jones, H. G. (Dovey Corris); Jones, L. (Aeron); Jones, M. (Coed Sarnau); Jones, O. (Aberhirnant); Jones, T. G. M. (Coed y Brenin); Jones, W. H. (Kerry); Lane, E. H. W. (Radnor); Little, T. E. (Llambed); Lloyd, I. (Dovey Corris); Maxwell, A. (Gwydyr); Morris, O. I. (Rheidol); Owen, G. M. (Mon Pentraeth); Pierce, G. J. (Hafren); Price, G. (Ystwyth); Rees, E. (Hafren); Roberts, R. H. (Gwydyr); Roberts, R. I. (Gwydyr); Roberts, T. (Clocaenog); Ross, J. L. (Clocaenog); Royle, J. H. (Cynwyd); Shaw, D. L. (Ystwyth); Stockwell, L. A. (Tarenig); Storer, E. H. (Ceiriog); Tarran, J. (Edw and Coed Sarnau); Tear, D. (Dovey Bryn); Thomas, R. O. L. (Llangollen); Thomas, T. W. (Dovey Bryn); Wainwright, R. (Mathrafal); Waters, R. W. (Dyfnant); Watson, J. (Clocaenog); Watson, L. C. (Clocaenog); Williams, F. (Deudraeth); Williams, J. D. (Clocaenog); Williams, R. J. (Dovey Corris); Wood, J. A. (Maelor).

ASSISTANT FORESTERS

Ambler, C. R. (Coed y Brenin); Brown, R. H. (Coed Sarnau); Brown, R. I. (Mathrafal); Burns, A. (Penllyn); Davies, C. C. (Radnor); Davies, C. M. (Tanat); Davies, D. D. G. (Dovey Valley); Edwards, B. F. (Deudraeth); Evans, I. T. (Myherin); Evans, P. (Mon Newborough); Fletcher, K. W. (Radnor); Furnell, K. T. (Mathrafal); Goodbody, D. (Coed Sarnau); Grayson, J. (Dovey Bryn); Griffiths, C. (Coed Sarnau); Hamilton, J. P. (Aeron); Harker, G. (Gwydyr); Hindle, H. J. (Radnor); Hughes, P. M. (Deudraeth); Humphreys, D. (Gwydyr); Humphreys, H. J. (Ystwyth); Isaac, G. M. (Ystwyth); Ivison, G. H. (Dovey Valley); Jones, D. J. (Dovey); Jones, E. W. (Coed y Brenin); Jones, G. W. (Rheidol); Jones, J. E. (Dovey Corris); Jones, R. T. (Glanllyn); Lane, F. W. (Dovey Valley); Large, A. L. (Carno); Legge, D. A. (Clocaenog); McLean, A. F. (Tarenig); Morris, D. J. (Rheidol); Oxford, K. (Elwy); Philpot, G. (Radnor); Pritchard, I. W. (Coed y Brenin); Read, J. L. (Aeron); Richards, L. G. (Halcyn); Roberts, O. J. (Dovey Twymyn); Roberts, R. (Maelor); Roberts, T. (Dyfnant); Sandy, J. N. (Coed y Brenin); Sealey, B. (Coed y Brenin); Taylor, F. L. (Aberhirnant); Taylor, W. (Coed y Brenin); Waite, E. J. W. (Kerry); Webster, J. (Clocaenog); Westlake, M. J. H. (Hafren); Wiblin, J. M. (Taliesin); Williams, B. H. (Dyfnant); Williams, B. L. (Beddgelert); Williams, D. J. (Lleyn); Williams, J. M. (Gwydyr).

FOREMEN

Adams, C. (Hafren); Evans, I. J. (Ystwyth); Harker, J. (Gwydyr); Thomas, H. (Hafren); Westley, P. C. (Carno); Wright, W. A. (Dovey Valley).

WALES, SOUTH CONSERVANCY

Block 1, Government Buildings,
St. Agnes Road, Gabalfa,
Cardiff

Telephone: Cardiff 62131

CONSERVATOR:	J. Q. Williamson, M.B.E.
DIVISIONAL OFFICERS:	Fitzherbert, J. T. L.; Legard, P. H.; Williams, L. H. (Estates).
DISTRICT OFFICERS I:	Bell, T. I. W. (Brecon); Currie, J. H. (Brecon); Jones, E. (Llandovery); Pallett, R. E. (Carmarthen); Stumbles, R. E. (Cardiff); West, S. J. C. (Chepstow); White, J. (Neath); Williams, G. O. (Cardiff).
DISTRICT OFFICERS II:	Burd, C. J. S. (Cardiff); Davis, F. G. (Cardiff); Harris, E. H. M. (Cardiff); Henderson, J. W. (Neath); Howard, J. A. C. (Carmarthen); Marnie, R. J. R. (Neath); Miller, A. D. H. (Llandovery); Teasdale, J. B. (Carmarthen); Thompson, T. S. (Cardiff).
CONSERVANCY ENGINEERS:	Sinkinson, G.; Webbe, W. F. G.
MECHANICAL ENGINEER:	Percival, A. S.
ASSISTANT ENGINEERS:	Martin, J.; Mills, A.
CLERKS OF WORKS:	Edwards, E. J. (Brechfa); Evans, W. J. (Abergavenny); Godfrey, A. G. (Resolven); James, W. B. (Crychan); Pennell, J. R. (Margam); Price, V. D. (Goytre); Vest, R. E. (Wentwood).
SENIOR EXECUTIVE OFFICER:	Bradford, E. H.
HIGHER EXECUTIVE OFFICERS:	Morris, T. D. H.; Stutter, N. E.

EXECUTIVE OFFICERS

Baldwin, K. (Estate); Blundell, E. D.; Davies, R. R.; Griffiths, W. G.; Tarrant, J. W. A.; Thomas, J. L.

HEAD FORESTERS

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