JOURNAL OF THE FORESTRY COMMISSION

No. 35 : 1966-67

PRINTED FOR DEPARTMENTAL USE

FORESTRY COMMISSION PRICED PUBLICATIONS ISSUED BETWEEN 1st APRIL 1966 AND 31st DECEMBER 1967

A: PRICED PUBLICATIONS PUBLISHED THROUGH H.M. STATIONERY OFFICE

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Annual Report of the Commissioners, 1966	10*s*. 0*d*.	(10*s*. 6*d*.)
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Thirteen priced publications were revised within this period. They were:

Booklet		
No. 7 The Plan of Operations	4*s*. 0*d*.	(4*s*. 5*d*.)
Forest Record		
No. 52 Home Grown Roundwood	4*s*. 6*d*.	(5*s*. 0*d*.)
Leaflets		
No. 5 Fomes Annosus	2*s*. 0*d*.	(2*s*. 3*d*.)
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New Forest	5*s*. 0*d*.	(5*s*. 7*d*.)
North Yorkshire	7*s*. 6*d*.	(8*s*. 2*d*.)

Continued on the Inside Back Cover.

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PRINTED FOR
DEPARTMENTAL CIRCULATION
WITHIN THE FORESTRY COMMISSION
25 SAVILE ROW
LONDON, W.1

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ACKNOWLEDGEMENTS

We express our thanks to the various editors and authors who have kindly allowed the re-use of certain articles, as noted at the head of each.

Photographs

Plates 1 to 5 were kindly provided by the Ministry of Agriculture, who hold the copyright. Plate 6 is the copyright of the *Hampshire Chronicle* of Winchester, and Plate 7 that of the *Oxford Mail and Times*. Plate 8 was provided by the Central Office of Information, and Plate 9, which was taken by Fox Photos, is reproduced by kind permission of the *Teacher's World*. Plate 10 was kindly provided by Miss Phyllis Holder of Christchurch, Hampshire. Plates 11 and 18 are by Mr. G. V. Berry of Greenside, Kendal, Westmorland. Plate 12, by I. A. Anderson, is drawn from the Commission's official collection at Alice Holt.

Chief Forester R. J. Jennings, now in South Wales Conservancy, provided Plates 14 and 17. Plate 13 is by Roy Harris of Stonebarrow House, Charmouth, Dorset. Plates 15 and 16 were kindly made available by the *Merthyr Express* of Merthyr Tydfil, Glamorgan. Mr. J. V. Dishington, now at Glasgow, provided Plates 19 and 20. Thames Board Mills Ltd., gave us Plate 21. Plate 22 was contributed by Head Forester J. Weatherell and Plate 23 by Mr. A. P. F. Hamilton. All the photos of the wood sculptures were kindly provided by the sculptor himself, Forester J. Wilson, of Arden Forest, Warwickshire.

Drawings

The drawings within the text were kindly made available to us by the respective authors.

The rabbit cartoon is reproduced by kind permission of *The Forester*, which is the staff journal of the Forestry Division of the Northern Ireland Ministry of Agriculture. The *Scottish Field* kindly allowed us to use the pulp mill cartoon, and *Fire Protection Review* provided the Fire Station sliding pole picture.

The cover picture, showing a Sweet chestnut tree on Demston Common, near Norwich, and the tailpiece to these introductory pages, which depicts Great Bridgham Heath in Norfolk, are by Mr. Noel Spencer. The device on the title page showing Scots pine, English oak and Welsh ash is by George Mackley, and the golden pheasant at the tail of the text was drawn by Ruth M. Barnes.

EDITORIAL

The Forestry Ministers

On 24th May, 1966, the Prime Minister, Mr. Harold Wilson, announced that the forestry responsibilities previously held by the Minister of Land and Natural Resources were to be transferred to the Minister of Agriculture, Fisheries and Food. The transfer took place on 16th February, 1967 and the legal statement of responsibility is now embodied in the Forestry Act 1967, Sections 1 and 49.

The three Forestry Ministers are now:

The Minister of Agriculture, Fisheries and Food, who has a particular concern for our operations in England.

The Secretary of State for Scotland.

The Secretary of State for Wales.

Appointment of New Forestry Commissioners

Her Majesty The Queen has been pleased to approve the appointment of Mr. Harold James Watkins as a Forestry Commissioner. He succeeded Mr. F. Sellers, who retired on completing his term of office, on 5th October, 1967.

Mr. Watkins, who is in his early 50's, is a Director of Canusa Limited and has been with his Company for some 30 years. He served in the army in India in the war, and has subsequently travelled extensively in the Middle and Far East. In addition to his long experience in the timber industry Mr. Watkins has a degree in forestry. He lives at Woodford Green, Essex.

As we go to press we learn that Dr. F. C. Hummel, formerly Controller of Management Services, has also been appointed a Commissioner.

Sir Henry Beresford-Peirse Retires

Sir Henry Beresford-Peirse, Bt., C.B., has announced his retirement from the post of Director General of the Forestry Commission in January, 1968.

Sir Henry, who is 63, was educated at Eton and Magdalen College, Oxford. He joined the Forestry Commission in 1929 and served in the Lovat Scouts, 1939–40. After serving with the Commission in several parts of Scotland, including East Scotland, where he was Conservator of Forests at Aberdeen, he was appointed Director of Forestry for Scotland in 1947. He became Deputy Director General of the Commission in 1953 and in 1960, on secondment, became Deputy Director of the Forestry and Forest Products Division of F.A.O., in Rome. He returned to the Forestry Commission in 1962 as Director General.

Sir Henry has an international reputation as a forester. During his service with F.A.O. he was presented by the Mexican Government with a medal for meritorious service to forestry. He was recently elected an Honorary Member of the Society of American Foresters, there being only 30 Honorary Members of this body in the world.

In 1964 Sir Henry was awarded the Gold Medal of the Royal Forestry Society of England, Wales and Northern Ireland for his distinguished services to forestry at home and abroad.

On behalf of all his colleagues, we would like to take this opportunity to wish Sir Henry a long and happy retirement.

Our New Director General: John Dickson

It was announced from 10 Downing Street, on 28th June, 1967 that Mr. John A. Dickson, Forestry Commissioner for Harvesting and Marketing and formerly Director of Forestry for Scotland, would become Director General of the Forestry Commission on the retirement of Sir Henry Beresford-Peirse. Mr. Dickson will also be appointed Deputy Chairman of the Commission from the same date.

The new Director General, who is 52, is a native of Scotland, having been born at Udny, near Aberdeen. He was educated at Cultercullen and Stoneywood Schools, Aberdeenshire, and Robert Gordon's College, Aberdeen, and Aberdeen University. There he took an M.A. and a B.Sc. in Forestry, being awarded the Sutherland Gold Medal for this subject. He joined the Forestry Commission as a forest worker at Fleet Forest, South Scotland, in 1938 and subsequently became a District Officer at Aberdeen. During the war years he served with the Timber Production Department in Aberdeen and Grantown-on-Spey, and was later District Officer for Easter Ross-shire. He was appointed Divisional Officer, Inverness, in 1951 and Conservator, North Scotland in 1956. He became Director, Scotland, in 1963 and Forestry Commissioner for Harvesting and Marketing at the Commission's London headquarters, in 1965.

Honours

Mr. Alistair Cameron, Head Forester, Strathyre, received the M.B.E. in the 1966 Birthday Honours List. Mr. Cameron has been connected with Strathyre Forest ever since planting started there in 1935.

In the 1967 New Year Honours List Mr. M. V. Edwards received the O.B.E. This followed 14 years as Silviculturist North, Research Branch, and a much regretted early retirement.

The M.B.E. was awarded to Mr. James Watson, Chief Forester, Dalbeattie Forest, South Scotland, in the 1967 Birthday Honours List. Mr. Watson started with the Commission in 1921 as a forest worker, and has served at Loch Ard, the Bennan and Dalbeattie.

Mr. George Robert Mackay, Ganger, Thurso, received the B.E.M. in the same list. Joining the Commission in 1920 as a forest worker Mr. Mackay has worked on research in many forests in the North Scotland Conservancy.

The Forestry Commission Landscape Consultant, Miss Sylvia Crowe, was appointed a C.B.E. at the same time.

We send our congratulations to all those who have received honours during the past year.

Appointments

Mr. J. Q. Williamson, formerly our Senior Officer for Wales, and Conservator for South Wales, was seconded from the Commission to the United Nations Food and Agricultural Organisation in Chile. There he advised the Chilean Forestry Department on its planting programmes. On his return early in 1968, Mr. Williamson was appointed Director of Management Services, stationed at Savile Row.

Promotions

We are pleased to report that many of our staff have been promoted, since our last issue, to more senior posts.

Mr. J. W. L. Zehetmayr was promoted to Senior Officer, Wales, from Conservator West Scotland, and he also has charge of the South Wales Conservancy.

Mr. G. G. Stewart was promoted to Conservator West Scotland, from South Scotland, to replace Mr. Zehetmayr.

Mr. R. Chard, formerly District Officer, New Forest, has been made Assistant Conservator, South Scotland. Mr. J. A. Spencer was promoted to Assistant Conservator, Planning and Economics, from District Officer, Forest and Estate Management.

Mr. D. J. Seal was made Silviculturist North also on promotion. He was formerly with East Scotland Conservancy.

Mr. G. D. Holmes has been promoted to Conservator, to serve as Deputy Head of Research at the new Research Station which is to be set up at The Bush Centre of Rural Economy, close to Edinburgh. Dr. D. Phillips has become Deputy Head of Research at Alice Holt, on promotion to the rank of Senior Principal Scientific Officer.

Other recent promotions to the Assistant-Conservator grade, whose postings had not yet been announced when we went to press, are:

Mr. N. Banister
Mr. R. E. Crowther
Mr. R. M. Hewitt
Mr. D. Y. M. Robertson
Mr. K. P. Thallon.

Retirements

Col. R. G. Shaw retired from the Commission after 17 years. Col. Shaw's work had been concerned with the development of machinery and research into fresh ways of using it. One of his many successes was the "Long Wide" County tractor, which has made possible the planting at large areas of soft peat.

Mr. M. V. Edwards who had been Silviculturist (North) in the Research Branch for fourteen years, retired, due to ill health, during the year. He organised a team of keen investigators who paved the way for our present expansion on to hard heather and peat moors that had previously been thought "unplantable".

Mr. R. F. Wood has just retired from the post of Conservator in the Research Branch, after a long and rewarding career, devoted mainly to the development of silviculture in the southern half of the country.

Obituaries

We regret to announce the death of the following members of the Commission staff.

In February, 1966, Mr. Gilbert Ballance, Assistant Conservator, South East England. During his thirty-one years with the Commission Mr. Ballance had served in Exeter, Bristol, Cambridge and Woking.

In October 1966 at the age of 59, the death occurred of Chief Forester L. V. Edwards of South Wales Conservancy. Mr. Edwards had been with the Commission since 1920 when he was 13 years of age.

We must also record the sudden death of Head Forester A. H. Spencer, Work Study, South Wales. Mr. Spencer started in the Commission as a forest worker in 1948. He was 46 when he died.

The death occurred on Christmas Eve 1966 of Head Forester A. C. Beard, South West England Conservancy. Mr. Beard was 59 and had served in South West England all of his 30 years with the Commission.

In January 1967, at Basingstoke, H.E.O. Mr. Vernon Collins died. Mr. Collins served in the R.A.F. in the last war, later he joined the Admiralty before coming to the Commission in 1949.

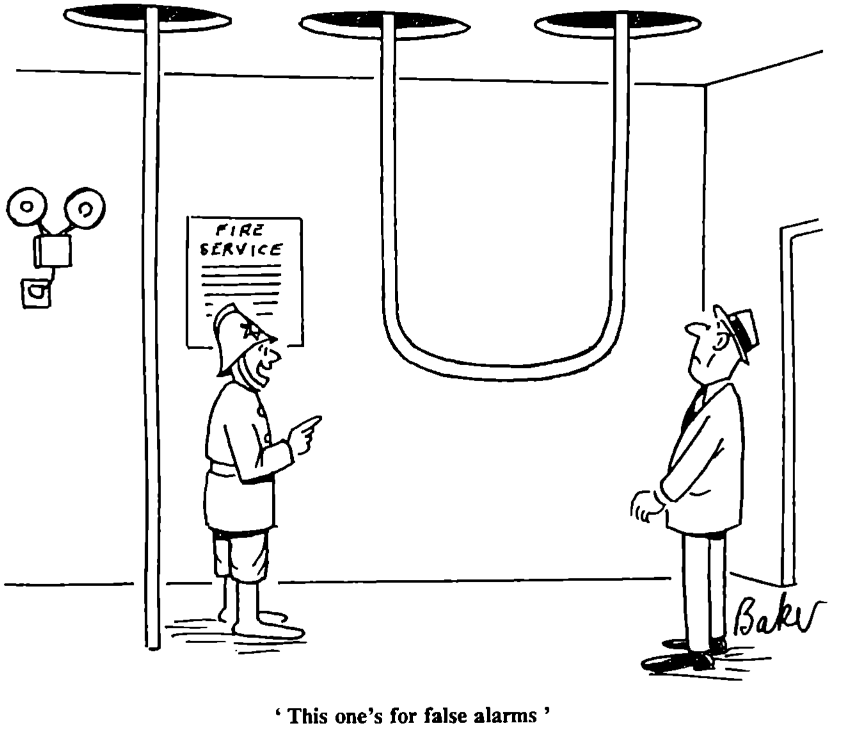
Mr. James Chrystall, District Officer, East Scotland Conservancy, died in April 1967. Mr. Chrystall had been with the Commission all his working life, and was in charge of a number of forests in Angus and Kincardineshire. He was 53.

Lastly, we record with sadness the passing of Mr. Douglas Graham-Campbell, who had recently been appointed an Assistant Conservator in the Forest Management Division at Basingstoke, after previous service in South Scotland.

The New Forestry Act

The Commissioners' powers and duties received a fresh definition on 22nd March, 1967, when the Forestry Act 1967 received the Royal Assent. Described in its opening phrase as "An Act to consolidate the Forestry Acts 1919 to 1963", the new Act brings together all the changes that have occurred since the Commission was first constituted in 1919. It is published by H.M. Stationery Office at 4s. 6d.

This Act supersedes all previous legislation except for the special local Acts that govern our activities in the New Forest and the Forest of Dean.



' This one's for false alarms '

Large Increase in Commission Planting in Scotland

It was announced in October, 1967, that the Government have decided there should be a substantial increase in the Forestry Commission's planting programme in Scotland from 1969 onwards.

The present annual rate is slightly more than 30,000 acres. This will now rise to 50,000 acres a year by 1976. The extra cost over the period is estimated to be about £3.3 million.

The Commission's previous programme provided for the planting in Scotland of 141,000 acres in the five years from 1964–1968. In 1965, 12,000 acres were added to the programme, bringing Scottish planting up to about 30,000 acres a year. The White Paper on the Scottish Economy published in January 1966 announced a further increase to 36,000 acres a year from 1969 onwards. This new increase to 50,000 acres a year is accordingly a substantial one and of particular importance as a long-term investment.

Supervisory staff and workers employed by the Commission in Scotland numbered 5,000 at the end of 1967. The Commission are now obtaining higher productivity by new working methods and techniques. With the new programme, however, numbers employed will be maintained and there will be local increases. These cannot be qualified at present.

The Government have taken into account the implication of the increased programme for the interests of other land users, and are satisfied that the general level of farming production should not be adversely affected. The Commission and the Department of Agriculture will extend their joint surveys to identify where plantable land mainly lies, and where planting can best be undertaken.

In 1966, in the programme then announced, the emphasis was on increasing planting in the seven crofting counties to 20,000 acres a year. The Government remain of the view that forestry is vital to the welfare of the Highlands and the emphasis on afforestation in the crofting counties will continue. There is, however, scope for further expansion in the upland areas on the fringe of the Highland counties, and in the Southern Uplands which are conveniently situated to wood-using industries.

A New Look at Footpaths

Sir Arthur Gosling, former Director General of the Forestry Commission, has been appointed chairman of a committee on "Country Paths".

The Committee, set up by the Minister of Housing and Local Government, will probe the system of paths and other rights of way in the countryside.

It will look at closure, diversion, creation and maintenance. The Committee will report on the possibility of developing a modern system of pathways, for public use and enjoyment.

Prime Minister opens New Workington Mill

The new integrated pulp and board mill built by Thames Board Mills Ltd. at Workington, was officially opened by the Prime Minister, the Rt. Hon. Harold Wilson, O.B.E., M.P., on the 9th June, 1967.

This mill, which is now in full production, is the first in the United Kingdom to produce high quality packaging board using homegrown timber. Initially, production of board will be at the rate of 35,000 tons per year, using some 70,000 tons of timber. A general view of the mill will be found in our centre pages.

Here and There in the Woods

Gas. On 20th May, 1966, the *Yorkshire Post* reported that:

"The largest find of natural gas discovered on land in Britain has been made at Lockton, about seven miles west of Scarborough.

A flow of between 5–10 million cubic feet of gas a day—enough to supply a town of 50,000 people—is claimed by the Home Oil Company of Canada, whose crew of 38 men worked with a German rig 1,000 feet above sea level on Forestry Commission land.

'This is beyond our wildest dreams—it is fantastic,' Mr. Murray Craig, the firm's chief geologist, said last night. 'Everybody has been concentrating their search on the sea bed. Now we have proved there could be just as much gas on land.' "

Paper. The *Flintshire County Herald* for 23rd September, 1966, in a special feature on Cheshire's agriculture, told its readers:

"It may interest you to know that the paper on which this article is printed is made from timber all of which is grown in Cheshire, North Wales, and Lancashire."

The product, no doubt of Bowaters Paper Mills at Ellesmere Port.

Grub. According to the *Scottish Daily Mail* for 1st October, 1966:

"Three meals a day are not enough for Scotland's lumberjacks. They need four or five.

This is the conclusion of a team of scientists. They have told foresters' wives to get cooking.

A special diet issued for the Scottish Forestry Productivity Committee is not designed to make woodmen lose weight. It should make the forest ring with the sound of axes.

According to the experts, woodmen may have been sparing trees because their wives have been sparing with the second helpings.

To reach 100 per cent axe-swing output, says the pamphlet, the average man requires 4,500 calories a day.

So, this is what he needs every day:

Milk, two pints; fish, meat, 7 oz.; cheese, $\frac{3}{4}$ oz.; eggs, 2 oz.; butter and other fats, $3\frac{1}{2}$ oz.; bread, 14 oz.; cereals and other meal products, $3\frac{3}{4}$ oz.; potatoes, unpeeled, 1 lb. $1\frac{1}{2}$ oz.; jam, $1\frac{3}{4}$ oz.; sugar, $1\frac{1}{2}$ oz.; fruit, 7 oz.; vegetables, 7 oz."

£1,000 Saves Viaduct

Two grants received by the Northumberland and Newcastle Society have saved the Kielder Viaduct. The grants, each of £500, were given by the Sir James Knott Trust and an anonymous donor.

The Viaduct, built in 1840 to carry the old North British railway at Kielder, is one of the last remaining skew masonry arches.

The Forestry Commission recently acquired the Viaduct from British Railways, and had intended to demolish it. It is now hoped to provide a footpath across it.

Errata

We offer editorial apologies for the following slips that appeared in our last issue, *Forestry Commission Journal* No. 34 for 1965.

Page 43*: J. M. B. Brown: Northern Ireland Tour Report*

Line 16: For "4 oz. G.M.P. per acre", please read: "4 cwt. G.M.P. per acre" —a much more reasonable dose!

Page 55*: T. L. Jenkins: Northern Ireland Tour Report*

Seventh line from foot: For "electric thinning", please read: "eclectic thinning"—shocking mistake, that one!

Page 85*: Article by J. Weatherell on Soil Preparation*

Literature reference shown as "(2)", should read: "(1)".

Page 86*: Same article*

Second para., last four lines should read:

"The top of each rigg is about 10 inches above the original soil level, and the total "rise and fall" is thus at least 30 inches in 25 feet. Therefore, though the furrows are deeper than normal, 20 inches instead of 12 inches, the pitch is much less—only 1 in 5 instead of 4 in 5."

BASIC FORESTRY

What happened to the forester
Of yesterday who walked the hills
And tramped the vales full master
Of his beat? Whose sylvan skills
Were mainly based on instinct?

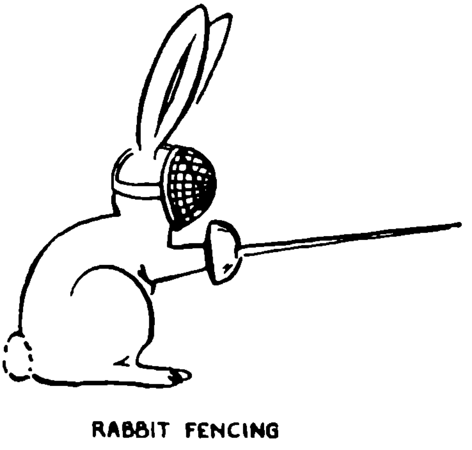
He formed his woods and planted trees
Then weeded without chemicals;
He brashed and set his fees
Without Work Study decimals;
No Yield Class table in his hand,
When marking his plantations,
No "pulling chain" a magic wand
For basal computations.

He's gone, it seems, and given way
To groups of automatons,
With Alice Holt now holding sway,
Through endless publications

But trees have souls and need to share
The love of servile man,
Responding more to loving care
Than distant Working Plan.

Where is the sage whose basic skill
Was mainly native instinct?
He knows the wheel is turning still,
And trees he planted with such
Care live long, live on to reach
Their span
As they began—
With love and basic instinct.

EUROS JONES



RABBIT FENCING

JOURNAL OF THE FORESTRY COMMISSION
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TOURS

ROYAL FORESTRY SOCIETY OF ENGLAND, WALES AND NORTHERN IRELAND SUMMER MEETING IN NORTH WALES 8th–13th MAY, 1966

By J. D. WEBSTER
Forester, East Scotland

The picturesque village of Llangollen in North Wales became headquarters of the Society members who took part in the Summer Meeting. I had the privilege of joining the excursionists in what was, to me, a first visit to North Wales. From the time I arrived at Ruabon station on Sunday, 8th May, to be met by a member of the local region of the Society, until I said goodbye to a fellow excursionist who kindly provided a lift to Birmingham on Friday evening, 13th May, I found from everyone I came in contact with, only friendliness, hospitality and a willingness to impart knowledge. The hotel accommodation, arranged by the Section Secretary, was also very good, my bedroom window overlooked the River Dee, this too helped to make me feel at home as my present house near Banchory also overlooks the River Dee in Scotland.

First Impressions

During the car journey the few miles from Ruabon station to Llangollen I was surprised to see:

(*a*) so much forestry in the form of small blocks and shelter belts of hardwoods,

(*b*) the splendid integration of forestry and agriculture with the grazing land breaking up the large blocks of conifers not only on the lower slopes but also on the higher ones,

(*c*) the absence of cereal crops in favour of grass for grazing purposes,

(*d*) the houses dotted singly over the hillsides on steep slopes it would be difficult to traverse; this I understand dates back to the time when the Welshman clinched his claim to a piece of land whenever smoke appeared from the chimney of his dwelling house,

(*e*) the flat plateaux at altitudes of 1,000 feet plus,

(*f*) the scarcity of rabbits, hares, and virtual absence of deer, black game etc., making North Wales almost a forester's paradise. I later learned that the Welsh sheep can be very troublesome and is no respecter of fences, walls or dykes.

Monday, 9th May, 1966: Gwydyr Forest—Forestry Commission

Gwydyr Forest, in the Snowdonia National Forest Park, lies mainly on the slopes of the Conway valley and its tributaries, and is divided into blocks by the main roads and rivers in the principal valleys. The original acquisition was a lease of 6,000 acres followed soon afterwards by a further lease of similar size. Planting commenced in 1921 using E.L. and D.F. on the lower slopes and

Spruces and Pines on the higher ground. The later plantings included stands of most of the North West American conifers together with Oak, Ash, Beech etc.

The annual production is over 300,000 hoppus feet, approximately half of which is sold standing. The remainder is worked by Forestry Commission labour using worker-owned power saws, tractors etc.

Our first stop was at a viewpoint overlooking an area which combined three important essentials in an area such as Snowdonia. Firstly, the lake which could form part of a catchment area or be used for recreational purposes such as water ski-ing and picnicking on the shores, secondly, the forest area which provided timber, work for the local population, amenity, and to a lesser degree, recreation; thirdly, the grazing ground around and above the plantations. Looking across the valley it was very obvious how the straight edges of the plantation spoil the landscape.

Production work by Forestry Commission labour included thinning, extraction and conversion for sawlog and pitwood markets. The party also discussed underplanting of J.L. P.38.

After lunch at a strategically situated picnic site the excursionists visited sample plots of L.C., S.S., R.C., D.F., C.P., W.H., N.F. and G.F. I was impressed with the S.S., age 41 years, total crop yield to date, 12,210 hoppus feet, the D.F., age 44 years, total crop yield to date, 7,290 hoppus feet, and G.F., age 37 years, total crop yield to date, 9,280 hoppus feet.

The last item on the programme was a demonstration of the Isachsen winch, by students of Gwydyr Forester Training School. This increasingly popular piece of equipment showed how useful it can be on difficult sites where horses would be in dire trouble.

Tuesday, 10th May, 1966: Palé Estate—The Duke of Westminster

The area of the estate is 15,000 acres of which 3,000 acres are under forestry. This estate also lies within the Snowdonia National Park and with

(*a*) a rainfall of from 45 inches in the fertile alluvial soils in the valleys to 100 inches in the more mountainous regions,

(*b*) the ability of trees to grow well at altitudes up to 1,500–1,600 feet with a modicum of shelter,

(*c*) the absence of forest pests such as roe deer, rabbits etc.,

this area could be described as a forester's paradise.

Principal species used are S.P., Spruces, D.F. and J.L. The sycamore grows very well in North Wales and commands a good price.

The main object of the visit to Palé was to see demonstrations of modern methods of extraction, conversion and peeling. The machines on view, each working at its respective task were:

1. Cembro Bark Peeler (tractor mounted)
2. Farmi Winch and Skidding Unit.
3. Bristol Crawler (overall widths 30 inches to 60 inches)
4. Cundey Continuous Feed De-Barker
5. Partner Chain saw with cross-cutting stand
6. Cundey Logging Shoe for ground skidding of timber
7. Unimog multi-purpose tractor/tool carrier/driving unit
8. Hiab Hoist
9. D4 Caterpillar with Sulky.

Each piece of equipment had its limitations and I was very pleased at the end of the demonstration to see the D4 with sulky working on extraction and loading of hardwoods in the full length with ease, speed and efficiency. Some of the other machines on view had been finding it difficult to create a really good impression, due mainly to the operators overloading and trying too hard to display the talents of their respective machines.

During the tour of Palé Estate the party halted at a stand of D.F., 85 years of age, the measurements of the largest tree being as follows:

Douglas Fir	Top Height	136 feet
	B.H.Q.G.	31 inches
	Mid Q.G.	21 inches
	Volume	360 hoppus feet

Wednesday, 11th May, 1966: Clocaenog Forest—Forestry Commission

One of the largest forests in North Wales, Clocaenog has 15,000 acres of plantations mainly on undulating moorland at elevations from 1,000 feet to 1,500 feet. Sitka Spruce has been planted extensively, some 60 per cent of the total area, with N.S. occupying 20 per cent of the total area. Other species used are J.L., with D.F. and W.H. on the small isolated blocks at lower elevations. Planting started in 1930, mainly on turves cut by hand, but ploughing was introduced in 1936 and was extensively used from that time. Manuring with G.M.P. or Triple Superphosphate is normal practice.

The bulk of produce is sold standing and it is estimated the annual yield will be 450,000 hoppus feet by 1970, rising to 850,000 by 1980.

Rain curtailed the programme and the first item, a general view of the forest, was abandoned in favour of a discussion on windblow problems. The party then visited a stand of P.37 N.S. being thinned for the first time. Discussion centred on the type of thinning, method of working and thinning control of volume removed. A stand of S.S., P.41 was also inspected. After lunch in a wet weather shed, the party moved to the P.65 area where establishment techniques such as complete ploughing and extensive drainage were discussed. A demonstration of deep drainage by a County Crawler with trenching attachment attracted much interest.

Thursday, 12th May, 1966: Lake Vyrnwy Joint Afforestation Scheme—Liverpool Corporation

The Lake Vyrnwy Estate extends to 23,000 acres and lies between the 750 and 2,050 feet contours. The Vyrnwy Works were authorised by Parliament in 1880 and construction of a masonry dam containing 7,000,000 cubic feet was commenced in 1881. The present lake is 4¾ miles long, has a top water area of 1,121 acres, and a capacity of 13,125,000,000 gallons.

Afforestation on a small scale commenced in the early 1900's, by 1912, 919 acres had been planted. In 1914 a profit-sharing scheme was formulated which aimed at planting a further 4,000 acres by 1933. A new partnership agreement with the Forestry Commission in 1946 catered for the planting of further areas of bare moorland or felled areas. The total area of woodland in the joint scheme is now 4,774 acres.

The Corporation also farm 11,300 acres at the higher elevations, maintaining 9,000 sheep and 120 beef cattle. Tenanted farms amount to 5,300 acres and carry a total of 5,000 sheep and 240 cattle.

Sitka Spruce has been the most successful species, N.S. has been heavily infected with rot, but D.F. has done well on the drier slopes. Windfall is now the most serious problem especially where drainage has been defective. The annual production of the forest is 300,000 hoppus feet of thinnings and 200,000 hoppus feet of fellings, mainly of sub-standard crops.

Following the introductory talk at the Resident Agent's office, the party inspected an area of P.26 S.S. marked for clear fell, followed by a walk into a replanted area where deep drainage work was being carried out by a BXT 55 digger. At the next stop summer planting with S.S. from cold storage was explained and the method of planting through the brash demonstrated. After lunch the party climbed a small knoll and viewed the catchment area, then proceeded on a tour round the lake. At one stop en route we were very impressed with D.F., one of which was 167 feet high and had a volume of 379 hoppus feet at age 79 years. At one end of the lake sample plots of S.S. were inspected and grades of thinning compared. Figures given were:

S.S.—P.21—CD grade—161 trees per acre—90 feet top height—5,463 hoppus feet per acre standing at present—the total yield 10,943 hoppus feet.

S.S.—P.21—E grade—92 trees per acre—90 feet top height—5,800 hoppus feet per acre standing at present—the total yield 10,700 hoppus feet.

Before returning to Llangollen the party was entertained to an excellent tea in the splendid Community Centre.

Friday, 13th May, 1966: The Vivod Arboretum and Species Plots—Llangollen Forest

To enable members travelling long distances to leave when they wished, Friday's excursion visited the Species Plots in the Forestry Commission's Llangollen Forest, a few miles from the Headquarters. The Arboretum was started in 1952, covers about 5 acres and lies between the 850 and 950 contours. Eighty-four groups of single trees have been planted, made up of 29 Spruces, 13 Pines, 24 Firs and 18 other species. The Species Plots cover 20 acres on a steep northerly aspect between 1,200 feet and 1,400 feet elevation. Eighty-one plots, each with where possible, 400 plants have been planted. I was impressed with the growth of *Abies grandis*, *Picea omorika*, *Picea orientalis* and *Picea hondoensis*. *Pinus monticola* was growing very strongly and the heavy branching certainly suppressed the strong heather at an early age.

General Comments

The organisation during the week was first class but I did feel in some cases the time allotted to a particular subject was inadequate causing the party to break up in the middle of some very healthy discussion. I would suggest that talking by the leaders be limited to the absolute essentials and hand-outs be used for reference. The wealth of experience and knowledge in such a group of "forestry people", should be drawn into discussion to the benefit of all members of the party. In most of the tour this was done, but I believe the greatest benefit can be derived by all members of the party, in discussion and even healthy argument; after all, in the majority of cases they are dependent on forestry for part if not all their livelihood and sharing of knowledge must be beneficial to all.

In conclusion, I wish to thank the Forestry Commission for granting me the opportunity to take part in this very interesting and enjoyable excursion to North Wales.

ROYAL SCOTTISH FORESTRY SOCIETY
69th ANNUAL EXCURSION
NORTH EAST SCOTLAND, 16th-20th MAY, 1966

By A. T. LEWIS
Forester, South Wales

Members assembled at three hotels in Huntly, Aberdeenshire, in time for dinner. To the writer after a most pleasant motor journey from West Wales, the wonderful Beech hedge just outside Blairgowrie, Braemar, and some fine Scots

Pine at Royal Deeside had really whetted the appetite for a Forest Excursion.

After dinner the members assembled at the Gordon Arms for four brief talks describing the main features of the region. Professor O'Dell dealt with the geographical characteristics, Mr. Frank Oliver with Forestry, Mr. Bruce Mackie with Agriculture, and Mr. W. Riddoch with the Timber Industry. These talks were most informative and filled in the background of what excursionists were to see during the next few days.

Tuesday, 17th May: Clashindarroch Forest

We were welcomed by Mr. R. J. G. Horne, Assistant Conservator, Mr. Townsend, District Forest Officer, and Mr. D. Anderson, Chief Forester. The tour was most ably conducted by Mr. Townsend.

General

The main block was acquired from the Duke of Richmond and Gordon in 1929 during a period of agricultural depression. A number of smaller areas were subsequently acquired from adjoining landowners.

Area Statement

Forest Land	12,838 acres	
Unplanted	192 ,,	
		13,030 acres.
Agricultural	913 acres	
Holdings	82 ,,	
Unusable	2,738 ,,	
Other	134 ,,	
		3,867 acres
		16,897 acres

Planting Programme P.66—122 acres.

Production 000 H.ft.	F.Y.	66	67	68	69
Thinning		299	283	320	357
Felling (Larch and Pine)		—	117	108	101
Total		299	400	428	458

Climate

The annual rainfall varies from 35 to 40 inches and is evenly distributed throughout the year. The prevailing wind is westerly, but North and North West winds can be severe. Snow drifts lie late in depressions and on North slopes. Severe frosts are frequent in spring and may occur in any month of the year.

Topography

The forest is hilly and elevated, approximately 2,500 acres lie above the 1,250 contour. South facing slopes are dry, but North facing slopes tend to be rather moist with considerable moss growth. All aspects are found, the exposure is greatly moderated by the high proportion of valley slopes within the plantable area. It is a serious factor on the upper slopes, ridges and plateaux.

Soils

The area is extensively covered by drift, the covering being thin or absent on the upper slopes, ridges and convex features generally. The drift is specially deep in the region of the hornblende schists, norite, contact-altered schists and pebbly bands.

Except on the ridges and plateaux there has been no serious podsolisation or pan formation. The fertility of the soil has not apparently been a limiting factor to tree growth, but surface conditions caused early failures, particularly of spruces.

Theme

"The establishment and growth of Sitka Spruce in marginal conditions of climate and ground conditions and vegetation".

The early plantations of larches and Scots Pine showed their unsuitability for the major afforestation of Clashindarroch.

Some 1,500 acres of Norway Spruce have been established, but in general, moisture, adverse ground vegetation and severe frosts have limited its range, while exposure has precluded this species from higher elevations.

Calluna has covered very extensive parts of the forest, where there is no *Calluna* severe unseasonable frosts have dominated the problems of establishing Sitka Spruce.

Early mixtures of S.P./S.S. and L.P./S.S. with cultivation by tine plough, phosphating and planting in the furrow bottom, were highly successful once the S.S. had come out of check.

It was demonstrated: S.S. planted with a screef, with ground cultivation, on heather, on grass, in mixture, in check, coming out of check, the rate of post-check growth, and the productivity of S.S. both pure and in mixture with S.P. and L.P.

Compt. 128

S.S. P.42 Calluna site planted on screef and no manure, still in check, height after 24 years barely six feet. This would not be the method used today.

Compt. 4

Fast growing P.30 S.S. planted on furrows (agricultural plough) grass site. The MAI to date approx. 200 but indicated yield class is about 180.

The success of planting S.S. in mixture with Pine was clearly demonstrated in Compts. 194, 195 and 198 all P.40. Compt. 194 being pure S.S. the other two in mixture. The results are shown in the tables below.

Basal Area and Vol. measurements include all trees 2½ in. B.H.Q.G. and over.

Common Factors: Each plot 1/10 acres—P.40—Ploughed—Planted on top of ridge. Spacing approx. 4½ × 4½—mixtures planted intimately 1 S.S. and 1 S.P. along the rows of trees. Elevation between 1,000 and 1,100 feet. Moderately exposed with Southern aspect.

Compt. No.	*Mixture or Pure*	*Species*	*No. of trees planted*	*No. of dead or missing trees*	*No. of live trees under 2½" B.H.Q.G.*	*No. of live trees over 2½" B.H.Q.G.*
194	Pure	S.S.	1,790	120	340	1,330
195	Mixture	S.S.	850	80	80	590
		S.P.	850	390	10	450
	Total		1,700	470	90	1,140
198	Mixture	S.S.	820	80	170	570
		S.P.	820	540	130	150
	Total		1,640	620	300	720

Basal Area sq. ft. per acre	*Aver. top Ht. 4 largest trees*	*Aver. B.H.Q.G. crop*	*Yield Class based on 40 LTPA*	*Tariff No. of crop*	*Total Vol. H. ft.*	*Aver. Vol. per tree H. ft.*
133	36	3½	140	19	1,820	1·37
S.S. 104	36	4½	140	19	1,613	2·34
S.P. 43	30	3½	100	18	534	1·19
147					2,147	
S.S. 97	41	5	180	21	1,747	3·06
S.P. 17	34	4	120	18	234	1·56
114					1,981	

Since this Forest cannot grow good S.P., it is now common practice to use L.P. in mixture with S.S.—the results are most encouraging. It makes one wonder whether more of this should be done on some of our large S.S. areas. Even though *Calluna* is not yet apparent on some of the peat/molinia sites, I have the feeling that it will appear after a few years of non-grazing and the extensive drainage now being undertaken. It is already appearing in small patches and this visit certainly makes one a little apprehensive.

In the evening a Ceilidh was held at the Ballroom of the Huntly Hotel. It was as well that the following day was not very strenuous, this Scottish form of a "Noson Lawen" can be most hectic!

Wednesday, 18th May: Dunecht Estate

This was the Open Day and all members had been kindly invited to inspect the plantations at Lord Cowdray's Dunecht Estate. His Lordship welcomed members to Dunecht.

Dunecht Estate has been owned by the Cowdray family since 1912. The woodlands are worked to an Approved Plan under Dedication or Approved Woodlands Scheme. They are part of a woodland management plan covering 5,750 acres of woodland. The Dunecht Estate portion is the largest portion of this and comprises 2,448·3 acres of which 604·5 acres are managed under the Dedication Scheme and 1,843·3 acres are managed under the Approved Woodlands Scheme. The productive area at the end of F.Y. 65 was 2,392 acres. The altitude varies from 275 feet around the Loch of Skene to 600 feet on the Hill of Fare, and the soils are very varied.

Hatton Wood

Theme: The Economics of growing Scots Pine, Hybrid Larch and Sitka Spruce.

The crops inspected were 92 acres of predominantly Scots Pine of Q.C. III; Y.C. 80; planted in 1910. Six acres of Hybrid Larch Q.C. II; Y.C. 140 planted in 1928, and seven acres of Sitka Spruce Q.C. IV; Y.C. 180; planted in 1950.

Soil pits had been opened in these stands and the soils under the different species were broadly similar, being moderately to strongly podsolised. The soil characteristics were described by Dr. E. A. Fitzpatrick (Soil Science Dept., University of Aberdeen). Choice of species by Mr. C. Y. Ross (Head Forester, Dunecht) and economic comparisons by Mr. M. S. Philip (Forestry Dept., University of Aberdeen).

The tabular statements on the economics of growing these three species were most informative, and the explanatory talk by Mr. Philip using charts to illustrate the costs and resultant profit or loss was most ably done.

North Affloch Wood

An inspection was made of Compt. A42 (8·5 acres of Norway Spruce planted in 1948) and Compt. A41 (6 acres of Scots pine planted in 1952). The subject for discussion was the underplanting of Birch with N.S. and a comparison of this with the adjacent older S.P. The topic was introduced by Professor J. D. Mathews (Forestry Department, University of Aberdeen) and Mr. C. Y. Ross the main points covered were the value of the birch overstorey in giving protection from late frost, and controlling the growth and development of the understorey be it Norway Spruce, Western Hemlock, Douglas Fir or Silver Fir.

Heather Hill

Lord Cowdray gave an account of the damage incurred by the gale of 1953, when 265 acres of mature timber were blown, this meant the clearing of approx. 1 million hoppus feet. Remnants of the 160-year-old crop of Scots Pine were seen; it was also described how logs were stored in the various lochs on the estate. Some planks recently sawn from logs recovered from the storage ponds were on view. The quality of the planks was not impaired by this method of storage—for a period of 12 years! A tour by bus was then made of the windblown areas and the replantings were seen. Lunch was taken near the marquee erected adjoining the 8th fairway of the golf course.

After lunch the Annual General Meeting of the Society was held, a formal decision was taken to establish an aboriculture group of the Society, with the object of advancing and spreading in Scotland a wider knowledge of aboriculture. The resolution described their activities as: to promote interest in the cultivation of trees for primary purposes other than commercial production of timber, especially in regard to management and improvement of amenity plantings in both town and country; to raise the standard of craftsmanship in aboriculture; to provide instruction and education in the subject and organise conferences, demonstrations and competitions for people with an amateur interest in the subject.

This was followed with the presentation of the Hunter Blair Trophy and the various competition prizes. Lady Cowdray had graciously consented to make these presentations.

After the presentations a Softwood Log Grading Demonstration was carried out by Mr. F. G. O. Pearson of Forest Products Research Laboratory. A number of logs of S.P., N.S. and E.L. had been graded and crosscut. The rules governing how this is done were described, the examples inspected, followed by a general discussion.

This was followed with a walk through the Garden Wood where the natural regeneration of the area was described by Mr. W. M. McNeill (retd), Forestry Dept., University of Aberdeen, and the subsequent tending by Mr. C. Y. Ross.

The gathering then reassembled at the marquee to take tea provided by the courtesy of Lord and Lady Cowdray. This was a most enjoyable day, in very delightful surroundings.

Thursday, 19th May: Speymouth Forest

The party was welcomed by Mr. R. J. G. Horne, Assistant Conservator at Fochabers, the tour was conducted by Mr. J. Everard, District Forest Officer and Mr. R. Allison, Chief Forester.

Speymouth Forest was formed in 1946 when the Ordiequish section of Teindland Forest was linked with ground which was being acquired from the Crown Estate Commissioners. The land in the Fochabers area had previously been part of the Gordon Richmond Estates.

Since 1946, by further acquisitions, mainly from the Crown Estates, and by the incorporation of Lossie Forest in 1966, the area of Speymouth Forest has been increased to about 13,300 acres.

Area Summary:

Plantations	12,310 acres
Bare Plantable	370 "
Agriculture	60 "
Unplantable	660 "
Total	13,300 acres

Age Classes:

1–10 years	2,980 acres	24%
11–20 "	5,870 "	42%
21–30 "	2,340 "	18%
31–40 "	960 "	7%
41–50 "	610 "	5%
Over 50 "	550 "	4%

Species

Scots Pine	7,310 acres	60%	—78%
Lodgepole Pine	1,730 "	14%	
Corsican Pine	480 "	4%	
Sitka Spruce	1,190 "	10%	—11%
Norway Spruce	180 "	1%	
European Larch	100 "	1%	— 7%
Japanese & Hybrid Larch	680 "	6%	
Douglas Fir	350 "	3%	— 4%
Other	190 "	1%	

Rainfall —The average annual rainfall is 24 in. to 30 in., varying with distance from the coast and elevation.

Soil —The soils are mainly derived from boulder till. The degree of podsolisation varies, but fertility is low.

Timber Production —	1966	1975	1985	*Estimated Max. Production*
	150,000	250,000	650,000	1,200,000

About 50 per cent of timber production is sold standing and the remainder is worked by the Forestry Commission. The main market has, until this year, been mining timber, but from 1967 the estimated utilisation is:

Pulpwood—40%; Chipboard—25%; 6 in. Saw Logs—30%; 8 in. Saw Logs—10%; and Poles—5%.

It was most unfortunate that the tour of this forest was unavoidably cut short, as we were due to visit a shipyard after lunch. A very hurried tour was made of eight different compartments on Whiteash Hill. Some fine specimens of 1764 Scots Pine had been underplanted mainly with Western Hemlock, it is now an amenity area. A stand of P.31 S.P. high pruned in 1963, this was a very fine stand indeed. The other areas visited were varying mixtures of pines and spruces, some ploughed and others unploughed.

At Deer Park Scots Pine of varying ages were seen in passing, along with a small stand of P.12 D.F. The S.P. seed stand plots were really worth spending time to inspect in more detail, but this was not possible, I hope to return to this area some day to roam at leisure through some of these magnificent stands.

After a late lunch we motored to Messrs. Jones' Buckie Shipyard Ltd. in Banffshire where we were joined by the party that had been to the Cullen Estates. The whole party was welcomed by Mr. Tom Bruce Jones. The yard is a typical North East shipbuilding yard where seine netters and yachts are built, using mainly home-grown Oak and Larch.

It was an interesting tour where the old-type craftsman still holds his own, even though he is now aided by some modern equipment. A short sea voyage was also arranged in a fishing boat, the weather was most unkind, and a number of us who are by nature "land lubbers" kept our eyes on the distant hills and forests. This assisted in retaining our digestive juices for the dinner that lay ahead!

Forestry Forum

After dinner, a Forestry forum was held at the Castle Hotel, Huntly, under the able chairmanship of Mr. T. H. Woolridge. There was a most distinguished panel composed of Dr. Theodore Frankel, Managing Director of Corpach Pulp Mill, Fort William; Sir William Gordon-Cumming, Altyre, Forres; Professor J. D. Mathews, Aberdeen University and Mr. James D. G. Davidson, M.P. for West Aberdeenshire and Mr. Tom Jones of Larbert.

In reply to a question regarding the prospects for small timber in the North East, Dr. Frankel said it might be bought by a development board in the Aberdeen area or passed to Corpach.

Opinions were divided on the need for a new road from Upper Deeside to the West coast. Mr. Davidson said it was something everyone, whatever their politics, would like to see. It would be an aid to the timber trade.

On the Common Market Professor Mathews said the inevitable scarcity of timber would eventually fit into Common Market policy. Timber growers would benefit from entry into the Common Market, but a barrier would have to be erected against the Commonwealth imports of timber.

Sir William Gordon-Cumming said the question was really one of land use, forestry and farming should be properly integrated wherever possible.

Mr. Tom Jones had good hopes that forestry would surmount the labour problem if better housing was made available for timber workers.

Sir Henry Beresford-Peirse, Director General of the Forestry Commission, addressed the meeting briefly.

This Forum was something new for these excursions, and the general feeling was that it had come to stay.

Friday, 20th May: Mosstodloch Sawmill

The last visit of the excursion was a brief tour of Mosstodloch Sawmill, owned by Messrs. A. G. & W. J. Riddoch. This is one of the bigger mills in this part of the country, dealing entirely with home-grown softwoods and hardwoods. The machinery installed is able to deal with a wide range of sizes and qualities of home-grown timber.

It comprises four units—two cutting softwood battens and boards, one only larch, and one larger softwood and hardwood logs, all home-grown.

Like Topsy, the mill just grew, keeping pace with increasing supply of logs from the great gale and its after effects, and from thinnings and clear fellings from Forestry Commission and private forests.

Analysis of conversion of Softwood Logs
8 ft and up by 7 in. top diameter, and up by weight

Logs unbarked taken as:	100%
Deals, Boards and Battens	67%
Slabs and Bark	20%
Sawdust	13%
Loss in conversion hoppus overbark to sawn measure Scots Pine and Spruce sawn to deals, boards and battens	30%
Average length of battens and boards, length of log restricted to 14 ft	8–9 ft
Proportion of softwood logs 10 ft and over in length	12%
Proportion of battens	66%
Proportion of boards	34%

The tour was very enjoyable and most instructive, a great deal of hard work had been carried out by the organisers, owners and staffs of the various estates and forests.

POST-GRADUATE STUDIES AND FELLOWSHIP, CANADA AND THE U.S.A., 1964–65

By **T. I. W. BELL, M.Sc.**
District Officer

Studies in Toronto

From the list of available courses of study I selected Silviculture, Soils and Soil Ecology. In correspondence with Dean Sisam he recommended that I make final arrangements for my programme of studies when I arrived in Toronto and that I would be working with Professor Armson as an adviser on my thesis project and for assistantship requirements. In addition to two forestry subjects the degree course required a subject to be taken outside the forestry faculty. At Professor Armson's recommendation I took Glacial and Pleistocene Geology and Ground Water.

The Silviculture course (Professor Hosie) was mainly concerned with the practice of Silviculture in Canada with particular reference to the commercially important trees in Ontario. It consisted of lectures and discussions ranging from forest tree nursery practice to artificial and natural regeneration of cutover areas. Field trips consisted of visits to forests and forest nurseries in various parts of Ontario.

In the Glacial Geology course (Dr. Deane) lectures and discussions included glacial erosion, transport, formation and distribution of drift deposits (mainly in North America). Weathering and soils including derivation of soils and interpretation of ancient soils. Soil Maps. Measuring of varved clays. Economic features of clays, sands and gravels. Stratigraphy and post glacial chronology. Field trips were arranged to study glacial, interglacial and post glacial beds and land deposits including soil profiles in a drumlin, esker, spillway, outwash quarry, commercial clay workings, varved clay and till combinations. Southern Ontario prides itself on being one of the best areas in the world to study glacial deposits.

The Soil course (Professor Armson) consisted of lectures and discussions dealing with soil properties of main importance to crop production including soil fertility, root growth and fertiliser and management problems. Field trips overlapped in interest with the Silviculture and Geology courses and included a study of soils in nurseries and forests and of management problems particularly related to root systems in the soil.

Being limited in time (many of the graduate students spend two years at the university working for their Master's degree) the thesis project had to be fitted into one forest year. In discussion with Professor Armson, I submitted and had approved by the M.Sc. committee a proposal to make a study of "The effect of pretreatment on seedling survival and growth". Professor Armson had in hand a number of research fertilizer and spacing plots laid out in Ontario nurseries and stock from these plots was put at my disposal. As I would be unable to study a season's growth in the field due to limited time, I was allocated a section of the research greenhouse and the facilities of soil and plant analysis equipment at Glendon Hall—a part of York University retained by the University of Toronto. In my first introduction to research work I was impressed by the amount of work required for even the simplest operation. For example, my first task was to find half a ton of suitable forest soil for potting in the greenhouse. Having made arrangements to collect soil from a state forest I set out to hire a truck for hauling it but was informed that I must first obtain a special "chauffeur's" driving licence. My first research work therefore involved taking an advanced driving test on the wrong side of a road partly obliterated by snow!

Tours

On completion of work on my thesis I set off with my family for a brief visit to the New England states, and then back to Toronto to check the typing and submission of my thesis. We then set off via the trans-Canada Highway through Ontario, Manitoba, Saskatchewan, Alberta and British Columbia to Vancouver and on to Vancouver Island for about a week. As some of the foresters that I wanted to see were on Annual Leave until mid-August we returned to the mainland and headed south for Washington, Oregon and California. We then returned to Vancouver island for another week. I then had to return to Toronto to be examined on and defend my thesis and so home via New York. Visits ranged in duration from one week at an individual forest station to brief interviews with forestry men at numerous Ranger stations across the country. The following give a cross section of the visits:

One important task in Ontario is to re-establish tree crops on millions of acres of low grade land cleared for agriculture and by logging companies. As part of the programme nurseries have been established at strategic points in the province.

St. Williams

This is the oldest of these stations (established 1908) and is sited near the shores of Lake Erie on the only, relatively small, deciduous region of Canada. Despite wholesale clearing for agriculture I was able to find a few virgin stands of black Walnut, Hickories and Oak. There is a big replanting programme especially on derelict farms and plants for this purpose are grown at the station nursery—an annual production of about 6,000,000 trees. Facilities offered to the public are camp sites, a picnic park and a 12-acre lake stocked annually with rainbow trout.

Orono forest station is sited on glacial ridges and flats on the North shores of Lake Ontario. Again the main task is replanting of abandoned farms. On the flatter lower slopes (glacial sand) a 350-acre nursery was established in 1922 and this still provides much of the planting stock for this part of the country (output about 8,000,000 plants a year). The nursery forester has discovered that plants lined out in July after 1½ growing seasons and left in the lines for a further 1½ seasons give a much more vigorous 1½×1½ plant than the more usual 2×1. In my literature review I found that Guillebaud referred to the use of this technique by the F.C. as early as 1929!

Swastika

This is a relatively new forest station in the predominantly coniferous Boreal region of central Ontario. Again the centre of the area consists of a large nursery recently cleared from the virgin forests. Seeding is carried out in the Autumn and then the beds are given a thick covering of sawdust and battened down with laths to protect them from a six-month winter of snow and sub-zero weather. Practically no work goes on in the nursery during the winter and most of the staff are suspended for six months a year.

Jasper National Park and Banff area, Alberta

There are numerous easily accessible active glaciers in this part of the Rockies where I spent a productive day.

Vancouver Island

One outstanding drive was along the 50-mile logging road connecting Alberni with the West coast. This was a narrow metalled tortuous track often crossing precipitous slopes. Much of it was below the standard of F.C. roads but was used by a constant stream of timber trucks often hauling loads of 80 tons or more. These logging roads are opening up areas formerly classed as inaccessible and are yielding vast quantities of D.F. sawlogs. Timber along this route had been felled by the large McMillen Bloedel logging and pulp company and replanted with D.F. as part of their 13,000 acre annual planting programme. In the past restocking of felled areas had been attempted by hand seeding or by helicopters but results proved very variable and as in most Canadian forests it is now more usual to re-afforest by planting nursery stock. There is also a great swing from expensive nursery transplants by developing nursery techniques to produce plantable, much cheaper seedlings.

Harmac Pulp Mill (Vancouver Island)

This is the largest producer of bleached Kraft pulp in the world. The mill gives direct employment to a working force of nearly 1,000 employees. Consumption is about 3,000 cords of wood per day.

Cowichan Lake (Vancouver Island)

The upper slopes of this area are typical of thousands of acres of productive formerly inaccessible forest. Road making is now opening up much of this land, giving access to trucks and heavy mobile machinery. The region I visited was being worked by British Columbia Forest Products logging company. At selected points on the logging roads they set up a 120-ft telescopic steel spar and slack cable logger (cost about $130,000) which takes in several tons of logs in each sling. Working in conjunction with this is a "tree farmer" which can mechanically load a truck with up to 80 tons (Canadian) in under 20 minutes. Logs are lifted individually by means of a cable attached off centre, the base of the log then lodges against a heel boom giving complete control to the operator. The timber is then trucked to water where it is loaded in a few seconds by an overhead boom. In the water it is sorted out to various specifications by small tug-like boats. As a result of diminishing supplies of large-sized timber and improved working methods the companies are now making more use of small wood formerly classed as waste.

The Weyerhauser Company Headquarters, Washington State, U.S.A.

This is a very powerful firm owning or controlling about two million acres of forest in the U.S.A. and Canada.

The Ranger Station at Coos Bay, Oregon

The world's largest lumber shipping post. Contrary to Canadian experience the Oregon forest service is getting very satisfactory re-afforestation by helicopter reseeding. Douglas fir (state tree of Oregon) and redwood areas are reseeded with D.F., S.S. and *Sequoia sempervirens*. Although there are still many fine stands of over 200 ft height, future crops are to be grown on a 40-year rotation up to about 15 inches diameter butt.

California Fire Lookout

Fire equipment here was typical of the expensive modern machinery used in this part of the world. Lookouts and spotter planes pinpoint a fire very quickly and then ex-navy bomber planes bomb the fire at vital points with 2,000 gallon sticky water bombs (Diammonium phosphate). The Ranger on duty had never heard of fire beaters! My most nerve-wracking experience of the trip was climbing a vertical 110-ft. ladder up one of these fire lookout towers.

Campsites

We camped wherever possible on sites maintained by the Forest Service. These were always intelligently laid out in the forest. The number of tents or caravans catered for varied from a dozen to over 300 on any one campsite. Full use was made of trees and small clearings gave complete privacy for each party. In all cases each tenter was provided with a picnic table, a level tent area and a fireplace with a supply of free or very cheap logs. Toilet facilities varied from a dry lavatory and communal cold tap in the most primitive wilderness areas of Maine and Ontario to the more usual modern washrooms containing hot showers and electric razor plugs. The more luxurious sites also offered slot machine electric cookers and automatic washing and drying machines. The private sites also included up-to-date washrooms but were usually unimaginatively sited on treeless clearings and had rather a dull suburban atmosphere. The most frequent nuisance on camp sites were the energetic mosquitoes. On some of the more mosquito-ridden sites the Ranger came round each evening with a powerful DDT gun at sunset. Visitors also included the occasional bear looking for the store tent and one unpleasant encounter with a rattlesnake in California. The most trouble-free but not the quietest night was spent in a municipal tennis court on the woodland fringe of Boston.

The foregoing paragraphs have only given a quick record of what was to me a very full and helpful year. I much appreciated the opportunity to study in a different University in a very forest-conscious country with all the facilities offered in the form of staff, libraries and discussions with other graduate students. This type of post-graduate course I think is of more benefit to someone who has been in the field for some time rather than for a new graduate. The usual chore of examinations, term papers and seminars meant that there was not full freedom of study but on the whole the recommended reading list was useful and interesting.

As far as visits outside Toronto were concerned I was fortunate in having the opportunity to see a fairly large variety of country. Time was limited however and I feel that a year could usefully be spent by F.C. field staff particularly on the west coast; possibly on an exchange basis with the state forest service or a logging company.

The results of my academic year were top marks in Soils and Silviculture and in Geology I obtained 70 per cent. I successfully defended my thesis and had the degree M.Sc.F. conferred at the November Convocation (in absentia!).

EXPEDITION TO THE GUYANA RAIN FOREST

By **T. I. W. BELL, M.Sc.**
District Officer

Early this year I was invited to join, as the "forestry man", an expedition of staff and final year Science students of the University of the West Indies, Trinidad, to the Guyana forests. The visit was to include a field study of an area of rain forest. Having spent a few months of my two year-contract with the Trinidad Forestry Division I welcomed the opportunity of seeing forestry in another tropical country, especially Guyana where the forests cover more than 50 million acres.

The plans were to fly to Georgetown, join up with staff and students from the University of Guyana, then travel 60 miles upriver to Bartica and continue a further 24 miles inland to the lowland forest in the Bartica triangle.

We made an early start from Piarco airport passing down the east coast of Trinidad. Within a few minutes we sighted the coast of Venezuela and many square miles of muddy water washing out from the Orinoco river. The next break in the densely forested coastline was the Essequibo river, our route for the following day. At the tiny Atkinson airport we were met by members of the University of Guyana staff and the local press. We soon cleared the informal Customs and set off on the 25-mile drive along the banks of the Demerara river to Georgetown.

The drive into Georgetown, like so many other city approaches, involved passing through a poor slumlike district but the beauty of the city centre made up for this. Apart from one new concrete section the buildings are mainly of local Greenheart (*Ocotea rodiaei*) timber in a variety of styles, reflecting Dutch and English influence, but a liberal use of white paint brought back some nostalgic memories of New England. Many of the houses are perched on stilts and this plus the sight of the sea several feet higher than the city streets gave me an uneasy feeling despite the sturdy looking sea wall. Perhaps the most unexpected thing about Georgetown was the pleasantly cool sea breeze.

At 5 o'clock next morning we set off from Georgetown by Land Rover crossing the Demerara river by ferry and so along the coast road to Parika. This drive was mainly through poor agricultural land with little forestry interest although the zoologists and botanist of the party collected some interesting material from the canals and drains along the way. At Parika we loaded the Land Rover and ourselves into the river boat with its mass of brightly dressed talkative Guyanese passengers including a few green uniformed soldiers. Deeper in the boat near the steerage-class coffee bar were tied several cows on their one-way trip upriver. At various points along the river small boats pulled out from the banks to pick up or despatch passengers and mail with no more fuss than meeting a country bus.

One of the main halting places was Fort Island Stelling, a small town boasting a landing stage on which several fruit vendors were lined up with bananas, hot corn cobs and other tempting local products. Here some of us left the main party and transferred to a waiting Forestry Department launch so that we could have a closer look at the forest on the way. This consisted of rather scrubby-looking mangrove swamp forest, the red mangrove (*Rhizophora mangle*) at the water's edge, doing the pioneer work of holding newly-formed deposits of soil, giving way the the black (*Avicennia germinans*) and white mangrove (*Langunicularia racemosa*) on the slightly higher ground. Further upriver, as salinity decreased and drier banks became more general, many species of palm and shrub were seen. None of this could be classed as commercially attractive forest and the only large trees seen were a few specimens of corkwood (*Pterocarpus officinalis*).

At Bartica after six hours on the river we rejoined the main group who had already transferred our gear from the river boat to a truck. We met the local forest officer who, with the generous co-operation of the Forestry Department, had arranged for line cutters and two Rangers to accompany us on our trip. This included Rufus Boyan, an Amerindian and son of Jonah Boyan referred to in Nicholas Guppy's *Wai Wai*. Rufus Boyan not only knew the forest very well but could identify any tree found there, usually giving both the local and scientific name.

We were quickly out of Bartica, a straggling rather shanty town, and into open scrubby forest with some young plantations of *Pinus caribaea*. After about five miles the road had deteriorated to a sand track but we had our first glimpse of the Rain Forest in all its magnificence. The evenly-sized close-ranked trees with long clean boles are a wonderful sight, especially to someone more used to young Sitka spruce on wet Welsh hills.

At the 24-mile post on the Bartica-Potaro "road" we unloaded the truck and ferried our baggage by Land Rover a few hundred yards to our campsite in a clearing in the forest. Here we stretched tarpaulin sheets over a framework of poles and set up our camp beds and nets although there were so few mosquitoes the latter were hardly necessary. The cooks and forestry men set up camp nearby and soon we were tucking into our first meal of plantain, cassava, dasheen and other local vegetables accompanied by Guyana hot-pot and black coffee.

Far from being quiet the nights were filled with weird creaking and moaning foghorn noises of tree frogs while at dawn the screeching of parrots and toucans showed that there was no shortage of bird life. Loud gruntings on the first morning sounded like an invasion of wild pigs but turned out to be a party of red "howler" monkeys that had come to take a look at us. Much quieter visitors were occasional scorpions and the hordes of ants that frequently swarmed over the site. The Bachac or Parasol ants usually came at night looking for anything edible that we might have left lying about. This they would cut up into small pieces and carry away as fodder for their underground fungus farms. On one occasion the bread-bin was left open and our bread supply disappeared overnight. Much more aggressive were the columns of Army ants that we occasionally came across. These could swarm over you and bite quite viciously if you accidently got in their way. Perhaps because of the ants, we only saw one snake in this area—a miserable looking harmless little thing eight inches long.

While climate has an effect in determining the general forest type, edaphic influences play an important part in smaller-scale local changes. This was very well illustrated in the country round our campsite. The topography there was a gently undulating peneplain dissected by many small water-courses and streams developing into wider valleys where they drained into the Essequibo river to the east and the Mazaruni river to the west.

The soil in the valley bottoms consisted of often swampy silty clay with Mora (*Mora excelsa*) evident as the dominant tree forming practically a pure crop. The mora characteristically have large buttresses often exceeding 35 feet diameter at ground level and reaching up to 20 feet high on the trunk. The main canopy is around 100 to 150 feet high. On the side-slopes the soil occurs as a fine brown sand with excessive drainage but moisture retention is assisted by a percentage of clay. Here the forest crop occurred as a Greenheart faciation of the Rain forest. Higher up the slope the brown sands changed very sharply to the excessively freely-drained coarse white sands of the watershed. The change in vegetation was equally sharp, the white sands supporting Dry-evergreen Wallaba (*Eperua* spp.) forest which occurs on sites where the soil moisture is fairly consistently inadequate to meet the evaporating ability of the air.

One of the first steps in the management of Tropical High Forest is to make an assessment of natural growing stock. If available, maps and aerial photographs can give some indication of what to expect but a closer study is normally made by carrying out a physical low-percentage strip-sampling survey of the forest. The girths, heights, species distribution etc., obtained from such a survey coupled with a description of the forest in words are very important. However for a clearer idea of the stratification of the forest, drawing profiles of representative strips of forest is most helpful.

It was decided to mark out a transect and collect information for drawing up a forest profile in the Greenheart forest and another in the Wallaba forest. A line 200 ft long and 30 ft wide running east-west was pegged out in both forest types. All trees over nine inches girth at breast height were recorded by species, girth, heights to lowest branch, distance from lowest branch to crown, depths and width of crown and position. The information collected was then used to draw the profile diagram.

The most striking thing about the exercise was that although a large number of tree species was found in each transect none of the species in one transect occurred in the other. Also, up to a point, different storeys can be noted in the profile. In the dry-evergreen Wallaba forest a broken canopy 80 to 100 ft is apparent with a more consistent understorey 45 to 80 ft high. Beneath this is a fairly dense undergrowth from 20 to 40 ft. Nineteen different species were noted in this transect, at a stocking of 350 trees per acre. The Greenheart profile shows three storeys rather more clearly defined than the Wallaba forest. The canopy is 90 to 130 ft high with a lower storey between 40 and 75 ft, and a continuous undergrowth from 20 to 40 ft. The uneven appearance of the canopy is due to grouping of the dominant trees. Sixteen different species were noted in this transect at a stocking of 254 trees per acre.

Although the campsite was on the boundary of a virgin forest reserve, much of the forest in this area is let out on concessions to several large timber contractors. In this particular locality the forest between our camp and the Essequibo river was worked by Guyana Timbers (Colonial Development Agency) and in the other direction to the Mazaruni river by Willems Timber Company. The principal trees exploited are Greenheart, Wallaba, Mora and Crabwood (*Carapa guianensis*). The cutting limit is based on diameter but species is determined by market. Apart from such small markets as Walaba telegraph poles the bulk of the demand is for Greenheart. This gives an excellent timber highly resistant to decay, insects and fire. Among its many uses it makes excellent fishing rods.

Logs are extracted by wheeled or crawler tractors to trucks which haul them to loading bays on the Essequibo or Mazaruni and then down river on barges to the sawmills. These are very wide deep rivers and remembering the enormous timber rafts in Canada I naïvely asked: Why not do the same here and save time loading barges? It was quietly pointed out that fresh Greenheart immediately sinks to the bottom when dropped in water!

Much of the work in the forest is done by Amerindians who are very capable industrious workers. Back in the Willems Company compound we saw some of their houses where they live mainly amicably with the more recent Guyanese. Alcohol is forbidden as revelling in the past often resulted in the West Indian exercise of chopping—literally chopping someone with a cutlass! Most country dwellers in this part of the world carry cutlasses as an all-purpose tool which have a habit of being used for fighting.

Our stay in the forest passed all too quickly and at 4 a.m. on the 9th day we reluctantly broke camp. Loaded with zoological and botanical specimens we made our way back to Bartica and downriver to Georgetown. Here we were met by the press who had been taking a keen interest in our expedition. We were then taken to our hotel, a drably respectable place with an air of Somerset

Maugham about it. The management looked less than glad to see our bearded faces and clothes that looked as though they had been slept in—which in fact they had been!

Our last three days in Guyana included a trip into savannah country, visits to an Amerindian village, the Georgetown botanical gardens, the Forestry Department headquarters and the University. Everyone was most friendly and hospitable and we found ourselves being entertained into the small hours of each morning. We were seen off at the airport by a number of University and forestry friends, the sadness of leaving only being eased by the thought of returning to the home of Calypso.

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FUNGI

"Fungi ben muscherons . . . There be two maners of them, one maner is deedly and sleeth them that eateth of them and be called todestoles, and the other doeth not." *The great herball*, 1526

They grow on trees in woods and fields
On heaths and open spaces,
They fructify on cheese and lawns
In damp and shady places.

They bear the most attractive names
Like Grisette and Morel,
Their microscopic forms in moulds
Mycologists know well.

In varying sizes, colours, shapes,
White, scarlet, pink and grey,
They smell of almonds, garlic, musk,
Turnips or mouldy hay.

With gills and scales they grow from spawn
And yet they are not fish.
Reputed deadly poison but
When cooked a savoury dish.

The Cep (*Boletus edulis*)
Is boiled in oil in Spain.
A Roman Caesar ate some raw
And finished up insane.

The herbalist identifies them
All by the rule of thumb,
But amateurs who try this
Get convulsions in their TUM.

An appetising meal when served,
Of this there is no question,
But grilled and fried or eaten dried
Won't help a weak digestion.

So Reader . . . heed this warning
Do not taste in haste when hungry,
You may consume a Fly Agaric
With your Beef Steak fungi.

R. J. JENNINGS.

STUDIES OF PARTICULAR TREES

SCOTS PINE

Report of a Technical Discussion at Annual Excursion of the Society of Foresters of Great Britain, Inverness, Thursday, 24th September, 1959

Contributed by North Scotland Conservancy†

1. The Native Pinewoods and their Management

By
PROFESSOR H. M. STEVEN
Aberdeen University

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 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 most 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 silviculturally, 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

* 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.

† No apologies are needed for printing this account, for the first time, in full, even 9 years later.—*Ed.*

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.

(*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 conditions 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:

(A) 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.

(B) 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.

(C) Keeping Native Strains Pure

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 unforgiveable sin to bring other strains into it.

(D) 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

* by H. M. Steven and A. Carlisle, Oliver & Boyd, Edinburgh and London 1959.

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, but we do not yet know how this can be best done. 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.

(E) 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.

2. The Formation of Scots Pine Plantations with Particular Reference to Seed Provenance

By

M. V. EDWARDS

Assistant Conservator, Forestry Commission Research Branch

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 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 a 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 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 provenance 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 characteristics, 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 geographic 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 this country.

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 to 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 fertilised 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 reached the stage at which the older 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

Lethen Estate, Nairnshire,

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.

Before I start I would like to say that I regard it as a very great honour indeed to be invited to address the Society of Foresters of Great Britain; and I would like to take this opportunity of thanking you, Mr. President and Members, for allowing me to speak on this important subject.

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

(A) Scots Pine produces less and takes longer to do it than any other of our conifers, with the exception of European Larch.

(B) 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.

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

(D) 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 then 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 a 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 rings is less important than the fact that 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 practising 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 recognise 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 valaluble 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 aggressively dogmatic.

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

First, the published results of the Forestry Commission experiments in thinning at Bowmont Forest. Though these are in Norway Spruce, they undoubtedly apply to Scots Pine. The lessons I want to point 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. They are not new, though they have lately been brought to notice afresh by Mr. Hiley's new book. In this country we first heard of them when Dr. Craib came over here to attend the Empire Forestry Conference in 1947.

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 Utilization of Scots Pine

By

W. J. RIDDOCH

Timber Merchant, Rothiemay, Banffshire

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 that which 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 discoloration.

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 its 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 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, made 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.

THE STORY OF THE CHRISTMAS TREE

Published by courtesy of the "Mourne Observer", Northern Ireland

Those magic words "Let's have a Christmas tree!" set many a family of children agog with excitement at this time of year.

Lore and legends about the Christmas tree are very numerous. The notion was originally conceived by an Englishman, very long ago and in a strange way. At the beginning of the eighth century there lived at Crediton in Devon a fair-haired boy with the attractive name of Wynfrith. He was intelligent and his parents were reasonably rich, so he was able to attend school, which was something that few boys of that time could do. Wynfrith grew up to become a missionary, and visited Rome. From there he was sent to work in Germany under the new name of Boniface. He crossed the Alps to Thuringia, where he began his ministry.

At Hesse, in those days, the Druids were in the habit of holding a ceremony, during which, under a magnificent and ancient oak tree, they offered a sacrifice of human blood to Odin, whom they believed to be the most powerful of the gods. One Christmas Eve, Boniface committed the bold stroke of cutting down the sacred oak. In its place there sprang up a young fir tree, miraculously, it seemed, though doubtless the removal of the old oak released the small tree and permitted it to grow. It might be that the tiny fir tree had been growing up inside its hollow trunk. Whatever the cause of its appearance, the thoughtful Boniface perceived in it a useful symbol. To the crowds attracted by his eloquent preaching and benevolent appearance he offered it as a substitute to the Druids' oak, unstained as it was by sacrificial blood, and representing, that Christmas Eve, the anniversary of the gentle Christmas Child's birth on earth. Boniface lighted the little tree with candles in honour of the nativity and so actually began a custom which so delights the modern child—that of decorating the Christmas tree. Boniface was slain some years afterwards by his pagan enemies but his picturesque symbol lives on.

In Christian parts throughout Europe the practice of lighting a fir tree with candles at Christmas was developed and became widespread. Legends grew up about the tree. One told of a poor and hungry child who knocked at a wood-cutter's door on Christmas Eve and asked for food and shelter. The poor peasant lacked sufficient for his own needs, yet he still befriended the hungry child. In the morning before he went away, the stranger child thanked his friend, and, breaking a branch from a fir tree growing outside the door of the hut, stuck it into the soil. It immediately blazed with light and became covered with fruit. "You gave me of yours when I was in need", said the child. "Now you shall partake of mine, for this tree will bear fruit for you when you need it." So folk began to hang the Christmas tree with fruit as well as lighted candles and then with small gifts which they had set aside to give to their neighbours.

Particularly in the Scandinavian countries the notion of the Christmas tree became more and more popular as time wore on. During the passing of a thousand years, the idea of the ceremonial tree was developed in Germany, Norway, Denmark and Finland. There is a recorded account of a dressed tree seen in Strasbourg in 1605 and Martin Luther is reputed to have used such a tree to point his sermons. A custom grew up which might well delight children at a modern party—namely, the singing of a multi-versed Christmas carol while the unlit candles decorating the tree are lit one by one till the whole tree is ablaze.

The Christmas tree was very slow in returning to this country. Henry VIII once set up a tree made of gold to decorate a Christmas pageant, so some idea of the practice must have crept across the channel at that time. Apart from one or two foreign families who had made their homes in this country—the Princess Leiven and the Duchess of Orleans are said to have followed the custom in the early part of the nineteenth century—the Christmas tree never appeared here. Then, in 1840, a handsome young prince—who was probably very homesick—introduced a decorated Christmas tree at Windsor Castle. His name was Albert and he had then been married to Queen Victoria only a few months. He was unpopular for a long time because of his fondness for introducing German customs here, but the advent of the Christmas tree ultimately proved a great success. Rich families copied the Queen, and "had a tree". The benevolent-minded gave the practice a charitable angle by inviting poor people and bestowing on them gifts from the tree.

Well-known authors of the time were also giving support to the idea of the Christmas tree and the kindly charitable actions of the season. Most people know Hans Christian Andersen's story of "The Little Match Girl"—"She lighted another match. Then she was sitting under a beautiful Christmas tree. Thousands of candles burned upon the green branches . . .". This story was written in the 1840's and was the cause of many people seeking out and benefiting the poor at Christmas. Charles Dickens wrote "A Christmas Carol". This encouraged the trend to have a Christmas tree and to broadcast from it gifts of food and money to the poor.

Rules concerning the correct dressing of the tree are traditionally quaint. From Germany comes the idea that nothing useful must hang from the boughs. Presents for family and friends are ranged beneath the tree, where little figures representing the manger at Bethlehem are also often put. On the tree itself only glass baubles, sweets, fruit, Christmas crackers, and ornaments of all sorts are hung. There should be a star or an angel at the top of the tree. A fairy doll is often understudy for the angel. In a modern household coloured electric lights are usually substituted for the candles but, while these are safer, they are no real substitute for the magic of the real thing. Many adults will remember the nostalgic odour of burning fir—"the tree's alight!"—and the quick application of moistened thumb and finger to make all safe again, for the kindly tree soon announces the mishap with its resinous perfume. When buying Christmas tree lights and other glittering but fragile ornaments, it should be kept in mind that they are an investment for the future, as it is traditional to bring them out year after year. Perhaps there are some even now in the attic! Search the shops for tiny novelties for the tree, and when the budget is expended, gild nuts and oranges, hang up red apples, scatter imitation frost on fancy shapes of cardboard moistened with paste and allow to dry, stain discarded egg-shells with coloured varnish and gum a small coloured cord inside by which they may be hung on the tree.

The shape of the tree should be as symmetrical as possible. A central stem too tall for the rest of the tree is a common fault. Lop the top off, remove a portion of stem if necessary, and bind on to the lower part with red or metal ribbon.

Twelfth Night (the evening of 5th January before twelfth day, the Epiphany, 6th January) is the traditional time for dismantling the tree, for on the next day it must be burned, with other green decorations, or ill luck, it is said, will invade the house.

SIC TRANSIT GLORIA SITCHENSIS

or

A PLEA FOR THE LATE DEVELOPER

(*From the Gaelic of the Brahan Seer*)

The forester despised his Japanese Larch,
But lauded his Sitka Spruce
And vowed they would be the replacement tree,
As he planned his future land-use.

Yet, while time has flown, so the Larches have grown
To majestic bole and crown.
And how have the Sitka throve the while?
Oh! the winds have blown them down.

Air: *Tha a chuan gu eilean a cheo*
(*Over the sea to Skye*)
A. M. MACKENZIE.

NURSERIES, PLANTING AND WEEDING

THE EVOLUTION OF THE THEORY AND PRACTICE IN THE MANAGEMENT OF A FOREST NURSERY

By **J. T. FITZHERBERT**
Assistant Conservator, South Wales

Introduction

In order to appreciate the value of and the reasons for this big change in the workings of Nurseries in South Wales a certain amount of history is necessary. It must be realised first of all that forestry in South Wales was started in the early twenties and thirties because of unemployment. We were not worried then as to quality but merely to employ miners who had been left without work as the result of a depression. Since the War this position has changed somewhat, with the considerable increase and introduction of industry into South Wales we now find ourselves in the position that there is a shortage of labour for our type of work. Any individual who has the urge for big money can get it in a factory or heavy industry. It is only the youngsters and the older men who are either prevented by law from working in factories or cannot keep up with the pace that are prepared to come into forestry.

In the early days the siting of nurseries and their soil types and soil conditions were not quite so critical or given quite so much consideration as they are today. Heathland nurseries were not heard of thus today we find the existing nurseries rather heavy and not ideal for the growing of certain species, with the result that we could not compete economically with the lighter soils of Scotland or the East. To make matters worse the accountants have put the microscope on nursery work and have shown that as a result of these heavy soils and old techniques there has been no comparison between South Wales costs and those of the heathland types; thus something had to be done if we were to survive. A survey of South Wales showed that there were no sites which could be described as heathland and the only alternative was either change of techniques or import all our plants from England, North Wales or Scotland, this would naturally not only increase costs but would leave us at the mercy of the other nurseries.

In trying to analyse our faults it was very obvious that the first item was transplanting or lining out, this being the most expensive. Secondly the poor quality of work put into this operation resulting in very high loss between those plants lined out and the plants lifted fit for the forest. Thus we concentrated our efforts on these two items, improvement of survival in transplanting and to some means, if possible, of cutting out this very costly operation, for example by undercutting.

Procedure

(1) Lining Out

Having decided on this we then had to decide on the quickest and most effective procedure to adopt. Obviously lining out had to be done to carry out our programmes and here was something on which we could start. By checking our previous results and records we found rather a shocking state of affairs. I should say at this stage that we had tried all forms of incentive even to the extent of almost doubling the piece-work rate on the condition that the workers gave us a high percentage lift. After the first few days or week of good work I regret to say that it dropped back to the usual poor quality. The following year we decided that there would be no piece-work at all in the nursery; everything would be done by day-work and under very, very close supervision. As an additional safeguard we also insisted that all seedlings lifted would be lined out in the same day, we felt that there was far too much loss in plants being badly heeled-in or drying out pending lining out some time later. This close supervision and day-work lining out continued for three years but during this period we started our other line of attack in the form of researches on undercutting and producing an undercut plant cheaper than a transplant.

The success of our efforts is shown in Table 1 below.

(*Extract from "A Nursery Bonus Scheme", F.C. Journal No.* 32, 1963)

TABLE 1

PERCENTAGE YIELDS FROM PLANTS LINED OUT

Species	P. 50	51	52	53	54	55	56	*Aver.* 50/56	57	58	59	*Aver.* 57/59	60	61	62	*Aver.* 60/62
J.L. ..	36	64	80	75	—	83	75	69	76	85	63	75	84	90	87	86
H.L.	—	—	—	—	—	—	—	—	—	—	77	77	51	91	100	81
S.P. ..	—	35	78	—	31	9	—	38	—	—	—	—	—	—	93	93
D.F.	66	55	76	54	—	64	51	61	55	77	57	65	95	92	96	94
N.S.	—	66	76	54	61	100	77	72	67	—	83	75	—	80	94	87
S.S. ..	57	58	87	79	57	89	75	72	—	64	54	59	88	75	88	84
P.C.	—	—	72	—	18	—	—	45	—	—	—	—	77	100	75	84
A.Pr.	—	—	—	—	77	100	57	78	20	64	100	61	—	—	62	62
All Spp. Aver.	—	—	—	—	—	—	—	62	54	72	72	68	79	88	87	84

(2) Undercutting

Our first efforts towards undercutting consisted of sowing seed at various densities to a square yard varying from 150 to 500 and wrenching them with a garden fork. Later we progressed and sowed in drills and undercut with a spade. Gradually we found that the best spacing was, or rather the best density was, somewhere between 180 and 240 plants per square yard depending on species. We did our first researches with Douglas Fir chiefly because we use rather a lot of this species from this nursery and also because it has a tap root and produces a good plant in two years.

By 1961 we had progressed far enough to give us a certain amount of confidence in that we could produce a plantable plant as one-undercut-one (1u1) at almost half the price of a transplant. Mainly because we had cut out the cost of transplanting there were no losses as a result of this operation or during the process of lifting the seedlings and carrying them to the transplant lines. By about the same time also, the workers had improved the quality of lining out to such an extent that we felt that they had justified not only our insistence on quality before quantity but that they justified some reward for this extra effort.

I should mention that throughout the period during which they were on day-work there were protests from unions etc., requesting piece-work. These we rigidly resisted on the strength of our previous figures. However, by 1962 we felt that we should give them some incentive and perhaps not only encourage them but also increase their production and so reduce our costs. (See *F.C. Journal* No. 32, 1963, "A Nursery Bonus Scheme".) So we can say that after about five years we had not only found an alternative to the costly process of transplanting but we had found (*a*) undercutting and (*b*) quality lining out, which was giving us an eighty-one to eighty-five per cent survival and lift fit for the forest. (See Table 1).

Our next problem was to decide which of these two methods we should adopt. Could we completely cut out transplanting or would we have to work a fifty-fifty basis. It soon became apparent that we could not completely do away with transplanting because of importing seedlings of species which we do not grow ourselves and furthermore at times germination is not always true to the record with the result that we got seed beds sown for a density of perhaps 200 to 300 per square yard but we got a stocktaking of anything from 500 to 800 due to extra good germination or nursery technique. Our next stage therefore was to try and compare costs between the two operations which we were going to adopt. (See *F.C. Journal* No. 33, 1964, "Undercutting as a Nursery Technique"). For this purpose we drew up our own nursery costing record which gave us immediate costs and allowed the Forester and District Officer to control costs within a few days of expenditure. This is a feature which has never been present in the existing or past Commission methods of costing, perhaps it was not required for general purposes but nevertheless it did help local management. We are now able to see at any stage of the year exactly what seed beds or lines have cost, and with stock-taking we can assess the value per thousand at any time in the year. Using separate sheets for each species and each year we were soon able to cost out the difference between undercut (1u1) and one-plus-one (1+1). This showed us that the undercut plant could be produced at half the cost of a transplant in spite of the fact that the workers were turning out an eighty-one to eighty-five percentage survival of plants fit for the forest after lining out. (It may be of interest to note that in F.Y.66 the figure was 93 per cent). On sight of these figures we shuddered to think of the past costs when we were only getting sixty per cent survival from lining out.

Mechanical Equipment

I think we must accept the fact that machinery has not only come to stay but in view of the labour position and of economics these days it is far cheaper and quicker to get mechanised than to rely on hand labour, thus all our work gradually swung over to mechanisation. We were already using lining out ploughs of recognised designs and our own. We already used machines such as grit distributors and all the various Ferguson attachments of normal cultivation. Various undercutting machines had been developed but about this time the Marsh reciprocating root pruner was developed and this machine has proved the turning point with undercutting. In addition we found that undercutting, weeding and all auxiliary operations were greatly assisted if the sowing was done in drills rather than broadcast. While there are several machines which claims to sow seeds in drills we found none suitable for our purpose, therefore we decided to develop our own. This proved extremely successful and has recently been in great demand. Revolving around first the Drill seed sower, then the Marsh reciprocating undercutter, we made further machinery which helped the undercut plants and in fact all plants by developing the disc side cutters and various other cultivators. If the nursery is to be mechanised then the lay-out must be such that you get the least wastage and such that the machines are employed for the greatest time, consequently some of our nursery hedges, roads etc., were removed and the lay-out was set out for the whole purpose of mechanisation, with long runs and no hindrance.

This feature, together with the accountant's microscope on costs, convinced us that the small nurseries were a dead loss and should be scrapped. Apart from being costly in labour and units of mechanical equipment they also required as keen and as skilled a Nursery Forester as did the bigger nursery. These valuable men are few and far between and very difficult to find. Thus better and fuller use could be made of everything by concentrating our activities in as few big nurseries as possible. We find from 50–70 acres a good workable unit

At this stage I think I should mention that the seed sower to which I referred above has as one of its main features the fact that it is a combined seed sower and grit distributor. One of the problems of seed sowing is the fact that wind often scatters seed and makes sowing impossible. The object of this sower is that within six inches, or alternatively a fraction of a second, of the seed being dropped on the ground it is covered by grit, thus seed sowing can be done on days when normal broadcasting is impossible. (Actual time 100 sq. yds in 50 seconds). Furthermore as the grit only covers the drill and is aligned with the drill the saving of grit is quite considerable; the depth of drill grit can be adjusted to suit conditions be it $\frac{3}{4}$ in. coverage or $\frac{1}{2}$ in. coverage as desired.

An additional feature of mechanisation and nursery work is that once it is decided to adopt machinery it should be standardised. All our equipment is fitted to the Ferguson Tractor; thus all seed beds, lines and in fact everything is worked to the wheel-span of the tractor.

Plant Classification

By the production of undercut plants which are fit for the forest a complication arises which in some circles creates embarrassment. During the past forty years or so the Commission and the the nursery trade have devised a system denoting the age and treatment of nursery plants. This has stood the test of time. It is quite excellent and the fact that it has survived forty years proves the case; I refer of course to the system of referring to transplants as "one plus one" etc., and seedlings as "one plus nought" etc.

While the old universally adopted system helped to evolve a rough standard of quality, size and sturdiness of plant, it also created a kind of inferiority complex between a seedling and a transplant. Unfortunately the past history of so-called undercut seedlings has not been good, chiefly because of overcrowding in the seedbeds and insufficient and ineffective undercutting of the resulting plants. Thus we find that there is a considerable barrier of prejudice which has to be broken down in trying to dispose or sell undercut plants and claim them to be as good as the transplants. If the phraseology of seedling and transplants continues, nurserymen will never get the encouragement to improve their techniques to the extent that they can produce an undercut plant cheaper and as good as a transplant; therefore, the cost of plants would always remain high. Alternatively an advantage is given to the nurseries in the East, having less rain and lighter soils.

It is suggested therefore that there should be a change in the phraseology. The simplest would be to work on the British Standards Institute Specification, using height and collar diameters only. In this way the age and the treatment the plant has received is irrelevant to the customer. A forest plant would be any plant suitable for planting in the forest and acceptable on sample. (See *F.C. Journal* No. 33, 1964, "Undercutting as a Nursery Technique. Table I. Survival of Undercuts in the Forest".) If the customer wishes to know the age, it can be described as either a two-year forest plant or a three-year forest plant; this would be the equivalent of the old 1+1 or 2+1. The nursery plant on the other hand would be any plant requiring further nursery treatment before it is fit for the forest. Again, this could be described in years as one-year, two-year or three-year if necessary, but without the condemning "plus" signs.

Only if we accept the classification of plants according to British Standards and by sample, leaving the techniques to the skill of the nurseryman, will he reduce final costs of production. I appreciate that the prices in the past have had to be scaled or graded according to the costs of production in order to arrive at a basic price, but now we have got these figures. Therefore if the high costs of a transplant are due to increased lining out costs, then obviously the sooner we can remove that costly operation the sooner will be the cost be reduced.

Miscellaneous Operations

Up to now I have dealt mainly with the known and accepted main operations in a nursery but, obviously, there are numerous others which are necessary such as grading of plants, packing of plants and what to do with the squad during wet time. This last item is a very costly one when you have a large nursery with a squad of somewhere near 60 to 100 people, and also when you have fairly high rainfall or numbers of wet days per annum. At this point it would perhaps be worthwhile mentioning that while the forest wet time is only recorded when it is actually raining, in a nursery a heavy day's rain can put work out of action for at least two to three days depending on the season. Unless there is a forest attached, you have on your hands a very expensive immobile squad.

An additional feature of having a large nursery with a lot of wet time is that you have during the lifting season a considerable quantity of plants being sent out. If the weather is bad they cannot be lifted, nor can they be graded and packed in the open. Thus suitably equipped sheds and work properly organised helps in the final disposal of this produce. In connection with these two items we have in South Wales adopted two wet time occupations. Firstly, the manufacture of potato boxes as a light industry when the men are unable to work on the nursery. This is not an economic job costed on its own, but at least it keeps the men occupied during the time we must pay "wet time" and it also produces something in return for that payment. At this nursery we employ almost 50 per cent female workers. Here we find that by the provision of a conveyor belt for grading of plants we are able to do much of our grading in a shed during wet weather and by electrification we are also able to utilise the early morning hours when it is normally too dark and often the last half-hour in the evening when, again, it might be too dark. An additional feature of the conveyor belt is that apart from the fact that the women are working in comfort we get extremely close supervision, we get very good grading and excellent counting. The packing is done in ideal conditions and stacked in storage sheds ready for collection.

Very recent additions to our equipment include an escalator-conveyor for loading plants in polythene bags from storage to lorry, and also using the same machine in loading the plants from the seedbed on to the trailer before going into the packing shed. Our own cold storage sheds are being built within the nursery. These will not only help in later lining-out but will also store plants in ideal conditions when taken out from the main storage pending lining-out in the nursery. Our very latest mechanical asset is the Potato Lifter that can lift 5,000 plants a minute in perfect conditions, and with more roots than we ever dreamt they had. Sorry we cannot produce any figures for these last three items for they are still in the trial stages but show great promises.

These notes are written from experience in the two South Wales Nurseries of Tair Onen and Slebech, where the soil is not light, where rain is frequent and over 45 in. p.a. It does not follow that your nursery will suit all these factors or will want to follow any of the features. They have been recorded in the interests of efficiency wherever they can be applied.

AERIAL FERTILIZATION AT KILMORY FOREST

By E. J. M. DAVIES
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1. Introduction

As early experiments are analysed and the studies of tree nutrition on relatively infertile ground become more sophisticated, it has become clear that many acres of older plantations, which are at present growing slowly, are short of phosphate and possibly potassium and nitrogen as well.

Several years ago, small manuring plots were established in the Mid Argyll district in the West (Scotland) Conservancy to study the effect of putting ground mineral phosphate on areas of slow growing Sitka spruce and the results were startling. Trees planted in 1945 on *Molinia/Calluna/Eriophorum* sites, doubled their total height after four years. New leaders up to three feet have been recorded and on average, leader lengths have trebled.

The most effective dosage was found to be 3 cwt of ground mineral phosphate per acre, broadcast. If the ground mineral phosphate is placed near the collar of the slow growing tree, the reaction is a good deal slower, presumably because the tree roots have spread out a long way from the stem, and the area where the phosphate can have a beneficial effect on the soil microfauna and microflora is restricted.

As a result of these experiments and surveys made by Mr. J. Atterson of the Research Branch of the Forestry Commission, and Mr. I. Gillespie (the District Officer) and his staff, it became clear that several thousand acres of plantations in Mid Argyll would benefit greatly from the application of phosphate.

2. Problems

However, immediately certain difficulties arose. Hand application was certain to be expensive. The country is broken, there is a strong growth of *Calluna* and *Molinia*, sometimes 18 in.–24 in. deep, intersected by drains which are often concealed by the vegetation, and there are lots of groups of thicket spruce which are practically impenetrable. Hand application of 2 cwt. ground mineral phosphate at time of planting costs between 20/– and 40/– per acre. To get anything like effective coverage in this type of terrain would cost three or four times as much and would be difficult to supervise.

Triple superphosphate was considered and about 2 cwt/acre would be equivalent to 3 cwt of ground mineral phosphate. Economies in labour could be made but these would be largely offset by the fact that it is a much more expensive material.

The use of aircraft was investigated. Fixed-wing light aircraft are relatively cheap to operate, but there were no landing strips anywhere near the area and there were grave difficulties in flying close enough to the ground in the broken terrain to achieve a good uniform spread.

Helicopters are expensive but very flexible and after writing to several helicopter companies, Autair Helicopter Services Limited of Luton expressed interest and discussions were held.

It became clear that there was no great difficulty in dropping 2 cwt of triple superphosphate per acre from the air but it would clearly be cheaper overall to drop 3 cwt of ground mineral phosphate. The difficulty was that there was no distributor or spinner on the market that would distribute a flour-like substance such as ground mineral phosphate from a helicopter.

Scottish Agricultural Industries were consulted and it was ascertained that crude Gafsa phosphate has a sand-like consistency and was remarkably constant in its chemical composition. It costs about the same as ground mineral phosphate and contains an equivalent amount of phosphorus. Autair reckoned that it could be spread evenly through a Wiggins spinner.

Accordingly, a trial contract was drawn up to fertilise a defined area of 1,000 acres at Kilmory Forest in September, 1966.

3. Planning and Procedure Adopted

The pilot had a good look at the area and selected six landing/loading sites from which to work. Each of these sites was designed to serve a specific area of the forest block and they were sites on or by forest roads. Once the site and the area it had to serve were decided, a 6 in. print was marked and the amount of Gafsa phosphate needed at each site calculated and ordered.

At this stage a costing was carried out which is summarised below:

	£
150 tons of Gafsa phosphate delivered at £11. 5s. 0d.* per ton	1,688
Cost of spreading by helicopter, 1,000 acres at £2. 8s. 0d. per acre..	2,400
Labour for loading 108 man days at £5 including bonus and oncost	540
Hire of Transport	50
	£4,678

* The price of the fertilizer has hardened a little since September.

which was equivalent to £4. 13s. 7d. per acre.

Certain snags were foreseen:

(1) Drift of fertilizer in high winds.
(2) Clogging of the spinner if the fertilizer got wet.
(3) Difficulty of marking areas treated and liaison with lifting sites.

It was believed that by ordering the fertilizer in sealed ½ cwt polythene sacks, the problem of dampness could be overcome.

Simple flags were made for workers to carry and to show the pilot where to fly. Radio pocket sets were loaned from a nearby forest to liaise between dump and dropping zone.

Twenty 5-gallon oil drums were provided to enable the phosphate to be loaded into the hoppers quickly.

4. The Operation

Mr. R. Fryer of Autair Helicopter Services Limited, flew in the aircraft, a Bell 47 D1, on 10th September, aiming to start work on Monday, 12th September, 1966. The weather was very wild with high winds and nothing much was achieved until Friday 16th. However, once the weather relented, good progress was made, and the area was covered in 40 hours flying which was spread over nine days. On the best day 186 acres were treated. 4 cwts were carried on each sortie, expenditure was carefully analysed and the final account showed:

	£
150 tons of phosphate at £11. 5s. 0d. per ton..	1,688
Spreading as per contract	2,400
Labour cost, including overtime, oncost and bonus	475
Radio and transport	27
	£4,590

equivalent to about £4. 12s. 0d. per acre.

5. Difficulties Encountered and Lessons Learned

(*a*) *Material*

In spite of misgivings the amount of drift of Gafsa seemed to be small. In high winds it is not safe to fly anyway. However, keeping the phosphate dry is not easy and the pinpricks that are made to let air out when sealing polythene bags let in water, particularly if the bags are stacked on their sides in dumps.

Gafsa phosphate also seems to contain foreign bodies and it must be screened through a ¼ in. sieve before it is put into the hoppers on the helicopter. The coarser the Gafsa the better.

(*b*) *Loading*

Men must be carefully briefed on safety. The speed is vital—and loading time from touch-down to take-off reduced, during the course of the operation, from 1 minute to 15/20 seconds average. It is hard work and a simple bonus keeps interest up. A minimum loading team is four workers and one supervisor.

(*c*) *Marking and Liaison*

Effective swathe-width was taken as 10 yards. This meant that one load covered a lineal distance of about 645 yards, i.e. 1⅓ acres. Whenever possible the area was treated by forest compartments although sometimes two or three compartments were included in one block. This enabled a progressive check to be kept of loads delivered to acreage. Too small an area is wasteful of time, whereas too long a run over-extends the marker interval. The best swathe length proved to be in the range of 300–600 yards. Markers on the boundaries of the area under treatment carried red flags, whilst intervening markers used white flags. Since the trees were occasionally about 15 feet high, it is recommended that these flags be fixed to canes or poles about 8 feet long. For effective treatment, the minimum number of markers should be 5+1 supervisor who knows the forest well. Since the accuracy of application depends largely on the efficiency of the markers maintaining an even line of advance at 10 yards, a skilled team would be desirable for maximum effectiveness.

However, as noted above, it is essential that the supervisor should be someone with previous knowledge of the ground. Boundaries between compartments were often difficult to discern on the ground. Some difficulty was encountered in some areas which required treatment generally, and enclosed unplanted sections, and sections where the trees were growing satisfactorily, where treatment was not desired. Since these sections were often of irregular shape or of relatively small area and not always readily distinguishable from the air, marking and spread were rendered difficult. In future, areas to be treated should be squared out as much as possible, and it must be accepted that either small areas requiring treatment be excluded in "squaring the line", or that similarly small areas, not really requiring treatment, will be covered in the effort to treat the desired area. The portable radio sets were found to be invaluable in saving time, passing of instructions and clarification of difficulties or doubts encountered.

(*d*) *Choice of Loading Sites*

These had previously been selected by the pilot and were adequate for the purpose, although occasionally restricted in choice of landing and take-off direction. Little preliminary work was required apart from the clearance of rank heather and the occasional small tree which was unacceptably close to main or tail rotor. Whenever possible it is helpful if a pilot can visit the sites beforehand and agree suitable loading zones, bearing in mind not only the operation requirements of the helicopter but also the problem of reasonable access for vehicles delivering material. Should this not be possible the following general guides should enable foresters to choose sites:

(i) A roughly level area about 80 feet in diameter should be selected within which there should be no trees, shrubs, coarse grasses or clumps of rushes over 3 ft in height.

(ii) Inside this area, at the centre, a smaller circle 15–20 feet in diameter should be cleared of all coarse vegetation and rocks, and any drainage, ditches or potholes should be temporarily filled in—this inner circle should be as level as possible.

(iii) Ideally, the area outside the 80 ft circle should be clear of obstacles taller than 15 feet within a radius of 50 yards, and of obstacles taller than 50 feet within a radius of 100 yards. This will not always be possible and some sectors may be unsuitable for approach and take-off paths. However, it is stressed that the greater the degree of obstructions, the greater the risk that flying operations may be impossible due to wind direction.

(iv) The area within the 80 ft circle must be kept clear of large dumps of material, vehicles and unnecessary personnel.

(v) The ground to be treated should lie within a straight line distance of 1 mile from the loading zone. If further, a secondary or alternative site should be chosen.

6. Conclusions

(1) Helicopters offer a cheap method of applying fertilizers to standing forest crops.

(2) If the terrain is difficult of access or the plantations are unbrashed or checked, or growing very slowly, helicopters are likely to be far cheaper than hand methods.

(3) The introduction of crude Gafsa phosphate applied through a Wiggins spinner mounted on a helicopter means that phosphate can be applied in its cheapest unmanufactured form.

(4) Helicopter rates may reduce further as more efficient machines come into operation but it is clearly safer to get the contracting company to quote for a per-acre rate, rather than a hire rate, in our unreliable climate.

(5) If one is prepared to work outside the crop spraying period of May-August, helicopter rates are lower. In the case of phosphate, the season of application is immaterial, but with potassic or nitrogen fertilizers, early summer applications may be essential.

7. The Future

One can foresee a time in the not-too-distant future when regular aerial application of fertilizer to standing crops becomes routine practice.

Perhaps we are on the threshold of a major change in the management of coniferous plantations in Britain. The initial investment in establishing a crop is high, but if one can increase its total yield by, say, 25 per cent for an average additional annual expenditure of £1 per acre per annum on scientific manuring, it is likely to be highly remunerative.

Furthermore, it may well be possible to extend the range of profitable high volume producing species, such as Sitka spruce, on to infertile sites where only

Lodgepole pine would normally succeed, using the helicopter as the distributing machine at least until the plantations are brashed.

Acknowledgements

The writer wishes to thank Mr. Atterson of the Forestry Commission Research Branch, Edinburgh, for his assistance.

He has also drawn heavily on reports written by Mr. R. Fryer of Autair Helicopter Services Limited and Mr. I. Gillespie, District Officer, Forestry Commission, and wishes to acknowledge their help.

DEVELOPMENT OF CHEMICAL WEEDING ON MINISTRY OF DEFENCE WOODLANDS, SALISBURY PLAIN, WILTSHIRE

By **B. A. PAINTER**

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On Salisbury Plain there are some 2,500 acres of woodland scattered in various sized blocks over the Ministry of Defence's holding. Since 1957 these woodlands have been managed by an agreed plan of operation with the Forestry Commission, and attract the normal planting and management grants. Except for certain old woodland areas situated on the greensand or the colite (cornbrash) the majority of stocked woodlands, or areas about to be established, are on the chalk with a considerable variation of soil depth and constituent. The caps and upper parts of the Wiltshire Downs often have a brown forest soil or clay-with-flints overlying the chalk. In other exposed areas there may only be a few inches of soil over the upper chalk. These variable soil types produce a wide range of flora from the chalk downland grasses, *Festuca* species, *Poa* species (meadow grasses), *Avena* species (oat grasses) through to the *Urtica dioica* (stinging nettle), *Rubus* and *Rosa* (brambles and briar) with associated coppice re-growth principally of hazel and ash. In certain places *Deschampsia caespitosa* (tussock grass) and the *Agrostis* species (bents) are also prevalent.

Choice of tree species presents a problem especially in the selection of suitable conifers to grow effectively with the final crop of beech. The use of the Lawson cypress, Red cedar and Norway spruce in this context has produced encouraging results. Due to the scattered nature of the woodland and restricted access in certain areas, management especially in regard to forest weeding is complicated. With over six hundred acres to weed annually, careful assessment of the work load, and subsequent programming is essential.

In an effort to produce early weed control consideration has been given to the use of herbicides. This did not prove too fruitful until the introduction of paraquat and the Arbogard applicator which is a means of applying the paraquat around individual trees giving a dessicated area of approximately 3 feet by 3 feet. To ascertain the effectiveness of paraquat in 1964 certain trial blocks were laid down where the downland grasses, and some broadleaved species, were in dominance in a P.63 Beech/Lawson cypress 3 by 3 row mixture, planted at 5 feet by 5 feet spacing.

These trails consisted of:

(*a*) Spot weeding only with paraquat through the Arbogard in May.

(*b*) Lane weeding by hand in July.

(*c*) Lane weeding by hand in July followed by a spot application of paraquat through the Arbogard in August and September in two separate blocks.

In all areas of chemical application effective dessication of the weed species was achieved and could still be seen after a period of twelve months. It was noted, however, that there was a limited reinfestation particularly of bramble and the surrounding grass tended to flop into the dessicated area. During hand-weeding the following year, it was observed that trees in the chemically treated blocks would easily be found compared with neighbouring sections of the same compartment where no chemical had been used. This speeded the operation up, and reduced the incidence of "Sheffield blight".

As a result of this initial work, chemical weeding was extended in 1965 and 1966. In 1965 the strong-growing difficult weed compartments were spot treated with the Arbogard in April and May. Although nettles and other weeds recovered so that additional weeding was necessary, later in the summer, the trees were at no time under suppression as in previous seasons. The bulk of chemical weeding in this year was undertaken during August and September. The method employed being conventional lane-weeding, followed when the weed re-growth was approximately five inches high by a spot application of paraquat through the Arbogard.

Spot weeding by the Arbogard in 1965 was costed at the rate of £4. 0s. 11d. per acre, which included cost of labour and materials plus an overhead of approximately 30 per cent. Lane weeding with a later application of paraquat averaged £9 per acre, which included the cutting back of coppice bramble and briar.

From experience in 1965 chemical treatment was further extended up to 200 acres in 1966, and, in certain cases, modified techniques were adopted as follows:

(1) In downland areas to be established, pre-planting strips were sprayed with paraquat by a knapsack sprayer fitted with a 078 flood-jet. This was later mechanised up and dealt with by a tractor-mounted sprayer. Trees being planted into the dessicated strips three weeks after spraying. It was discovered at this point that late autumn applications of paraquat took an appreciable longer time to "show-up" than early autumn spraying.

(2) In compartments of particularly rank re-growth a better control of the nettles was aimed at. This was attempted by applying a mixture of paraquat and a formulation of 2, 4, 5.T., through the Arbogard at the rate of 2 fluid ounces of paraquat, and one fluid ounce of a formulation of 2, 4, 5.T per gallon of water. This extended the control of the weeds, especially the nettles, and delayed hand-weeding of the surrounding growth until later in the summer.

In other areas where spot application of paraquat was employed the cost in 1966 was reduced to £3. 14s. 7d. per acre. It is considered that this was achieved by the labour force becoming more familiar with the technique, and the early teething troubles with the pump of the Arbogard having been ironed-out. As an alternative to the methods described above certain chalk downland areas have been given over to a farmer to cultivate and take off a cereal crop. These areas were then fenced, and a mixture of beech, Red cedar, Lawson cypress and Norway maple is being planted into the stubble. It is hoped that an early spot application of paraquat when the weed re-growth is around five inches high will dessicate this re-growth and effect an early control of the sites so treated. Herbicides are a means of killing or seriously checking weed growth, as opposed to the somewhat pruning effect of hand or mechanical cutting. It is therefore felt that an application of paraquat at the time of the first spring flush could go a long way way to preventing an early and often disastrous suppression of young trees; by grass and other species. Alternatively autumn application could be a means of retarding the early influx of weeds, and reducing the associated root competition at a critical time in the spring when the young trees are searching for nutrients. Following from this, pre-planting spraying could also be included as a basis for early weed control.

It must be emphasised that the success of paraquat on Salisbury Plain must be considered as localised, and it could well be that the local associations of downland grasses are particularly vulnerable to this method of treatment. However, when assessing the degree and intensity of weed growth and subsequent control techniques, paraquat can be a useful tool in the armoury, and can reduce the chances of growth getting out of hand in many areas. It is felt that this allows the work of forest weeding to be planned more carefully, and difficult areas brought under control much earlier in the season.

THE CULTIVATION OF FELLED WOODLAND

By **J. T. WEATHERELL**
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An article in the *Journal of the Forestry Commission* No. 29, 1960, pp. 54–56, plates 7–9, outlined thoughts on the cultivation of felled woodland and compacted chalk, together with experiences on the use of a D4 with a two-throw Parkgate tine plough and also a D8 pulling a twin-tined Blaw-Knox Ripper. Use of the Blaw-Knox ripper is also mentioned in Bulletin No. 32, p. 49 under *Tine Ploughing and Other Recent Developments.*

The experiment at Dalby which involved the comparison of attempted ploughing and tining has, after six years, indicated useful gains in survival and growth of species other than Lodgepole pine due to ploughing, and to a less extent to tining. Data are in the following table.

MEAN HEIGHTS (FEET) AT END OF SIXTH YEAR
(ALLERSTON EXPERIMENT 91, P.60)

	S.P.	*L.P.*	*J.L.*	*S.S.*	*Ts.*	*Mean*
D.M.B. tine plough	5·4	4·7	9·1	5·7	3·9	5·7
Blaw-Knox Ripper	4·5	5·1	8·3	5·1	2·3*	5·0
No cultivation	4·2	4·7	6·0	3·4†	2·4†	4·1

* Survival moderate.
† Survival very poor with associated frost damage.
Survival elsewhere satisfactory.

A common effect of the ploughing and of the ripping was to discourage the previously dominant vegetative cover of *Deschampsia flexuosa.* Upthrust soil, particularly from the B horizon, covered much of the grass and was itself very slowly colonised. The "No cultivation" plots, on the other hand, remained grass covered, and these differential intensities of grass cover were associated with radiation frost damage to spruce and Western hemlock.

White-woods with their higher potential yield are more desirable than pines or Japanese larch, and since the initial trial indicated the impossibility of using standard ploughing equipment because of stumps, interest has centred on finding a tine capable of greater soil disturbance than was obtained by the twin tined Blaw-Knox ripper. As part of a P.67 experiment concerned with the reforestation of a Japanese larch plantation, an area was clear felled for further tining trials, and on this occasion a D8 with a single hydraulically-mounted Kelley Ripper was obtained on hire. The ripper was massive, and with its mounting attachments weighed approximately six tons; the complete machine weighed 35 tons. It was noted that forest roads and gates, and indeed minor public roads are not designed to cope with the movement of such large equipment. Depth of ripper penetration was, on average, 52 inches, maximum depth was 64 inches, this being achieved in a moderately compacted sandy clay (middle calcareous grit, leached but without pan) with frequent J.L. stumps up to 13 inches diameter. The tine or ripper was virtually unbreakable, and the remarkable depth of penetration was simple a function of the power and the grip of the tractor. Brash had been burnt to eliminate fouling of the ripper. Stumps were no obstacle, either to the ripper or to track functioning—on occasions they provided useful track grip. Whereas earlier work had shown that tracks were liable to be dislodged in stump-strewn ground, the machine on this occasion, being designed to operate amongst rock, had guards which precluded track displacement. The machine operated continuously, without trouble, apart from bouts of track spin when on loosened soil with the ripper at maximum depth.

One intention was to run the ripper at intervals of three feet for maximum soil disturbance which involved running one track on the disturbed profile. Stumps and track-spin precluded accurate working, and the average spacing achieved was 4½ feet. There was also some re-consolidation and displacement of loosened soil, a factor avoided on the previous occasion by the twin tine set-up; nevertheless, the amount of soil loosened is considerably in excess of the earlier effort. Trenches reveal substantial air pockets down to ripper penetration depth with frequent and obvious cleavage across the soil bands between ripper channels with the soil loosened to a width of approximately 2 feet on either side of the ripped channel.

Operational cost per acre was £17. 12s. 0d. at a hire charge of £6. 12s. 0d. per hour for driver and machine. The normal hire charge of this particular outfit in quarrying work was quoted as £8. 10s. 0d. per hour.

The current exercise demonstrated most convincingly that reasonably low cut stumps need not be an obstacle or a nuisance to a tracked vehicle which is fitted with track guards to preclude track displacement. It also demonstrated that soil disturbance to depths far in excess of earlier achievements is possible. Further work is needed to decide on optimum intensity of cultivation and how the equipment can be improved to obtain more shattering and mixing of soil layers. The long term performance of Sitka spruce, Western hemlock and Grand fir will be tested on the area of deep ripping and for comparison, on an uncultivated area where *Deschampsia flexuosa* had been treated with mistblown paraquat before felling, to preclude frost effects apparently associated with such grass, and to minimise weeding.

A picture of the Kelley Ripper appears as Plate 22 on our centre pages.

MICROBIOLOGICAL ACTIVITY IN SOILS AND ITS INFLUENCE ON THE AVAILABILITY OF MAJOR NUTRIENTS TO PLANTS

By **T. I. W. BELL, M.Sc.**
District Officer

Fertile soils have been noted to have higher numbers of bacteria than non-fertile soils and in fact there is a relationship between numbers and relative proportions of most soil micro-organisms and soil fertility. The continual oxidising of dead plant remains by micro-organisms makes nitrogenous and mineral compounds available for plant growth. Fertile soils must either contain an adequate supply of nutrients in an available form or have a microbial population which releases nutrients fast enough to maintain rapid plant growth. An infertile soil results if micro-organisms remove and lock up available plant nutrients.

The soil micro-organisms can be roughly classified into two major divisions; (1) the microflora which include bacteria, actinomycetes, algae and fungi; (2) the microfauna represented by protozoa. In fact the division between the two groups is not always clear and there is a certain amount of overlapping.

The study of microbiological activity in soils is difficult and often only a partial picture of what the smaller micro-organisms do can be obtained. They need food, mainly carbohydrates, to supply energy for necessary vital processes and to build up their body tissues. Some can use the same supply of food for both processes while others can use quite different sources of food.

The microfauna are classified into autotrophs which are capable of using the carbon of carbon dioxide as the sole source of carbon for body tissues, and heterotrophs which are not so capable. Most algae and some bacteria are capable of autotrophic growth while most bacteria, actinomycetes and fungi can only grow heterotrophically. All micro-organisms need minerals as well as sources of carbon and nitrogen, their requirements being rather similar to plants.

The Soil Micro-organisms

Bacteria

The most important and usually the most abundant group of soil organisms are the bacteria. They are very small, about 0·5 to 1μ in. diameter and up to 2μ in. length, and may occur as single cells or in some forms the cells are linked into chains or joined end to end and appear as long filaments. The number of bacteria in the soil is continually fluctuating, generally constant in winter with an increase when the soil begins to thaw in the spring. Soil temperature and moisture influence seasonal fluctuation. Also exerting a strong influence are aeration, organic matter and acidity. Good aeration is essential for nitrification. Population size in mineral soils is directly related to organic matter content so that humus-rich localities have the largest bacterial numbers.

Bacteria carry out a wide range of chemical transformations. They are essentially surface feeders in their initial stages of colonisation of a solid corpus, of dead plant or animal tissue in the soil. Exoenzymes diffuse out from the bacterial colony and the rate of surface erosion of the substrate is determined by the rate at which enzymes are produced by and diffuse out from the colony.

Actinomycetes

Actinomycetes are usually regarded as a transition between bacteria and fungi. In the soil some of their filaments look like fungial mycelium and some of their spores like bacteria. In general appearance they are like long branched bacteria. By comparison with bacteria they are less common in wet than in dry areas and resemble bacteria in their intolerance of acidity. Unfavourable sites are peats, waterlogged areas and where the pH is less than 5. Sites high in carbonaceous materials and humus tend to have larger populations than habitats poor in organic matter.

They are mainly heterotrophic and can use a wide range of carbon and nitrogen compounds, e.g. celluloses, hemicelluloses, proteins and possibly lignins. Their presence is conditioned by the availability of organic substrates.

The activities of actinomycetes in soil transformations are not fully defined but there is evidence for their participating in the following processes.

(1) Decomposition of certain resistant components of plant and animal tissues. They fare poorly in competition with bacteria and fungi and are effective competitors only when resistant compounds remain.
(2) Formation of humus through the conversion of raw organic matter into the types of compounds native to the soil organic fraction.
(3) Possible importance in microbial antagonism through the liberation of antibiotics.
(4) Mineralization of the organic matter of the soil.

Their feeble competitive powers may explain their relative scarcity during the initial stages of plant residue decomposition. A few are parasitic of plants usually in the roots where they may affect the uptake of nutrients, but the majority are typical soil organisms associated with rotting organic matter.

Algae

The soil algae are minute green plants which occur either as simple unicellular organisms or organised as filaments. Generally they are few in number compared with bacteria or fungi. Being green plants they require light for their normal growth and development so that you would expect them to be primarily organisms of the surface of the soil. However, they are sometimes found not only on the surface but also several inches below the surface where no light can penetrate, possibly having been washed down by rain or carried down by soil fauna.

Near the surface they presumably function as green plants converting the carbon dioxide of the air into protoplasm and taking up nitrates or ammonia from the soil. The activities of those in the dark is not known.

The contribution of algae to plant nutrition is not clear but it is likely that it consists in part of building up organic matter in young soils. Also a few of the blue-green algae are reported to fix atmospheric nitrogen (Waksman 1928).

The waterlogged soils of the tropics often have considerable growths of blue-green algae and in rice cultivation the nitrogen contributed by the algae seems to form an important factor in the successful growth of the crop.

Abundant soil moisture favours an increase in the population. The addition of organic matter to the soil inhibits the growth of algae during the period of active decomposition of the material, by bacteria and actinomycetes, due possibly to competition for essential elements.

Fungi

Although not often the most abundant group of micro-organisms in the soil, in most well aerated cultivated soils the fungi account for the largest part of the total microbial protoplasm due mainly to the extensive network of fungal filaments. In most soils these filaments are too small to be seen with the naked eye or a magnifying glass. In some raw humus or mor soils fungi are predominant due to lack of competition from bacteria and actinomycetes for the food reserve. On the addition of organic matter, particularly in soils of low pH, fungi become quite numerous.

Representatives of all common classes can utilize and degrade the main plant constituents, cellulose, hemicellulose, pectins, starch and lignins. In woodlands the leaf debris becomes permeated with an extensive hyphal network that helps in the decomposition of litter and thus helping the formation of humus. As a result of using protinaceous substances fungi are active in the formation of ammonium and simple nitrogen compounds in soil. Under certain conditions fungi compete with higher plants for nitrate and ammonium, and lead to a decrease of the soluble nitrogen content of the soil, much of which is subsequently only slowly released in a form available to plants.

Fungi are well suited to decomposition of wood due to their intrusive hyphal growth habit—the fungal hyphae can easily penetrate the roughest wood although vigorous cellulose decomposing fungi are in a minority. Ability to decompose lignin is even less common.

The advantage of intrusive mycelia growth habit are not confined to decomposers of cellulose and lignin. Fungal hypae are able to penetrate relatively thin cellulose walls by pressure alone.

Certain fungi form an association with roots of higher plants resulting in the formation of an organism called *mycorrhiza* or fungus root. Two types may be recognised: (1) *ectotrophic*, which forms a mantle or sheath of fungal mycelium visible to the naked eye, enclosing the roots, and of fungal hyphae filling the intercellular spaces and (2) *endotrophic* in which, the hyphae invade the cortical cells without killing them and in which a mantle is not formed.

Most ectotrophic mycorrhizal fungi appear to behave as ecologically obligate parasites and have no independent saprophytic life in the soil. The fungus gets its supply of energy as carbon substrate from the host plant. Thus supplied with energy, the hyphae of the fungal sheath are able to absorb nitrogen, phosphorus, potassium and other minerals from the soil and a portion is then available to the host plant. This is particularly noticeable in infertile soils where mycorrhizal tree seedlings grow much more vigorously than do non-mycorrhizal ones, the fungal hyphae of the mantle being able to apparently compete more effectively for nutrient salts than the root hairs of uninfected rootlets.

When competition for soil nutrients is less important, as in highly fertile soils, mycorrhizal infection appears to be of little or no benefit to the host plant. The largest number of mycorrhizae are produced under shortage of available nitrogen, P, or Ca and it is therefore in unfertile soils that mycorrhizae regularly replace uninfected rootlets as the main absorbing elements.

Kessell & Stoats (1936) found that difficulties encountered in production of conifers in new nurseries in Western Australia could be avoided if surface soil from established nurseries was spread on. Rayner (1935) cited numerous examples from various parts of the Commonwealth of successful inoculation in growing exotics and in afforestation.

Protozoa

The protozoa are the simplest forms of animal life that occur in the soil. All the soil types, about 20, are microscopic in size with relatively simple acellular structure. The soil forms are grouped under amoeba, testaceous rhizopods, flagellates and ciliates, the simplest form being the amoeba.

Protozoa can feed in three ways; some possess chlorophyll and are autotrophic, some can feed saprophytically absorbing nutrients from solution in pure cultures, most normally only feed by capturing and digesting solid particles such as bacteria. Since bacterial development is important to soil fertility protozoa have a detrimental influence on crop production. Partial sterilisation of the soil by heating with steam or burning or adding sterilising solution increases the fertility markedly for a time. The explanation is thought to be that the protozoa are killed off thus allowing the bacteria to decompose the soil organic matter more vigorously. This has not however been proved.

When the edible bacteria are no longer available or the environment becomes unfavourable the active protozoa enters the cyst stage in which form they can persist for many years.

The Major Nutrients

One of the most important functions of soil organisms to soil fertility is that by feeding on soil organic matter there is the continuous conversion of nutrients from a relatively immobile and unavailable form into a form in which they are mobile and available to the plant. The soil organisms slowly release the plant nutrients from the organic matter into a mobile form that is available to the growing crop. The major plant nutrients derived from the soil are Nitrogen, Phosphorus and Potassium and in lesser quantities, Calcium, Magnesium and Sulphur.

Plants require nitrogen in greater quantities than any other nutrient. It is a key building block of the protein molecule upon which all life is based and is therefore an indispensable component of the protoplasm of plants, animals and micro-organisms. It is assimilated mainly in the inorganic state as nitrate of ammonium and is one of the few nutrients that is lost by volatilisation and leaching.

In what is known as the nitrogen cycle, nitrogen undergoes a number of transformations in which it is shuttled back and forth at the discretion of the microflora. Part of the reservoir of nitrogen in the atmosphere is converted to organic compounds by certain microbial-plant associations or by a microbial-plant association that makes the element directly available to the plant. The nitorgen present in the protein of plant tissues is used by animals where it is converted to other simple and complex compounds. When the plant or animal dies and decays the organic nitrogen is released as ammonium which is then used by the vegetation or is oxidised to nitrate. In this form it may be lost by leaching, may serve as plant nutrient or may be reduced to ammonium or gaseous nitrogen which escapes to the atmosphere thereby completing the cycle. The individual steps in the cycle are as follows:

Nitrogen mineralization

Conversion of unavailable organic nitrogen to inorganic nitrogen is essential to soil fertility and the process is called nitrogen mineralization. As a consequence of mineralization ammonium and nitrate accumulate and organic nitrogen disappears. The microbiology of protein breakdown in soil is not fully understood but it is probable that bacteria dominate in neutral or high pH soils but fungi and actinomycetes also contribute to the transformation. On low pH sites the main agent is fungi. The ammonifying population includes aerobes and anaerobes and organic nitrogen is mineralized consequently at moderate or high moisture levels.

Nitrification

In older literature the term was used in the same sense as mineralization but it is now thought of as the transformation of ammonium to nitrate. The transformation of organic nitrogen to ammonium is called ammonification. The organism responsible for transformation of ammonium liberated by ammonifying micro-organisms are the nitrifying bacteria. The first stages carried out by species of genus *Nitrosomonas* consists in oxidation of ammonium to nitrate. The second stage, oxidation of nitrate to nitrite, is mediated chiefly by species of genus *Nitrobacter*.

In soils too acid for the nitrifying bacteria to tolerate, soluble nitrogen remains in the form of ammonium salts, These can be taken up by the roots of some plants and there is evidence that a number of species grow better with ammonium than nitrate nitrogen.

Nitrogen immobilization

Adding, for example, excess sawdust as a seedbed cover almost invariably leads to a decrease in inorganic nitrogen content of the soil. This results in a marked depression of nitrogen uptake by the plant and decrease in crop yield. This immobilization of nitrogen results from microbial assimilation of inorganic nutrients. As new cells are formed not only must Carbon, Hydrogen and

Oxygen be combined into protoplasmic complexes but so must N, P, K, S, Mg and Fe, thus each of these elements is immobilized. This is the converse to mineralization which returns microbial and plant nutrient elements to the inorganic state. The immobilization or tie-up of nutrients is only temporary.

Denitrification

The steps that lead to gaseous loss of nitrogen is referred to as denitrification, the microbial reduction of nitrate with the liberation of molecular nitrogen. The major mechanism of Nitrogen Volatilization is by microbiological denitrification and may result in poorly drained soils. Nitrates are reduced to gaseous nitrogen by certain bacterial organisms to obtain oxygen. The denitrifying bacteria are all aerobic.

Many micro-organisms in addition to the dentrifiers *reduce nitrogen.* In the process of photosynthesis any micro-organisms that utilize nitrate as a nitrogenous nutrient are able to reduce it to ammonium as it is ammonium which enters into the organic combination necessary for protein synthesis with the cell.

Non-symbiotic fixation of Nitrogen

A number of free-living nitrogen-fixing organisms are found in soils, the main ones being the blue-green algae and photosynthetic bacteria. So far the chemistry of the nitrogen fixing process is not known. A small amount of molybdenum is required for efficient working and the nitrogen fixing only takes place when the level of available nitrogen is low.

Symbiotic Nitrogen fixation

Nodules in the roots of many leguminous plants contain bacteria living symbiotically with the plant. The plant leaves supply the carbohydrates and the bacteria the amine acid for the combined organism. These nodules are more efficient fixers of nitrogen than the non-symbiotic bacteria. The nodule bacteria are classified in the genus *Rhyzobium.* Nitrogen fixation is also carried out by actinomycetes living intercellularly in nodules on the roots of tree species, e.g. the alder.

Bacteria, fungi and actinomycetes act on the large reservoir of organic phosphorus and convert it into organic forms that can be used by plants. Affecting the rate of mineralization are soil temperature and pH which affect the micro-organisms. Also important is the quantity of substrate. The mineralization and immobilization of this element are related to the analogous reactions of nitrogen.

Although the microbial population is important in the transformation of *Potassium* little is known of the conversion of this element that can be effected by the micro-organisms. Certain bacteria are known to decompose alumino silicate minerals and release a portion of the K contained. Micro-organisms also liberate K from nephelite, orthoclase and possibly other sources.

Sulphate is the normal form of inorganic *Sulphur* in well drained soils. The main content of available sulphur in most agricultural soils is in the organic matter as plants take up sulphate from the soil and use them in the synthesis of the amino-acids cystine and cysterne which form a part of many plant proteins. The plant residues returned to the soil are attacked by soil micro-organisms some of the sulphur reappearing as sulphate and some remaining as humus. Little is known about the processes involved.

Root-attacking Micro-organisms

As can be seen, roots are important as absorbing surfaces for the intake of water and nutrients. Reducation in efficiency of the roots by the attacks of micro-organisms is common. An outstanding example of serious injury to trees caused by injury to small roots and root tips is the Little-leaf disease of Shortleaf pine which is prevalent on compact poorly aerated soils in the South-Eastern United States. The presence of the parasitic fungus *Phytopthora cinnamoni* on the roots results in the loss of so much absorbing surface that the trees become unthrifty and finally die (Kramer).

Conclusion

In this article it has only been possible to touch very lightly on the complex science of soil microbiological activities and major plant nutrients. The importance of the degradation by these organisms of plant refuse can be appreciated when the vast quantities concerned are understood. Kuhnelt quotes that in pine plantations 2,800 Kg. of litter containing 46·5 Kg. mineral matter fall per year per hectare. Scott quotes a figure of 1 to 1½ tons dry weight of forest tree litter annually reaching the soil. The smaller the nutrient reserve of the soil the more significant becomes the activities of soil micro-organisms on the influence of the availability of major nutrients to plants.

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PROBLEMS OF PEATLAND AFFORESTATION IN IRELAND

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(*Reproduced from the Edinburgh University Forestry Symposium*, 1967)

Introduction

I do not need to begin by persuading you that peatland afforestation still has its problems. This, I feel, is very obvious even to the most amateur of foresters and even though tremendous amounts of highly technical research has been carried out to solve these problems there is a good deal about the growing and harvesting of trees on peat soils that remains as yet vague or unknown.

Historical Background

The following is a very brief summary of forestry in Ireland from the latter half of the 19th century to the present day. In 1870 approximately one per cent of the country was under woodlands, all of which was on private demesnes. The first Land Act in 1880 provided for purchase of big estates and demesnes for division amongst the small farmers and landless people with the result that planting practically ceased and early 20th century forests and simple forestry practice were falling into decay. The Government's first attempt at peatland afforestation was in 1890 when 1,000 acres of a barren, exposed mountain, two miles from the sea, was planted at Knockboy, Co. Galway. This was not successful and restricted planting in the west for nearly half a century. This example shows the danger of selecting the extreme of any problem as a research subject. A very important event took place in 1903, when the embryo of a state forest service was set up with the acquisition of an estate of 500 acres at Avondale, Co. Wicklow, for training foresters. It was also used to test the suitability of exotic tree species for commercial planting in Ireland. Experience gained here proved valuable in the following years in the establishing of an efficient state forestry service. At the beginning of World War I the approximate area of woodland was 300,000 acres, mostly semi-mature woods which were severely reduced by the war and nearly all silvicultural management was abandoned. In 1923, twenty-six counties of Ireland formed the independent Republic of Ireland. More land was acquired and planting increased until World War II. This war left the remnant of the privately-owned woods in a derelict state and many were eventually taken over by the State. At present, 50,000 acres are privately owned, many of which are unmanaged. Thus we have only ten per cent of our 500,000 acres privately owned and compared with other European countries, have not only the lowest percentage of forests, but also far the lowest percentage of privately owned forest. The introduction from Britain, about 1950, of mechanical means of ground preparation and drainage, coupled with the advance in knowledge of the potentialities of certain tree species, particularly on their ability to grow on poor ground, brought about a radical change in the planting pattern here. Ploughing and planting of blanket peat mainly became possible, and also many other types of previously unplantable peat ground which meant that large areas could now be acquired in the western counties. By 1965 it was estimated that 43 per cent of the land acquired was in the west where previous to 1950 acquisition was static. It is now estimated that 60 per cent of the 25,000 acres planted annually is carried out on ground having peat of one form or another varying from a few inches to 25 feet in depth. From this we see that peatland afforestation constitutes a major portion of our annual planting programme.

Peatland

Forestry problems are practical problems. They arise because of difficulties or failures in particular sets of circumstances and their form depends on the details of those circumstances and on the role and outlook of the persons recognising them. It is from a very practical point of view that I shall deal with these problems.

Definitions. Authorities on this subject give various definitions of peatland but I shall give the one by Parker which seems to me the most appropriate: "Land on which there is a superficial layer of organic matter within which the roots of the vegetation which it carries are almost entirely or entirely confined".

Classification of Irish Peats

There are two main types:

(1) Raised bogs:—these constitute less than one-third of our total bog land and are usually well defined entities, the average depth of peat being 25 feet, the upper layers consisting of only slightly humified, highly acid sphagnum

peat. Due to the high expense involved, no large-scale afforestation of these virgin raised bogs has been carried out by the Forestry Division. It is my opinion that these may yet prove acceptable sites.

(2) Blanket bogs:—these cover very large expanses of the west of Ireland and are on an average eight feet in depth. They cover wide areas rather uniformly, often up to 15,000 acres, and it is on these that most peatland afforestation is being carried out.

Imperfections of Peat. The main problem of peatland afforestation is the imperfections of the peat itself as a substrate for tree growth. The most notable ratio likely to give a clue to the imperfections of acid peat soil, is the carbon-nitrogen one, which varies a lot but is usually more than 30, and under these conditions N and P are present only as complex organic compounds and are not readily available. The micro-organisms necessary for decomposition are very restricted in peatlands. The low N percentage probably also results from the very low rate of nitrogen fixation. The peatlands most likely to be lacking in nutrients are those which are not influenced by mineral-rich drainage water. Some nutrients may be lost altogether by being leached from the plants or the soil in drainage water but more are lost to the living vegetation on the bog surface, being built into the peat layer and passing out of the root range.

Land Acquisition

Acquisition is slow and carried out practically entirely on the basis of direct purchase, after negotiation by the state with individual landowners, who voluntarily offer their land for sale. Thus it is rarely possible to build up a reserve of land to meet more than a two years' planting programme. In practice most areas are planted up in the season following acquisition and this is far from ideal, as it does not allow time for proper pre-planting ground preparation. As the average area of each acquisition is only 50 acres transport costs of heavy machinery are greatly increased as well.

Preparation

The first step is to draw up a combined drainage, road and extraction route plan, which is based on the following principles:

(i) economic extraction of produce from thinning and clear-felling;
(ii) making forests easily accessible in the event of a fire;
(iii) elimination of the necessity for cutting out, immediately prior to thinning, extraction paths which expose stand edges and reduce the wind stability of the forest crop.

Peatland acquired for forestry must be suitable for ploughing. Pre-draining is by opening up natural water courses, or in the case of very soft ground, ploughing at wide intervals with the Cuthbertson "F" or Single Mouldboard Plough. Lack of slope or of suitable outfall presents many problems in the drainage of peatland flats.

Ploughing

Ploughing for planting is generally done with the Cuthbertson "P" or double mouldboard plough with drains spaced at 10 ft–12 ft giving ribbons for planting at 5 ft–6 ft apart. In some cases standard practice is to use the "F" plough exclusively, resulting in deeper drains spaced at 5 ft-6 ft, giving a larger peat ribbon on which to plant. This way reduces later drain deepening operations previously done by hand. According to the configuration of the land further drains may be necessary after the general ploughing has been carried out and these are usually put in with the "P" plough running across the previous furrows. This, however, gives rise to numerous difficulties in extraction of the produce over uneven ground and also the instability following the uneven root development induced by planting on ribbons. Experiments dealing with this have been laid down at Glenamoy in Co. Mayo. Prior to 1955 some drainage had been carried out. Drains 3 ft deep had been opened up with the Cuthbertson "P" plough at 50 ft and 100 ft spacings. A mound drain system with drains about 18 ft deep was superimposed over this system; three mound drains between each 50 ft main drain and six between the 100 ft drains. Planting was done on the ribbon and all plants received a dressing of G.M.P. After three years' growth this technique showed little promise. Drainage has been poor and the only species now showing any promise are S.S. and P.C.; even these are inferior to the neighbouring plantations of the same age, established after orthodox ploughing methods. A more promising implement in this line is the tunnel plough developed at the Peatland Research Station of the Agricultural Institute, Glenamoy. The tendency of the crawler tractors used, to sink into the ground, raises the cost of ploughing considerably. Winch ploughing was tried but this is slow, giving poor quality ploughing without straight, uniform lines. Hydraulically-operated ploughs, with a winch placed in front of the crawler, changing the centre of gravity and so providing uniform ground pressure, have proved a major technical advance in peatland ploughing.

Selection of Species

Although S.S. and P.C. are, in general, used in peatland planting, the selection of species is still one of the most confused and unsettled issues in this field. Some favour 100 per cent S.S. on the best soil types and 100 per cent P.C. on the poorer types—percentage varying in proportion to increase or decrease in soil quality. A mixture may seem to be a safe bet—if one fails the other will probably remain. However, this would leave a widely spaced crop unlikely to be economically attractive. In the past P.C. was the main species used, but with varying degrees of success, mainly due to the great genetic variations inherent in the various provinces. Coastal P.C. was used at first on shallow peats with quite a degree of success. However, inland P.C. was not so successful. Lulu Island P.C. was unfortunately a failure. Recently there has been an increase in the tendency to favour S.S. and with the advance of ploughing techniques, and use of proper fertilisers, this may yet prove to be a very effective crop on peats. Also the use of pre- and post-planting weedkillers is now seen as a great asset to the young tree, especially S.S. in getting away to a great start as the competition from the vegetation is immensely reduced. *Pinus radiata*, *P. pinaster* and *Apies procera* were also tried. Initial failure (Glenamoy) of the first two was high, but those remaining show good vigour. Survival of *A. procera* nearly 100 per cent but growth is slow.

Fertilizers

From 1950 onwards we witnessed a complete reversal of the former belief that "an ounce of patience was worth a ton of fertilizer". The first step in this direction was the application of 1 to 1½ oz. of Phosphate per plant on Lodgepole pines and 2–3 oz. on Sitka and other species, at the time of planting, followed by similar amounts at 4–5 years old where necessary. A recent development has been the broadcast application of fertilizers by mechanical means prior to planting. However, it was noted that one effect of manuring prior to planting was often a vast increase in the vigour of heather (*Calluna vulgaris*) and was generally associated with the tree crop becoming yellow and losing height increment. Use of the appropriate weedkiller, e.g., Gramoxone, will probably nullify this effect.

As a summary of the economics, I shall list the following:
Disadvantages:
(1) Low nutrient status.
(2) High roading costs leading to higher extraction costs.
(3) High drainage costs—closer drains than in mineral soils.
(4) Difficult working conditions for extraction and other machinery.
(5) Windblow—resulting from poor root development.

This leads one inevitably to consider the possibility of so-called pulpwood rotations. Pulpwood prices obtained in Ireland at present (2/3 of price here), do not make these rotations feasible. But with wider spacing, delayed thinning and roading, and higher prices, this type of "fibre-farming" may become a national possibility.

Advantages:
(1) The dramatic and relatively controlled response that fertiliser application gives on the peat medium.
(2) The huge areas of peat available with consequent economic, large scale forestry possible.
(3) The greater proportion of our peatland is in the West, which experiences a decaying rural economy, with consequent high emigration.

Forestry being highly capital intensive, with a large number of men employed per 1,000 acres, is an ideal way to boost a rural economy. (1 man per 80–100 acres).

Thus while peatland afforestation has many drawbacks and problems the outlook is not without hope and we feel that, as a nation with almost one-seventh of its land under peat, its development is worth the effort.

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NUTRIENT STATUS OF BOGLANDS AND THEIR MICRO-BIOLOGY WITH REGARD TO AFFORESTATION

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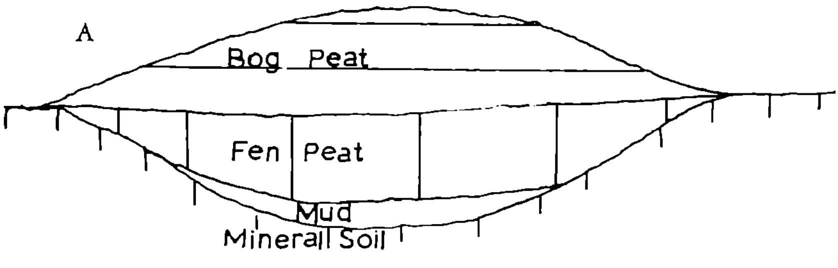
An early idea that the soil type which developed in any area was determined primarily, if not solely by the climate, though abandoned generally, still holds very true as far as peats are concerned. Not only is the formation of peat dependent upon climatic conditions but also the nutrient status within the different peats is influenced to a large extent by climate and topography. It can be said, that the great factors influencing the level of fertility of virgin peats are (*a*) climate and topography, (*b*) the microflora.

In discussing the effect of climate and topography on the nutrient status of virgin peats it is interesting to consider peats as fen and bog peats instead of the more usual division into raised and blanket bogs. Fig. 1 will illustrate this type of classification, which is dependent upon moisture source during peat formation.

A



B

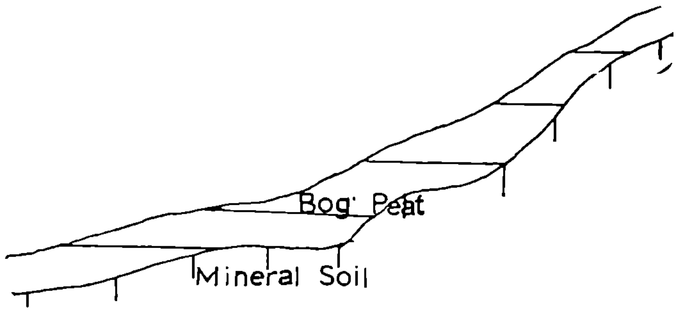


FIG. 1. Diagrammatic sections through a raised bog (A) and a blanket bog (B) (After Newbould 1958).

The formation of both fen and bog peat is primarily due to the presence of excess moisture, but whereas the vegetation of the former is favoured by a combination of soil and rain water the latter is solely dependent upon rain water for its additional nutrients. Table 2 therefore will serve to indicate the potential difference in the nutrient status of these two types of peat by reason of this difference in the water source.

TABLE 2

APPROXIMATE CONCENTRATION OF SOME INORGANIC IONS IN RAIN AND LAKE WATERS

	Rain Water (p.p.m.)	*Lake Water (p.p.m.)*
Calcium	1·00	21·00
Phosphate (P_2O_5)	0·04	0·46
Potassium	0·30	2·30
Nitrogen (NH_4)	0·70	0·96
Nitrogen (NO_2)	0·30	0·15
Magnesium	0·50	7·00
Sulphate	3·00	6·10
Chloride	5·00	19·00
Sodium	0·60	12·00

Where bog vegetation is dependent upon a mixture of rain and soil water any raising of the bog surface will alter the balance, until the surface vegetation becomes entirely dependent upon direct rain water. This leads to the formation of bog peat rather than fen peat with the resulting increase in dryness, acidity and poverty of mineral nutrients. The change in the type of peat formed becomes obvious when examining a profile consisting of fen and bog peat (Table 3).

Thus in fen peat because of the base rich conditions the production of plant material is probably greater, but the breakdown of carbohydrates and proteins and the subsequent utilisation of the end products by decreasing the organic content of the peat, increases its relative ash content, which is added to by mineral colloids and particles in suspension. In contrast, where acid conditions prevail, as in bog peat, the peat is often very fibrous and frequently has an ash content below two per cent of the dry weight. In both cases the nett result is an impoverished medium for plant growth.

Anaerobic, waterlogged conditions prevail with a resulting restriction upon microbial numbers and activity. This does not prevent the growth of plants and a type of microflora adapted to that environment, but it does prevent the growth of fungi, actinomycetes, and aerobic bacteria capable of rapidly decomposing plant residues. The obligate and facultative anaerobic bacteria favoured by these conditions are capable of attacking only some of the organic residues leaving the other constituents to accumulate. Thus on fen type peat bogs, fungi and aerobic cellulose decomposing bacteria are found at or just below the surface but they diminish rapidly. Actinomycetes are also found in abundance at the surface. The acid sphagnum bogs contain an abundant flora of acid bacteria, largely anaerobic, which increases with depth (Table 4).

TABLE 3

MINERAL CONSTITUENTS OF PEAT TYPES
(WALSHE AND BARRY)

(*a*) *Raised Bog* (*Bog and Fen peat*)

Depth cms.	H_2O %	*N* %	*Ash* %	*P* p.p.m.	*Ca* p.p.m.	*K* p.p.m.	*Decomp.* %	*pH*
0–20	94·25	1·58	2·8	15·50	4·0	205·0	14	4·60
20–50				6·24	4·5	106·0		
50–100	94·75	0·96	2·3	1·75	3·5	75·0	24	4·65
100–150	95·40	0·88	2·3	2·15	4·5	72·0	16	4·60
150–200	95·20	1·04	2·4	0·75	4·0	29·0	14	4·80
200–250	94·75	0·78	2·16	0·50	4·5	33·0	13	5·00
250–300	94·15	0·80	2·6	0·50	3·5	25·0	17	5·00
300–350	93·80	0·92	2·6	0·50	4·5	24·5	37	5·15
350–400	93·60	1·20	3·2	0·50	4·5	19·5	35	5·40
400–450	92·80	1·42	5·1	0·50	6·0	24·5	31	5·70
450–500	92·50	1·42	5·1	0·50	6·5	25·0	40	5·70
500–550	93·35	1·70	6·4	0·50	7·5	25·0	40	5·80

(*b*) *Blanket Bog* (*Bog peat*)

0–20	92·8	1·33	2·30	10·00	3·90	124·0	35	4·70
20–50				3·25	3·70	30·75		
50–100	93·4	1·44	1·60	2·30	3·60	36·00	42	4·70
100–150	92·7	1·12	2·46	0·50	2·60	36·60	43	5·00
150–200	92·4	1·08	2·70	0·50	3·00	33·00	44	5·00
200–250	92·2	1·08	2·70	0·50	3·00	39·00	45	5·16
250–300	91·4	0·98	2·70	0·50	3·00	31·30	53	5·26
300–350	91·2	0·70	7·70	0·50	2·30	27·00	55	5·20

TABLE 4

MICROBIOLOGICAL ACTIVITY IN TWO PEAT PROFILES
(WAKSMAN 1929)

(*a*) *Fen Peat*

Depth cms.	*Bact. and Actinomycetes*	*Actino-mycetes*	*Fungi*	*Aerobic Cellulose*	*Nitrifying Bacteria*	*Anaerobic Bacteria*
Surface	6,000,000	90	105,000	**	***	*
30	350,000	40	250	*	**	**
45	450,000	25	175	0	**	**
60	40,000	20	150	0	*	**
75	35,000	25	33	0	*	**
90	20,000	15	0	0	0	**
120	110,000	2	0	0	0	***
150	500,000	0	0	0	0	****

(*b*) *Acid Sphagnum Peat*

Depth cms.	*pH*	*H/O*	*Aerobic and Facultative*	*Acid resisting Anaerobic Bact.*
Surface	4·05	92·7	100,000	*
7·5–20	3·95	92·6	220,000	*
20–30	3·85	92·6	1,600,000	**
30–40	3·86	92·9	3,500,000	**
45–60	3·73	93·6	2,100,000	***
60–75	3·90	93·6	1,500,000	***
20–150	4·47	93·4	2,000,000	***

* Designates a few. ** a fair number.
*** abundance of micro-organisms. **** numerous.

Because of this restriction upon the microflora a one-sided decomposition is accomplished, the nature and extent of which is influenced to a large extent by the nature of the bog vegetation itself. The differences in chemical composition, shown in Table 5, illustrate this influence of vegetation upon the chemical composition of the resulting peat.

Probably a more important aspect of the nutrient status of peats is the availability of these nutrients to crops. In this respect, the solubility in barium acetate is one of the best indicators. On this basis it is found that all the potassium, two-thirds of the calcium and magnesium and only the inorganic phosphorus can be regarded as freely available. The inorganic phosphorus constitutes about one-third of the total phosphorus present. Perhaps the most surprising thing about the nitrogenous material in peat is its unavailability. The top layer of peat may contain 4,000 lb. of nitrogenous material per acre yet at any one time only two pounds or less may be available for plant or microbial growth (Table 6). The organic nitrogen in peat has its origin in plant protein, but during decomposition, is converted into various forms of microbial nitrogen and presumably by autolysis partly into residues therefrom. Several theories have been proposed to account for the apparent stability of this fraction, but it now seems that the unavailability is more apparent than real and is primarily due to the absence of available carbon to support a vigorous population of micro-organisms. Thus, while many groups of organisms are capable of utilising the

TABLE 5

ORGANIC CHEMICAL COMPOSITION OF PEAT TYPES
(WAKSMAN 1929)

Depth cms.	*Ether sol. Fraction*	*Hemi Cellulose*	*Cellulose*	*Lignin*	*Crude Protein*
(*a*) *Carex Peat*					
12	0·66	10·31	0	38·35	22·48
18	1·10	8·95	0	50·33	18·72
160–180	0·49	7·02	0	57·82	14·81
160	0·78	7·51	0	42·10	19·81
Lake-Peat	0·67	12·14	0	33·25	19·38
Bottom Peat	0·36	5·92	0	15·62	9·81
Woody Material	1·54	8·15	6·12	65·02	5·37
(*b*) *Sphagnum Peat*					
1–10	1·76	26·30	16·43	19·15	3·97
15–20	2·53	25·51	13·33	22·23	4·04
20–30	2·45	25·51	16·23	25·43	5·72
90–120	2·97	22·68	12·07	25·83	5·53
150–180	3·63	15·78	10·84	35·75	13·15
240–270	2·60	5·93	3·20	52·79	13·44
270–330	2·73	4·78	2·70	54·94	12·07

carbon of nitrogenous complexes, such organisms have not been isolated from or shown to exist in peat. Hence the indications are, that the incorporation in peat of decomposable material with adequate additional nitrogen to meet microbial needs in decomposition, causes some ammonia to be liberated from the organic nitrogen residues, that would not otherwise become available. This may well explain why true green manuring, i.e. ploughing under the immature vegetation, even in considerable amounts, rarely results in anything other than a transitory effect on the supply of available nitrogen. On the other hand plant residues of lower nitrogen content incorporated into peat may result in the liberation of a greater amount of available nitrogen than can be expected from the incorporated material alone.

TABLE 6

TOTAL NITROGEN IN LBS. PER ACRE
(VOZNYUK, S. T., ET AL.)

Depth (*cms.*)	0–10	10–20	20–30	30–40	40–50
Lowland Bog (Raised Bog and Fen)	4,404	4,017	4,570	4,833	3,419
Upland Bog (Blanket Bog)	4,783	4,572	4,332	4,783	3,890

The reclamation of peat for afforestation purposes presents many problems and from a microbiological viewpoint the most urgent is drainage. Any successful development of peatland for forestry purposes must be preceded by the establishment of an efficient drainage system, to remove excess moisture from the upper horizons of the bog. Excess moisture is itself not detrimental to plant growth, but the concomitant effect of very limited aeration adversely affects root metabolism and inhibits the activity of micro-organisms which play such an important role in the nutrient cycle. The depth and spacing of drains depends to a great extent on the nature of the peat, its permeability, and local climatic conditions. In general, where a bog has a large catchment area which brings in a large amount of soil water, the bog is subject to alternate flooding and drought. Mineral matter, carried in the soil water, forms a heavy gritty peat which sinks and allows the development of canalised water flow composed of streams running through the bog. The bog has therefore a low retentive capacity.

The hydrology of fens follows the same pattern, though the soil water may be greater in amount or richer in basic ions. Where, however, the catchment area is small and the bog is mainly dependent on direct rain water with low concentrations of minerals, Sphagnum peat is usually found. This forms a plastic colloidal peat, which floats because of the buoyancy of the Sphagnum hyaline cells and prevents any channelling of the water flow. Where these conditions are found the retentive capacity of the bog is in most instances of a high degree. This property in Sphagnum peat, together with high rainfall and humidity, necessitates an intensive drainage pattern.

Thus the results of experimental work indicate that if peats could be properly drained and then limed, the organic matter would be gradually decomposed with the liberation of ammonia. This ammonia would then be liberated to plants through nitrification, for while the acidity of peat is probably one of the factors hindering nitrification, the very wide carbon 1/1 nitrogen ration is undoubtedly the principal factor checking this process. With a wide C/N ratio the micro-organisms use up most of the available nitrogen and store it in their protoplasm, therefore little is liberated as ammonia. When lime is added and the moisture content of the peat brought to agreeable proportions, conditions are made favourable for the activity of aerobic bacteria and actinomycetes and, since bacteria can get along with less nitrogen per unit of carbon consumed as energy than fungi, more nitrogen will be liberated as ammonia. With the improvement in aeration and a more favourable reaction due to liming, nitrification will take place, though it may be advantageous to inoculate peats with a suspension of fertile soil as occasionally nitrifying organisms may be entirely absent. Upon draining and liming the actinomycetes become active also. Since these are thought to be the chief agents in the decomposition of the *x* fraction of organic matter and they are hindered by anaerobiosis and acidity, little decomposition of this fraction can occur under the conditions normally found. This leads to the accumulation of lignins and nitrogenous complexes (Table 5). The effect of drainage and liming upon microbial numbers is shown in Table 7 and the importance of the presence of a vigorously active microbial population will be realised when one considers that micro-organisms are involved in practically every process which takes place in the soil. Not only are microbes involved in the breakdown of organic matter but they also play an important role in such complex cycles as the nitrogen cycle, the carbon cycle, and the transformation of phosphorus, potassium, manganese, sulphur, iron, zinc, copper, molybdenum, cobalt, boron, arsenic and selenium.

It now seems, however, that the addition of nitrogen salts and phosphates have practically no effect upon the rapidity of decomposition of peat because available energy and not nitrogen is the limiting factor. However a need for phosphate has been established, and a very strong positive interaction between nitrogen and phosphate has been noted. This holds true for both undisturbed bog surfaces as well as ploughed and drained peats. Some doubts have been raised as regards the advisability of using superphosphate on peats because of its possible reaction with ammonia. If superphosphate absorbs ammonia, a mixture of ammonium and calcium phosphates is formed, much of which is soluble. However it may be that this takes place more readily at a very low pH (3·0) and low calcium concentrations, but not already at a pH of 5·0 and relative abundant calcium concentrations.

TABLE 7

NUMBER OF MICRO-ORGANISMS IN SOILS OF DIFFERENT MOISTURE CONTENT AND pH
(WAKSMAN, 1922)

Time of Incubation (Days)	*No. of Micro-organisms per gram of Soil*		
	Waterlogged	*Drained*	*Drained and Limed*
26	1,050,000	1,935,000	233,250,000
61	533,000	1,963,000	193,624,000
88	680,000	1,450,000	143,650,000
116	415,000	1,545,000	136,725,000
150	652,000	1,760,000	49,650,000
181	1,012,000	2,796,000	22,600,000
239	910,000	2,825,000	60,330,000
291	995,000	3,320,000	101,833,000
Averages	781,000	2,199,000	117,708,000

Thus it has been clearly shown experimentally that for successful establishment of plantations on peat some form of drainage and an application of phosphate is necessary. No long-term experiments with other fertilisers on peat have been reported; but it is clear that although nitrogen, potassium, and other nutrients may not be limiting factors, applications of these will give beneficial results and they may become limiting as the plantations become older because of storage within the trees. In fact there is considerable evidence that calcium and potassium deficiencies do occur in older trees. It also seems that occasional or even annual top-dressings of phosphate are necessary even where plantations have been treated at establishment. Since as far as is known at present all the coniferous species are likely to give rise to raw humus on base-poor peats, the supply of mineral nitrogen is likely to be low, and mineral nitrogen supplied as fertiliser is likely to become unavailable when it has been taken up by the trees and returned to the soil as litter. Applications of nitrogenous fertiliser appears to be necessary also in established plantations.

The position then is that phosphate manuring, combined with other recent advances in forestry practice, results in the establishment of plantations on even the worst sites. A greater understanding of the processes of plant nutrition and the increasing appreciation of the microbiological and biochemical principles involved give confidence that the level of fertility of peats can be improved sufficiently to make afforestation of these lands a practical and profitable undertaking.

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TARIFFING OF THINNINGS

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The following notes have been prepared as a guide to the implementation of the practical aspects of thinning control using the tariff system in conjunction with the new thinning densities as laid down in the Working Plan Code (W.P.M. 13).

Preparation

A sample area is marked to enable the team to put in a circular 1/10th acre plot (a 1/10th acre plot is a convenient size, 37 ft 3 in. diameter and easy to put in giving a reasonable number of marked trees), i.e. a minimum of nine marked trees. To arrive at the correct density at which to mark the crop, the following information is required from the plot:

(1) Measure the B.H.Q.G. of the largest marked tree and multiply by four.
(2) Measure the B.H.Q.G. of the smallest marked tree and multiply by six.
(3) Add both multiplications together and divide by ten to get the mean B.H.Q.G. for the plot. (Or measure all marked trees in the plot to arrive at the mean B.H.Q.G.).

The tariff number can be obtained using the following method:

(1) Find out age of crop.
(2) Use Yield Class for compartment by species (from Form W.P.1 or by measurement of top height).
(3) Look up Table 13, Thinning Control in Forestry Commission Booklet No. 16 (Forest Management Tables).
e.g. N.S. age 30 years Yield Class 120—Tariff Number 21
S.S. age 30 years Yield Class 140—Tariff Number 22

Having obtained the mean B.H.Q.G. from the plot and the Tariff Number using the method described above, look up Tariff Tables (Forest Record No. 31) and read off the mean hoppus ft per tree.

e.g. mean B.H.Q.G. 4 in. Tariff Number 22=1·84 h.ft.
mean B.H.Q.G. 6 in. Tariff Number 24=5·45 h.ft.

Now assume that you are thinning a crop of D.F. Yield Class 160, age 33 years on a three-year rotation.

70 per cent of 160=112 h.ft which represents the percentage of the increment that can be removed per net acre in one year. As you are working on a three-year cycle you remove $3 \times 112 = 336$.

Plot Data

Largest B.H.Q.G. marked in plot 9 in. ×4	=36
Smallest B.H.Q.G. marked in plot 4 in. ×6	=24
(or a mean of all trees in the plot)	60=6 in. mean B.H.Q.G.

Look up Table 13 on thinning control in Forest Management Tables.

D.F. Yield Class 160, age 33 years=Tariff Number 28.

Look up Tariff Table 6 in. mean B.H.Q.G. Tariff Number 28=6·35 h.ft per tree.

=53 poles per acre (approx.) to get your 336 h.ft.

The number of plots you have to put in will depend on the variability of the crop. A minimum of 5 in an even crop, 10 in an uneven crop.

The Actual Tariffing

Method

Several methods of marking and tariffing have been used, e.g. different number of men and supervisors marking and tariffing separately, felling of sample trees as a separate operation etc. The following method has been proved the most efficient and economical:

> A team of three skilled forest workers marking and tariffing (including felling of sample trees) in one operation—one man booking, the other two marking, each man taking turns with the booking.

Having put in sufficient plots to find out the number of trees per acre to remove (this can be checked as one goes along) tariffing can now commence.

For this we require a minimum of 200 girthed trees and 20 sample (felled) trees.

As we know beforehand the number of marked stems per acre to be removed it is easy to choose the correct sampling fraction by multiplying the number of marked trees per acre by the number of acres to be marked. 53 marked trees per acre to be removed, 40 net acres to be marked$=53 \times 40=2{,}120$ trees in compartment, which means that every 10th tree has to be girthed and every 100th tree has to be felled. (Any trees to be felled for extraction tracks, working bays etc. should be marked before tariffing is commenced and they should be incorporated in the tariff).

For record purposes a volume for thinning is required from each compartment tariffed. Where the stand permits a single tariff may encompass more than one compartment, a separate tariff sheet will be required for each compartment under these circumstances, but only one series of volume sample trees need be kept (on steep slopes it may be necessary to make more than one tariff to take account of the range in height growth between the top and bottom of the slope).

Marking

Trees of under 2^2 B.H.Q.G. are booked separately and recorded as rails or unmeasureable trees, on Part A of the tariff form S.15 (these should preferably be marked differently to trees of over 2^2 B.H.Q.G. for identification purposes). Each marked tree has to be blazed on two opposite sides, the area marked in such a way that you can see the blazes on the trees you have already marked.

Keep the blaze marks below 4 ft 3 in, if this is not done it affects the B.H.Q.G. on girthed and felled trees.

Having marked a tree the marker shouts "POLE", the booker replies "POLE".

Girthed Trees

If the tree is one to be girthed the booker replies "MEASURE" and the tree is scribed at 4 ft 3 in. and measured, the marker replying the B.H.Q.G. and scribing the B.H.Q.G. on the tree above the B.H.Q.G. mark.

Measure

There is only one way of doing this with consistent accuracy and that is to use a rod with a scribe fitted at 4 ft 3 in. The rod should be placed firmly at ground level except when trees have been planted on turfs. Measure from root collar. Scribe the tree at 4 ft 3 in. and measure, scribe the size above the B.H. mark on the tree. The Q.G. tape should be drawn firmly around the tree, always ensure that it is horizontal and never use a badly worn or stretched tape. When on a slope measure the B.H.Q.G. on the upper side of the tree. On a leaning tree measure the B.H.Q.G. on the lower side of the tree and always ensure that the rod is placed firmly at ground level.

If there is a whorl at 4 ft 3 in. measure above and below and take a mean B.H.Q.G. indicating that you have done so by putting a scribe mark at each of the two points girthed.

If the tree forks at 4 ft 3 in. treat as one stem and girth the narrowest point below the fork.

If the tree forks below 4 ft 3 in. treat as two separate trees, blaze accordingly and call each "POLE" to the booker.

If a tree forks above 4 ft 3 in. treat as one tree and girth at 4 ft 3 in.

Sample (Felled) Trees

When the booker replies "SAMPLE TREE" it should have the B.H.Q.G. measured and recorded on Part C of the tariff form as for each of the girthed trees, but put the scribe mark around the whole circumference of the tree. Having done this the booker will give the tree a number which is scribed on the tree.

NEVER leave the B.H.Q.G. measurement until after the tree has been felled.

The tree should be felled as close to the ground as possible (trimmed), snedded out and the 3-inch top diameter over bark point measured with a 3 in. gauge and scribed on the tree.

Measure the length from the butt to the 3 in. T.D.O.B. point with a tape and round down to the nearest foot. Indicate this point with an arrow.

Identify the Mid Quarter Girth point, scribe it clearly and measure.

If it comes on a whorl, measure above and below and get a mean M.Q.G. Indicate the points you have actually measured with scribe marks.

If the tree forks near the top, trace the longest limb to the 3 inch diameter O.B. point.

If the top is broken in felling below the 3 inch diameter O.B. point, make the correct allowance.

If a sample tree forks below 4 ft 3 in. treat the appropriate fork as a single tree, ignoring the common butt in the volume estimation.

If the sample tree forks at 4 ft 3 in. or above 4 ft 3 in. it will be necessary to calculate the volume of each section separately and add them together.

If the stem curves, measure the length along the inside of the curve.

Trees of 2^2 B.H.Q.G. are recorded as sample trees, but are not used in the tariff calculation. There is therefore no need to fell them, but they should be suitably marked (to enable them to be found again if necessary) and have the number scribed on them.

If on measurement the M.Q.G. and B.H.Q.G. are the same for a tree of over 8 ft in height, re-check, as very few trees are cylindrical.

Before you leave the tariffing area, make sure you have all the sample trees noted down.

Check any other anomalies on the ground, abnormal volumes, heights, girths etc.

e.g. If a tree is 8 feet or less in timber height the M.Q.G. and B.H.Q.G. will be taken as the same figure (B.H.Q.G.)

Identification of sample trees should be good to enable a tariff re-check to be carried out when necessary.

(1) Tree number should be clearly scribed near the butt in Arabic numerals.

(2) Length and M.Q.G. should be scribed above the tree number in Roman figures.

(3) The B.H.Q.G. SHOULD be marked at time of measuring before the tree is felled.

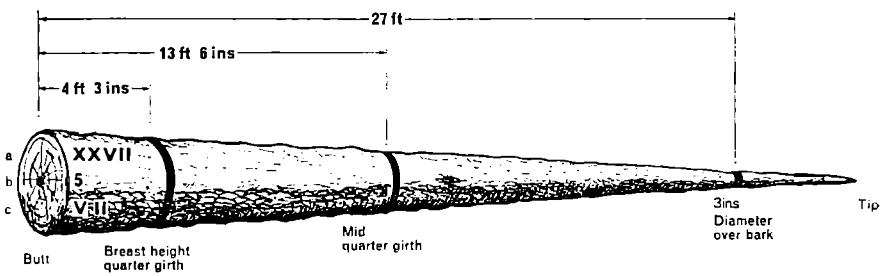

FIG. 2. Standard measurements and scribe-marking conventions for a sample tree. Bold lines indicate scribe marks.

Key to entries on butt-end of log:

a—length in feet; scribed in Roman numerals (i.e., 27 ft).

b—serial tree number, scribed as an Arabic numeral .

c—mid quarter-girth, scribed in Roman numerals (i.e., $5\frac{1}{2}$ in.).

Office Work

The tariff calculation.

Complete section D; if a tree volume falls exactly between two tariff numbers take the lower number.

The mean tariff number for the compartment must always be rounded down.

Complete section C taking column 6 to the nearest number; if you get exactly ·5 round down.

Complete section A under species and total.

Assume that your addition and multiplication are poor, check it, and if possible, get some other person to re-check.

PROBLEMS AND REWARDS IN PROCESSING AND STORING SEED

By G. BUSZEWICZ

Head of Seeds Section, Research Division, Alice Holt

The Forestry Commission of Great Britain during nearly 50 years' work has planted over 1·5 million acres of land and it is estimated that about 500 tons of seed were sown to produce the planting material for this work. A great majority of this seed was imported and the following list shows the primary sources from which seed supplies of the main species have been obtained:

Country	*Species*
Western Canada and U.S.A. including Alaska	Douglas fir, Sitka spruce, Lodgepole pine, Western hemlock, *Abies grandis* and *Abies procera.*
France (Corsica)	Corsican pine.
Germany and Austria	Norway spruce.
Switzerland, Austria and Germany	European larch.
Japan	Japanese larch.
Home sources	Scots pine, Corsican pine (in part) and hardwood species (in part).

When processing this seed care was taken to ensure that it had been collected from good stands and similar climatic regions to that of the area where the trees were to be planted. This, however, was not an easy task especially in the time before the second world war when many people considered it far-fetched even to think about controlling the quality of the forest tree seed. During the last two decades the situation has changed rapidly and radically and among the forestry practices that have been intensified is the large-scale production of the best possible seed.

This work is in progress and at the moment we have over 7,000 acres of registered seed stands and nearly 200 acres of seed orchards. The seed stands are an intermediate measure and devised only to yield a marginally superior seed up to the time when the seed orchards will be fully productive.

These sources and their annual production are recorded in a central register maintained in the Seed Section at the Forest Research Station. Every year, well in advance of the seed ripening, the crops of the most important species and sources are assessed in order to evaluate the crop and plan the seed procurement programme. To ensure the success of this one must apply the most advanced knowledge and techniques in seed collection, extraction, processing, testing and storing. The Seed Section at the Commission's Research Station is the centre of seed supply for the whole country and is well equipped to meet these requirements.

Seed collection from the Registered Sources is increasing every year, but still the greater part of requirements must be imported. This is because most of our plantations and especially seed orchards are too young to bear much seed. Here again every effort is made to ensure that the imported seed originates from the more suitable provenances.

As the result of Commission initiative the problem of seed certification is being tackled by O.E.C.D. (Organisation for Economic Co-operation and Development). Progress is promising and one can expect that in the near future there should be an internationally recognised scheme for controlling and certifying the seed origins of forest trees on similar lines to that for some agriculture crops.

The timing and methods of collection require continuous attention. If the seed is collected when ripe there is a better chance of obtaining seed of good germination and keeping qualities. The best time for seed collection varies for each species, from season to season and place to place.

Forest tree seeds, and especially conifer seeds, are collected from standing trees. Here the collectors must climb the trees and detach the cones by picking, cutting or knocking them off. This work is very expensive and amounts to over 50 per cent of the seed market value. Sometimes felled trees provide a cheaper source when the felling coincides with ripening of the seed. Here, however, one must watch that the seed is collected from the best trees.

The amount of seed which can be collected from one tree varies widely between species and years. It depends mostly on weather, but the age, size and health of the trees are also very important factors. Heavy rainfall, late frost or heavy winds can reduce pollination much below normal. Most forest trees bear seed in cycles. A good crop may occur at intervals of 2–10 years depending on the species. Between good crops the trees may produce only small amounts of seed or fail completely to do so.

After collection the seed extraction takes place which consists of a chain of processes: fruit/cone drying, seed extraction, dewinging, cleaning and grading. Each stage may require a different technique according to species. All these processes must be carried out with care and a good knowledge of seed physiology to ensure that the seed is not damaged.

Seed storage is generally defined as the preservation of viable seed from the time of collection until they are required for sowing. Under this broad definition seed extraction and cleaning are rightly included as they may affect seed keeping quality as much as, or more than, the condition applied in the store itself. The rate of aging or deterioration of seed in store is affected mainly by seed moisture content and by temperature. An increase in storage temperature and humidity increases seed respiration rate and destructive metabolism, thereby depleting reserves and decreasing seed longevity.

Seeds have a definite affinity for moisture and can absorb water from the air, thereby increasing their moisture content. When stored the seed must be kept dry either by controlling the relative humidity of the storage atmosphere or by sealing the dried seed in a container that will prevent absorption of the moisture. The latter is generally employed as being the most practical.

Evidence from many storage experiments has shown that good conditions for prolonged storage of our main conifer seed involve a moisture content in the range of 6–8 per cent and temperature in the range of 32°–40° F. (0°–5° C.). This is sufficient for storage up to 5–7 years but for still longer periods of storage sub-freezing temperatures must be considered. Temperatures exceeding 40° F. (5° C.) should usually be avoided since respiration and the rate of destructive metabolism increases rapidly above this level.

Sound forest management is dependent on the organisation of a regular supply of good quality seed. Due to irregular seed crops the seed storage is a practical necessity. Knowledge of good storage methods is of great economic importance as, properly applied, it can ensure building-up seed stocks in good seed years when prices and collection costs are low and seed quality is high.

The Forestry Commission central refrigerated store consists of three chambers of which two have a constant temperature of 36° F. (+2° C.) and one a temperature of 20° F. (—5° C.). The volume of each chamber is about 2,500 cu. ft. The higher temperature is used for the main bulk of seed which is stored for periods not exceeding 4–5 years and the lower temperatures for seed which is kept for longer periods and for seed of the more difficult species such as *Abies*, *Tsuga*, *Thuia* etc.

Each chamber is equipped with two thermostats, one being set for the desired temperature and the other set 5° C. higher and connected with an alarm bell to indicate any trouble with the controls of the first thermostat. Moreover each chamber has a 7-day recording thermometer of "Cambridge" type.

The seed is stored in tin-plate cans (9¼ in. × 9¼ in. × 14 in.) with a handle and a lever lid of 6 in. diameter. These cans are used with a 500 gauge polythene-bag liner to provide an inner sealed-container as a safeguard against undetected rust, pinholes or other damage to the cans. The capacity of one can is from 8–20 lb. according to species, i.e. seed size and density. These containers are stored on especially provided racks and each chamber can accommodate over 700 cans.

All seed lots on arrival are first tested for moisture content and if the seed is too moist for storage it is passed through a seed drier. This machine has a capacity of about 200 lb. and functions by forcing a large flow of warm air through a static column of seed. The system consists of a large air-flow of some 200 c.f.m. at a relatively low air temperature of about 35° C. It takes approximately one hour to reduce the moisture content of 200 lb. of seed by one per cent. Larger seed consignments are dried in the kiln normally used for opening the cones.

When the moisture content is at the correct level the seed is mixed to ensure homogenity. A homogenous seed lot may be defined as a quantity of seed that is reasonably uniform throughout its parts. Factors considered in this respect are purity, germination and moisture-content percentages. Experience has shown that many seed lots have inadequate homogenity after extraction and cleaning. Moreover, to reduce work in recording sampling and testing, certain categories of seed from different origins are mixed to produce larger uniform lots.

The machine used for seed mixing is of the conventional vertical type as generally used in agriculture for mixing seed and foodstuffs. The capacity of the mixer is from 700–1,000 lb. according to seed density. Tests have shown that the machine is safe and effective and mixing can be completed in three minutes.

After drying and mixing, the seed is ready for long-term storage. When in store, the seed qualities (purity, germination, moisture-content) are checked periodically, at least once per year. For this purpose representative small samples are taken from random cans and analysed in the seed testing laboratory. After completion of the analysis the results are reported to the seed store and then the seed is ready for dispatching. The nurseryman is always informed about the results of the last analysis and therefore he is able to adjust his sowing density accordingly.

Realistic forecasting of seedling yields from seed sown is of great practical importance and is a basic requirement in good nursery management and in planning sowing programmes. Until quite recently the standard practice in the Forestry Commission was to regulate sowing purely on the basis of germination capacity per cent. This simple procedure took no account of the large variation in seed size and purity and the effect of these factors on the number of germinable seeds per lb. For example, what is the value of a statement of germination per cent alone on species such as Scots pine when the number of seeds per lb. may vary from 50,000–120,000? Because of this variation all Forestry Commission seed tests results are now expressed as the number of viable seeds per lb. which takes account of variation in purity, seed size and germination per cent. In order to give the nurseryman this information the Seed Laboratory must perform an extra test for determining the weight of a sample containing 1,000 pure seed and then, when the germination test is completed, calculate and report the number of viable seeds per lb. This figure gives a valuable estimation of the potential seedling production per lb. and serves as a starting point for calculation of seed requirements and sowing densities. The basis for ordering seed and planning the sowing programme is "effective lb." which contains a stipulated number of viable seeds. The number being that contained in one pound of normal quality seed.

The refrigerated store and seed procedures as described above have been in operation for nearly 10 years, and are having widespread effects on seed economy as shown in Table 8 below:

TABLE 8

CONIFER SEED SOWN AND PLANTS PLANTED

Year	*Seed, lb., Thousands*	*Plants, Number, Million*
1955	16·4	94·6
1956	17·6	99·6
1957	16·2	100·9
1958	14·4	113·8
1959	10·5	117·5
1960	11·1	106·8
1961	7·6	113·8
1962	7·6	117·5
1963	6·5	104·8
1964	5·5	106·5
1965	5·4	97·2
1966	4·6	92·5
1967	2·3	—

One can see that over the last decade the amount of seed sown each year has decreased by about 12,000 lb. without any substantial changes in the planting programme. A straightforward calculation reveals that when in 1956 over 20 good seeds were required to raise one plant this is done now with about three seeds only.

The market value of 12,000 lb. of seed is well in the range of £120,000. This is a considerable sum and approximates to a saving of about 25s. per 1,000 plants raised. This is not however the full story and one must mention here also that a lesser area of seed sources are required, and home collections can more easily meet our seed requirements.

THE GORSE IN FLOWER

"When the gorse is not in flower kissing is out of season."
Old Country Saying

When briar haws are crimson and beech leaves russet brown,
  And old man's beard is fluffy and acorns clatter down,
When woods are dim and misty, reflecting autumn's gloom,
  There's colour in the hedgerows for the gorse is now in bloom.

When trees bend low in winter as winds blow half a gale,
  And the air is chilled and frosty with showers of snow and hail,
When clouds are low, and blizzards obscure the sun at noon
  The drifting snow has a golden glow as the gorse is still in bloom.

Primroses flush in April and cowslips early May,
  And rarer plants like orchids aren't spotted every day,
But all along the valley from September until June
  At any hour you'll find the flower of gorse with yellow bloom.

For colour choose a dahlia, for perfume take a rose,
  I live on peat at a thousand feet where a blossom seldom shows,
But around my garden borders amongst mountain ash and broom
  And bright and gay on the dullest day is dwarf gorse in full bloom.

R. J. JENNINGS.

HISTORY

A MESOLITHIC CHIPPING-FLOOR IN THE RHONDDA FOREST

By ARTHUR C. HAZZARD
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The planting of Craig-y-Llyn, the highest mountain in Glamorgan, by the South Wales Conservancy of the Forestry Commission has added very substantially to the knowledge of prehistoric archaeology in Wales. What emerged was, in fact, the first known Mesolithic site of the interior of Wales, dating from 6,000 to 4,000 B.C.

Situation

Craig-y-Llyn (Rock of the Lake) reaches 1,969 feet above sea-level. It is a bold Pennant Sandstone escarpment with its northern scarp slope falling precipitously to the Upper Vale of Neath and enclosing two glacial lakes, Llyn Fawr and Llyn Fach. These north-facing slopes around the lakes comprise part of the Rhigos Block of Rheola Forest. The lee slopes of Craig-y-Llyn enclose the sources of the Rhondda Fawr, Rhondda Fach, Corrwg and Afan rivers, and fall in wide-spreading, molinia-covered moorlands to the upper reaches of these valleys. All these valleys are very deeply entrenched except the Rhondda Fach, the easternmost, which forms the catchment area of the 242 million gallon Lluest-Wen Reservoir above Maerdy.

The summit of Craig-y-Llyn is marked by the cairn of Carn Moesen, below which rises the highest headstream of the Rhondda Fawr River—hereabouts called Nant Carn Moesen. A mile to the eastward runs the A.4061, the highest classified road in Wales, connecting the Rhondda Valley at Treherbert with the Vale of Neath at Rhigos. Between Carn Moesen and this road are the P.65 areas of the Rhondda Forest, site of the Mesolithic chipping-floor.

The site, besides being one of the finest view-points in South Wales, is the most exposed in all mountainous North Glamorgan. Its annual rainfall, measured at nearby Lluest-Wen Reservoir, reaches treble figures quite frequently. The year 1965 was a typical example, with 108·25 inches, out of which 32·51 inches fell during the month of December! There were 7·96 inches in the first thirteen days of January, out of which 2·65 inches fell in a period of eight hours on Wednesday 13th. Rhondda Forest workers remember the year quite well . . .

Prehistoric Environment

Hardly, one would think, a desirable residence for prehistoric man. A more detailed look at conditions following the final retreat of the ice, however, reveals the significance of the site. During Boreal times (up to about 5500 B.C.) there was a great advance of forest growth from the European continent into Britain. During the subsequent Atlantic phase, when Britain finally became an island, the climate was warmer, wetter and probably milder and less windy than at present, and the new forest growth would not be as prolific on these heights as in the sheltered valleys. Mesolithic hunters, fishermen, trappers and food-gatherers here had a region of lakes (one close by at Ffos Ton Cenglau below the site of the finds has long since silted up) and easily penetrable forest on a ridgeway commanding the surrounding countryside. Wood in plenty in the new forests enabled Mesolithic hunters to live in huts and tents—of a variety of kinds in different areas—whereas Old Stone Age dwellers were forced sometimes to use mammoth ribs to cover their underground lodges. The bow became the major weapon, using not only the familiar pointed arrows, but also chisel-headed arrow points and blunt-headed wooden arrows for stunning birds or small game without damaging the pelt. Dogs were used in hunting, the canoe came into existence, nets and fish-traps were used.

The first vague intimation of the archaeological importance of our Rhondda mountain-top site came in 1961 from chance finds of flint microliths (tiny blades originally set in wooden shafts) on an eroded track connecting A.4061 with the Rheola Forest plantations, and following roughly the very ancient ridgeway track here called Cefn Ffordd. These finds were made by Mr. David John Price, a retired Council roadman, who (under the more homely name Shon Price) has since become one of Wales's foremost amateur archaeologists and a valuable observer for the National Museum of Wales at Cardiff. The subsequent acquisition of this area by the Forestry Commission, its incorporation into Rhondda Forest and its ploughing and planting in 1964 and 1965 gave a fresh impetus to the search. Before this, however, the site had already become the scene of two small trial excavations.

Examination and Finds

The first of these trial digs was in the autumn of 1962, directed by Mr. A. D. Lacaille, former curator of the Wellcome Museum in London, and the second in the summer of 1963 directed by Dr. H. N. Savory, Keeper of the Department of Archaeology at the National Museum of Wales. The object was to establish the position of the flints in relation to the peat layer and the underlying soils, and the extent of the activity represented by the scattered finds made along the trackway by Mr. Price. It had been hoped that the density might increase down-slope south of the trackway near the margin of the now peat-filled Ffos Ton Cenglau lake—since fishing in this lake might well have been important to these Mesolithic communities. Charcoal, many fallen branches of birch, and stumps were found under four feet of peat, suggesting the margins of the lake were tree-covered when the Mesolithic flints were in use nearby. The whole area, before the present planting, was absolutely treeless by the mid-twentieth century.

The site of this Ffos Ton Cenglau lake is now preserved unplanted, the forest fence-line following the skilfully-contoured cross-ridge dykes of Ffos Ton Cenglau and Ton Caerau, themselves protected ancient monuments of a later era. The ploughing for planting within the forest area, however, revealed a wealth of flint and chert, the Rhondda Forest workers having been alerted to the possibility of these finds and responding admirably to the challenge. The finds included tanged and barbed arrow-heads, scrapers, knives, drills and points, harpoon-barbs, microliths and micro-burins, hollow-scrapers, convex and thumb scrapers, a well-made spear-point and two hand-axes, as well as unworked flint nodules, cores etc., and a quantity of chippings. Missile-stones and anvil-stones of limestone, and a number of red sandstone pounders, hammers etc. were found in conjunction with the flint implements.

The culture represented by the flints is the Sauveterrian of south-east European origin.

HISTORICAL ACCOUNT OF THE FORESTS OF ARGYLL

By ALEX M. MACKENZIE

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Very little is known of the forests of Argyll in primeval or even in historic times and their story is as shrouded in mystery as are the monoliths and rock markings around Dunadd, once the centre of the ancient kingdom of Dalriada.

Looking over the *Moine mhor* from the ancient fortress rock of *Dunadd* it needs very little imagination to see as in a dream the form of ages pass away and to visualize the successive waves of settlers in these parts.

First of all were the megalithic builders of the early Bronze Age, then the Irish Scots who settled about the middle of the third century followed by a second and larger colonization in A.D. 498 when the three sons of Erc, High King of Ireland—Fergus, Loarn and Angus—came to augment the settlement and extend the kingdom into Lorne, Knapdale, Kintyre and Mid-Argyll.

The main theme of the pageant thereafter is one of conflict between the colonists and the Picts to the east of Drum-Albyn and the Britons of Strathclyde until in 843 Kenneth Macalpin, King of Dalriada, became king of both the Picts and the Scots and left Dunadd for a new capital in Central Scotland.

Although each successive settler and visitant must have affected the future or derived some impression of the forests yet only scanty reference is made to them in literature and song. Claudius Ptolemy's "Tabula Brittaniae" of A.D. 150 places Caledonia Sylva imaginatively in a part of the country which might be associated with Argyll.

Another account gives that "The impenetrable forest of Calydon extended all over Argyll, its terrible depths peopled by wild bulls, boars, bears and wilder Britons formed an impassable barrier even to the invincible legions of Rome. In the peat masses which cover so large an extent of the western isles roots of forest trees are found in the position in which they grew 5 or 6 feet beneath the surface of the super accumulated moss. On a steep rocky bank by the house (Ardlussa, Jura in 1861) stands a most venerable witness to this fact in the presence of a hollow-hearted old oak tree 21 feet in circumference although very dwarfed in height. A great deal is dead but some boughs yet have leaves. This tree is reputed to be more than 1,500 years old".

In the 13th century Conan of Glenorchy gave the monks of Lindores abbey in Fife the right to take dead wood and hazel from the wood of Glenorchy. To avail themselves of this concession would have given the monks a round journey of nearly 150 miles but doubtless they prized the resinous fir for lighting and the withies of hazel for creel and basket making.

The *Black Book of Taymouth* says that Sir Duncan Campbell of Glenorchy "caused make parks in . . . Glenorchy and caused sow acorns and seed of fir therin, and planted in the same young fir and birch in anno 1613 and 1614". He also ordered penalties for destroying trees, and influenced his tenants and others to plant yearly three or six trees of, oak, ash or plane (sycamore) and made it an offence to carry out muirburn without six honest neighbours being present.

There are records of the Earl of Lauderdale and the Marchioness of Hamilton obtaining pine seed from Campbell of Glenorchy about 1637. In 1684/85 the Marquis of Atholl's men cut the growing wood in Glen Aray on the property of Campbell of Argyll, and carried back to Atholl large numbers of young trees including hollies, "silver and Spanish firs, pinasters", and others, for which the sum of 16,000 pounds Scots (£1,336 sterling) had to be paid in later compensation.

The treeless condition of Mull in 1773, when Dr. Johnson visited it, roused him to jibes.

His oak stick had disappeared and nothing could persuade him that it had not been stolen. "Consider sir", he said, "the value of such a piece of timber here".

The true position is likely to have been midway between these extremes of eulogy and disparagement for it would have been difficult to assess the woodland of the country by conjecture or by merely travelling along its bridle paths.

Deirdre when taking leave of Glenetive her bridal home, sings "Dearest Alban land o'er yonder thou dear land of wood and wave" while Macphail in the "Isle of Mull" praises the "Coilltean Uaine" or green woods of the island, which the exile longingly recalls.

Still, from the scanty records of the past and from the present field observations, it can be assumed that much of the land below 2,000 feet must at one time have been clothed with Sessile oak, ash, birch, hazel, rowan, holly and juniper with alder and willow in the wetter hollows.

This infers that the stable climatic climax is hardwoods of the above species together with Scots pine to a lesser extent on the morainic mounds and gravels.

The writings of John Smith, one of the ministers of Campbeltown, in 1798 in his *General View of the Agriculture of the County of Argyll* give a very comprehensive picture of forestry conditions at that time. He states that: "Even so late as the commencement of the present century (1700) the woods in this county, though then sufficiently reduced in quantity, were held to be of so little value, especially in the inland parts of it, that a large fir wood in Glenurchay was sold . . . for . . . no more than a plack (or one-third of a penny) per tree."

His estimate of the area under natural woodlands was about 30,000 acres.

Although Scots pine was subsidiary in distribution to the hardwoods its qualities were widely recognized, for Smith records: ". . . the quality of this fir is so excellent as not to be surpassed by any in the world. Some of this wood after it has stood above 300 years in the roof of an old castle (Kilchurn) in Glenurchay, when taken down some years ago, was fresh and full of sap as new-imported Memel (fir), and part of it actually worked up into new furniture".

Smith also indicates that pains were taken by some landowners to enclose their woodland areas and run them on a coppice rotation. Selective thinnings were carried out by some owners but "others leave it to nature and allow the stronger plant to destroy the weaker".

Smith shows remarkably good sense in questions of silviculture and management. He suggests that the areas of coppice be divided into 20 lots and one of these be cut each year. He was not altogether in favour of coppicing and made an earnest plea that the stems might be left till maturity. "To cut corn in June", he says, "would be almost as wise as to cut oak in coppice".

He advocates enclosure of existing natural woodlands and maintains that if these areas be planted ". . . the brushwood will prove an excellent nurse to young plants by giving them shelter . . . after which they will destroy the brushwood by excluding the sun and air from it, and reduce it to a manure which will help their growth". He further suggests that only waste ground capable of improvement should be planted and no meadow-land or good pasture should be used for this purpose.

The disappearance of the vast areas of natural woodland, he thought, had been paralleled by a change in the severity of the climate. "To provide shelter for sheep and cattle is," he states, "a matter of great moment" and goes on "It is now a matter of astonishment to the inhabitants of this county to find in some parts of it, the traces of corn ridges covered with heath so high in the hills that no corn could grow there at present. This shows how much warmer the country was when mantled over with woods and forests. An annual fair has for many generations been held in Glenurchay on the 8th day of March (Old Style) and some old men who died at the beginning of this century (1700) used to tell that when they were boys and living in Bocard, one of the highest farms in the parish, it was always a mighty dispute who should on this great occasion stay at home to keep the sheep out of the springing corn. But there nobody now would venture to sow corn so early. The country is bared of its woods, and the climate is changed."

In 1752 the first Iron Smelting furnace was established at Bonawe on Loch Etiveside. In those days, when smelting was done using charcoal, it was found to be more economical to transport the heavier commodity (iron ore) to the source of the more bulky commodity (wood). Acts of Parliament forbade felling for this purpose in England and the English turned their eyes north. As a result, furnaces were established at no less than 14 points in the county of Argyll and iron ore imported by sea from England for smelting. The remains of these furnaces and the charcoal pits built in the forest are still to be seen, especially along Loch Etiveside. Smelting continued until 1874 when the last furnace at Bonawe closed down. Coke had been used for smelting since 1754, but the increasing demand for iron and steel, coupled with the superior quality of the charcoal iron, enabled the charcoal furnaces to compete with the coke burners for a hundred years.

It was estimated that one ton of iron ore required five tons of wood (as charcoal) to reduce the ore to pig iron. In 1788 the furnaces of Goatfield and Bonawe between them produced 1,400 tons of pig iron which would indicate that the available wood must have been considerably more than there is today.

In a report of 1811, James Macdonald was sufficiently incensed to write, "The destroying of wood in every shape, or even inattention to the preservation of it, ought to be severely punished by persons of influence in this country. No transgression indeed, short of robbery and murder, is attended with more pernicious consequences to a country so destitute of wood; and every friend and benefactor of it, must not hesitate to act with the utmost rigour in a case of such pressing necessity".

In the course of the early fellings for charcoal, it had been realized that the natural woodlands could not meet the demands of the furnaces, and the woods were put under a simple system of management running them on a coppice rotation of 20 years. The timber was usually peeled of its bark and this bark was sold to the tanning industry. Records show that a large part of the income of the smelting companies was derived from this source, and 12 guineas per ton was considered a fair estimate. An acre of good oak wood at 20 years old was then said to yield about 200 stone, Dutch weight, of bark. Much of the remaining oak scrub of Argyll has been derived from the stools of these early coppicings and, as a result, much of it is extremely poor in form and vigour.

At the beginning of the 18th century, the economy of the country had been a purely rural one based primarily on cattle. The cattle:sheep ratio had been about equal, and the old clan social systems were still in force. With the coming of the smelting companies in the mid-eighteenth century the previous customs were disrupted. Timber was readily sold and exploited for financial returns, with no provision made for its replacement. Sheep and cattle in increasing numbers were brought in to feed on the newly cleared pastures, and thus natural regeneration had no hope of survival. One hundred years later, in 1828, the degeneration of the land was hastened by the eviction of the people, by the creation of extensive sheep runs and by the inception of deer forests.

On 27th September 1836 the vessel *Brilliant* sailed from Tobermory with 322 emigrants for New South Wales. Of these, 105 came from Ardnamurchan and Strontian and 25 from Morven. Thus the present problems of re-population and re-afforestation are merely the consequences of agrarian crime.

Planting to any extent was first carried out by the Marquis of Argyll (1653–1685) and by his son. It was stated in the *Old Statistical Account* of 1793 that almost the whole of the old trees about Inveraray then were of his planting. Smith notes, "Of plantations we have not a great many, nor can we boast of the extent of any of them, except the Duke of Argyll's which may be ranked among the greatest in the Kingdom". Most of these early operations were done for the purpose of amenity, and during the 18th century, exotics were introduced for this purpose. The areas planted, possibly with the exception of Inveraray, were never very large and trees were usually restricted to the immediate vicinity of the residences.

Smith in 1798 advocated the planting of large tracts which were then covered with "brushwood such as hazel, birch etc., and seldom allowed by the cattle to rise above two or three feet high. Patches of dwarfish oak which the cattle never allow to rise one foot from the ground are also common in many parts of the country. If these spots were brought within the enclosure of a plantation and the bushes cut over a little above the surface of the ground, they would soon be valuable".

Plantings during the 19th century were on a very limited scale and little attempt was made to enclose or regenerate any of the existing natural woodlands.

With the advent of the steamship, timber could be obtained more cheaply (and usually of better quality) from abroad and the interest in forestry by the end of the century was at a low ebb. The state of *laissez-faire* prevailing in the whole country with regard to forestry applied equally well to Argyll.

In 1907, however, with the active arousal in national interest, the Commissioners of Woods purchased Inverliever Estate for the purpose of conducting an afforestation scheme on a large scale.

With the creation of the Forestry Commission in 1919 it was appreciated that much of the land surface of Argyll was eminently suitable for the establishment of forests and a high proportion of the ground has been acquired since for the creation of forests.

Since the granting of state aid to private forestry the interest shown by landowners in the question of forestry has considerably increased, but is in no way yet considered adequate.

For the future, the problem of restocking the denuded and impoverished areas is not a simple one, despite the evidence of the past that much of Argyll had a covering of natural woodland. The retrogression of flora probably commenced in 750 B.C. when there began a wetter and colder epoch.

In this climatic deterioration peat bogs developed and there was a general intensification of moss growth. In consequence much of the prehistoric woodland suffered as much from natural processes as they did from human agency a millennium later.

With the removal of the protective canopy, soil fertility declined and podsolisation ensured, giving a combination of factors suitable for the promotion of heath. The regression of heath itself may become so far advanced as to form a stable para-climax when little can be done to revive the indigenous cover. Thus as Fraser Darling writes: "If we could gaze now a new Highland region appearing again as it did 1,500 years ago, and could give time to fundamental researches before laying it open to colonization, we should probably arrive at the truth that on the forested part of the country the underlying rock was so poor, the climate so adverse, and the glacial history so devastating that the soil stuff could persist only when the climax vegetation was preserved". In Argyll there are large tracts such as the Rannoch Moor basin for example, where this description is applicable and in them the pioneering forester is presented with a warning and a challenge.

HISTORICAL ACCOUNT OF THE WOODLANDS OF ROSS AND CROMARTY

By **ALEX. M. MACKENZIE**

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Very little information is available concerning the woodland in early times. It is almost certain however that most of the county was at one time completely covered by natural forests, partly composed of a northerly extension of the great Caledon Wood and partly of poor hardwood growth in the valleys, particularly of the south-east part of the county. Steady depletions occurred throughout the first 1,500 A.D., until only scattered, and usually degenerate, fragments remained. Due to its consequently reduced vigour, and the general inhospitability of much of the county, natural regeneration of the woodland occurred only on a very reduced scale. During the 16th, 17th and 18th centuries the growth of estates and mansion houses tended to establish and conserve a considerable amount of woodland in the form of policies. The earliest date at which these were formed is uncertain but there is a remarkable Sweet chestnut still standing at Castle Leod which was planted in 1549. Planted by John Mackenzie (1480–1556), IX Chief of Kintail, in the year 1549. It was probably nearer the end of the 17th century however before any plantations were formed, other than for amenity. These supplied shelter and pasturage for stock, brushwood—the main source of fuel—and timber of sorts for what little constructional work was carried out in wood. The extent to which the natural woodland was exploited for the manufacture of charcoal is not known but there is one definite record from the early part of the 17th century of "two brokers from England" who had an extensive wood of oak and birch on Struie hill cut down for this purpose.

By the end of the 18th century however, a fairly comprehensive view of the distribution of woodland in the county is available in the *Statistical Account of Scotland* compiled between 1792 and 1795.

The writers of the *Accounts* for parishes in the Eastern half of the county all give some space to the subject of woodland, whereas it is either altogether ignored or only alluded to in the most cursory manner by reporters in the West. As the compilers of the *Statistical Account* were parish ministers who would normally have both a thorough knowledge of their locality and an enlightened approach to its economy, this omission must be taken to indicate the virtual absence of woodland in the west at this time.

The most westerly parish in which any account of the woodland is given is Countin where are recorded fairly extensive tracts of natural woodland, composed mainly of birch and oak with some Scots pine mixed in, along the hill-slopes, particularly round Achilty and Loch Luichart. The oak had been sold for £500 and was in the process of being cut out. The presence of many fine and large beech in the grounds of Coul House is noted and these are again referred to by later writers. At this time active planting seems to have been going on further east, particularly at Brahan where an extensive nursery was operating for the purpose. Other owners in Urray parish seem also to have been taking an interest at this time in extending their policy woods.

From Dingwall North there are repeated remarks on the absence of natural woodland with the exception of some hedgerows consisting chiefly of alder, often accompanied by ash and hazel. Considerable areas of plantations are recorded however in the foothills to the west of this area, e.g. west of Tain, north of Strathpeffer, Hill of Nigg etc., and on the estates of Balnagown and Cadboll, which between them had 400 acres of planted Scots pine.

In the Black Isle the emphasis is on the extent of woodland—both policies and plantations—which is to be found on the country seats in which this area abounds. An active interest in the creation of woodland is apparent, some owners going to great pains and expense to increase the amenity of their estate. The minister at Cromarty records: "A considerable proportion of the above sum (£50,000) was applied towards beautifying and enlarging the pleasure grounds around the House and Hill of Cromarty. The latter is covered with firs and forest trees of all kinds." The most extensive area of established policy woodland however occurred at Belmaduthy estate "being above 500 acres, all in a thriving condition and many of them fit for market." This type of planting appeals to the writer as a bulwark of the economy of the parish, providing "a great abundance of wood for supplying the parishioners with timber and fuel."

This local market seems to have been the only one available and in many cases it is noted that the thinnings from policy woods were often given away free. Even newly made plantations were generally regarded only "as a useful fund for fuel" especially in districts where "moss" was scarce.

There are several references to the existence in former times of large tracts of woodland which had since become "quite exhausted". One of the last of such natural woods to go was one near Fortrose known as the Craig Wood. It had been cut down 30 years previously to provide "palisadoes and fascines to Fort George when they apprehended a visit from M. Thurot's squadron". Since then the wood had coppiced vigorously and Captain Mackenzie of Newtown attempted to extend it further west by planting. Unfortunately the steep rocky nature of the place prevented his getting proper fences established and his young trees were "mostly destroyed by the neighbour's sheep and cattle".

Of all this woodland of course virtually nothing remains extant today. Mackenzie in his review of Agriculture in Ross-shire at the beginning of the 19th century confirms this broad picture. He also notes the virtual absence of coppice in this area (although some oak coppice in the Black Isle was being worked for its bark) adding: "There is no temptation for converting the wood into charcoal: nor have we any inducement to attend to copses for poles or firewood." Natural woodland in the north was confined to Scots pine and birch. He echoes the *Statistical Account*—"of oak there are but few remains." Remarking on the size and the growth of hardwoods generally he notes the sweet chestnut at Castle Leod "whose trunk is beyond 4 feet in diameter." Among estates carrying out extensive planting at this time were Brahan ("5 million of various sorts"), Red Castle, Tulloch and Novar and he applauds the increased attention being given to the choice of species: "When planting first became a matter of importance in the north, hardly anything but Scotch firs were planted. But now all sorts of wood for timber are committed to the ground adapted for them. Scotch firs, being very cheap and good for the purpose, are employed as nurses for the other trees." The lack of a proper market for the thinnings from extensive plantations draws the comment that consequently "their management has in general become rather slovenly."

It is interesting to note the prices prevailing at this time. although those for Hardwoods are inflated, due to their general scarcity.

Fir, plane tree and lime	1/– to 1/3 per cube
Ash and elm	3/6 to 4/– ,, ,,
Good oak and beech	4/– ,, ,,

The second *Statistical Account of Scotland* published in 1845 reveals a somewhat altered state of affairs, and an increasing awareness of the value of timber supplies on the part of the writers causing them to be more exhaustive in their remarks on woodland.

Still typical, nevertheless, is the remark made concerning the parish of Nigg: "The woods, however, are of secondary consideration."

There is, for one thing, a realization that despite the large size to which hardwoods will grow in the policies, the latitude and exposure of much of the County prevent the extensive use of these species. The writer in Cromarty is particularly impressed with this: "The average heat of summer is in consequence lower than in most of the neighbouring parishes. I have observed that the acorn rarely attains the ordinary size and almost never ripens." And again for the parish of Risolis it is recorded that "Where hardwood has been planted, it is stunted in its growth and bark-bound. Comparatively young trees of ash are covered with seed, an almost infallible sign that their natural growth is checked." However despite these forebodings it is reported that "upon Kilcoy's property there is a considerable extent of planted oak for which he received a premium from the Highland Society". It has also been appreciated that the elements are not alone responsible for the poor growth. There seems to be an air of resignation in the remark of one writer: "Hardwood does not altogether thrive: the climate and the soil are against it." By this time too some advance had been made in recognizing and coping with adverse edaphic factors. "Upon the greater part of the ground a stratum of iron crust intervenes betwixt a shallow vegetable mould and a deep clay soil . . . and without the process of trenching, no species of tree would grow to maturity." The recommended depth for the ploughing to be effective was 14 to 18 inches.

The extended use of larch is also being advocated "not only on account of the rapidity of its growth and the value of its bark and timber but also . . . (because) instead of impoverishing (the soil) as the Scotch pine always does, it actually improves it by the fall of the leaf at the end of the autumn." In fact many of the new plantations were composed of a higher percentage of this species than ever before, although Scots pine still predominated.

In some districts landowners were now faced with the further menace to plantations of rabbits. The minister at Resolis reports: "Rabbits were introduced a few years ago by a gentleman who had a temporary residence in this parish and have now so much increased as to become a public nuisance."

There was also a better market for the timber produced on the estates most of which was hardwood. The owner of the "Fowlis property" reduced his conversion costs to a minimum: "Some of the hardwood had attained to such a growth as to be fit for the purposes of ship building and two ships were built and launched in the property." There appears also to have been a steady trade in pit props for the English coal mines, the produce being delivered at Newcastle or Hull often in exchange for "that expensive necessity of daily life, coal, or sometimes lime."

Reports from all parts speak of thriving plantations "not yet having attained their full growth" and of almost continuous planting over the previous 30 to 40 years. Novar estate particularly is credited with planting 4½ million trees, mostly Scots pine and larch, but also "a number of kinds of forest and ornamental wood". The conception of obtaining a sustained yield from plantations also comes into evidence at this time: "There was also a fir wood of 78½ acres on the Hill of Edertoun which . . . was sold in 1838 for £680. It is nearly cut down but is to be replanted whenever the ground is cleared of old wood."

There was still a general deficiency of trees in the North which has largely continued to the present day. The occurrence of poplars around Dingwall excited considerable interest, in fact the writer reports that "with the exception of . . . its rows of tall poplar trees which give it rather an uncommon air, the town presents little of interest. Numbers of these grow in the neighbourhood whose tall and pyramidal shapes disposed in rows have an uncommonly picturesque effect."

There is now more information available for the Western part of the County although it only serves to emphasize the absence of large areas of woodland. Growth seems to be rapid however "whenever the soil and situation are suitable" and the produce worked fairly regularly. Thus at Shieldaig "there is a good fir wood producing timber for boats, vessels and buildings" while the value of "annual thinning and periodic felling of woods" in Lochcarron is stated to be £100. Strangely enough the only trees planted for timber in Gairloch were larch and chestnut both of which thrived "extremely well".There are traces of some of these gigantic larch to be found in that district today. Again in Kintail—although the plantations were by no means extensive—the climate and situation appeared to be favourable, "all the sorts (of trees) introduced having attained great perfection." This state of affairs must have obtained also at Lochbroom where the writer was surprised to find that "firs of different kinds and hardwoods planted by the present incumbent have succeeded beyond the most sanguine expectations." He goes on to note that "the principal improvements which have been made in the parish were executed by the late Kenneth Mackenzie of Dundonnell who planted millions of firs and hardwood trees." The state of affairs in Glenshiel seems much more primitive, the writer there deploring the heathen beliefs of the people who "ascribe certain influences to the phases of the moon—on which account they will not fell timber while the moon is on the increase believing that it will not season properly." The trees occurring naturally here are the alder, willow and ash and to these are attached "some importance, from an economical point of view". The bark of the alder produced a good black dye, the twigs of the sallow were substituted for hemp in making rope, the timber of the alder was "well adapted for herring barrel staves" and the ash used "for the purposes of the boat carpenter and the agriculturalist."

Gunn's detailed account of the woods in Ross-shire shows the picture at the end of the century to be not very different except that the woodlands have undergone a period of 50 years' felling and planting and now total 43,000 acres. Almost all the plantations of conifers which he records occur today as felled areas. Many of the newer policy woods which are described however are still intact, particularly the ornamental planting alongside the River Orrin on Fairburn estate, which then was only 25 years old but already showing promise of majestic growth. The approach to forestry by estate owners had taken a more scientific turn and was beginning to be based on something like sound business principles. But while there was increased interest in the proper formation of plantations, their neglect continued everywhere. This is some measure could be attributed to the uneconomic size of plantations which were then in existence: they consisted either of too-large blocks or too-narrow belts, neither of which served much useful purpose on the estate.

The usefulness of raising stock in home nurseries—as opposed to buying plants from "public" nurseries of dubious repute—had become apparent, and whenever possible cones were collected locally, although without much regard to the trees from which they came. Seed bought off merchants generally bore the locality from which it originated though there was still little regard for its authenticity.

The problem of exposure and blast round the coasts was being investigated: Gunn records: "Along the shore where the soil is poor the sea breeze (!) has stunted the trees." Douglas fir especially, flourished up to 10 or 12 years and then lost their leader. Lawson cypress showed a fair resistance to blast and cold and also good growth. (15 feet at 14 years). After various trials however, *Pinus pinaster* was found to grow best in sandy soil, afford good shelter and suffer least from blast. But nothing was done about it and this species has been very little used anywhere.

Extensive damage was still being done to new plantations by rabbits and to older ones by squirrels which were not being sufficiently kept in check. Evidence of this can be seen in nearly all the older woods today in the Eastern part of Ross at least.

Drainage and cultivation of the ground before planting was now much more common than previously and was allowing large areas of waste ground to be brought under woods. It had also been discovered that old agricultural ground was not suited to the growth of good timber and in fact was found to give rise to "blister rust" in larch.

It is remarked that the best investment available for land worth 10/- or less per acre was to put it under plantations: it would then yield £1 per acre in rent for 60 years from the date of planting. Planting stock at that time cost:

Larch:	1+1	9/- per 1,000
	1+2	10/- „ „
Scots pine:	2+1	6/- „ „

Current prices for timber were:

Larch:	1/6–2/– per cube
Scots pine:	8d.–10d. „ „
Ash:	1/6 „ „

At the beginning of this century however the rate of planting slowed down although felling went on apace to meet requirements as they arose. In the 33 years from 1881 to 1914 the woodland area only increased by about 450 acres per annum. Despite the heavy toll of war fellings in the first World War however the woodland actually increased during the next 10 years at the rate of over 1,500 acres per annum. From 1924 onwards the story is one of a steady decline in the woodlands on private estates—almost no plantations having been formed in the next 30 years—although the total area has steadily risen due to State planting. The increase in the area of felled woodland between 1924 and the outbreak of the Second World War was only 2,400 acres compared with 10,000 acres felled from 1939 to 1947. Since 1947 a large part of the area of felled woodland on private estates has been acquired by the Forestry Commission and is again under plantations.

NOTES ON THE HISTORY OF BLAIRADAM FOREST, FIFE

By I. S. WATT

District Officer, East Scotland

The story of Blairadam Estate is of some interest despite the fact that in its broad outlines it is a familiar one in the annals of Scottish estates. In this case, however, the rise of the property has been carefully recorded; its decline is of recent years.

The history of the development of the estate was written in 1834 by William Adam, a Lord Chief Commissioner of the Jury Court.

Originally the property was called The Blair and in 1733, when the grandfather of Commissioner Adam commenced to improve it, extended to 640 Scotch acres or 813 Imperial acres. At that time there was only one enclosure on the place. Scattered corn ridges, ploughed till they would bear no more and then abandoned were all that were cultivated otherwise. The ground otherwise was either heathy or covered with "white russet grass". Only one tree, an ash, is believed to have existed. With Commissioner Adam it was regarded as an object of reverence to be spoken of as THE TREE.

There was, on the estate, the most northerly coalpit in Scotland and the produce of this was in great demand.

In 1739 there were added to the estate Dowshill, 525 Scotch acres; in 1741 Woodend, Blairenbathie, Craigencat and King's Seat, in all 1,320 Scotch acres; and in 1747 Dichendad, 48 Scotch acres (in all 2,406 Imperial acres). The proprietor of this time made improvements in the agricultural practices, but unless in the original property, beyond planting a few strips and the Blairenbathie Roundel, appears to have made no plantations of trees. Blairenbathie Roundel had a wall of more than the usual height built round it and cattle were folded in it for several seasons before it was planted with Scots pine, oak, elm and ash. The plantation remained in 1834 the most unhealthy on the estate.

A farm house and steading suitable for a hill farm was built at King's Seat after it was purchased. These, with land extending to near 400 acres, were let for the period of two lives at a rent of £10 per annum. In 1798 the lease came to an end, and so great had been the change in the value of money and stock that a new let was made at ten times the former rent.

Commissioner Adam's father inherited the property in 1748 and there were then 70 acres of plantations on the estate. In 1750 he prepared a nursery for trees in the place that is now the garden. Planting commenced in 1751.

In the earlier plantations there was great regularity and straight lines and formal figures were the rule. On Blairadam before 1756 they began to be formed to suit the ground or the fancy of the person who laid them out. At this time North Merchiston, near Edinburgh, belonged to Mr. Adam and this method had been adopted there so that it was "the most splendid *ferme ornée* that can be imagined". Encouragement and instruction in the art of planting were given by Dr. Hope, who was Professor of Botany in Edinburgh and by the Duke of Argyll. The latter also sent larch, spruce and silver fir plants.

But the improvements were not restricted to planting and the history of this period of Blairadam is indicative of the origin of progress of Scottish agriculture and industry. The proprietor of Blairadam established a bleaching ground at Dullomuir, a linen factory of eight looms and a lint mill. Premiums were given to the best spinners and to the best weavers. An experienced agriculturist was sent to Norfolk and other parts of England to learn the practice of husbandry in that country so that improvements might be made in the local methods.

When Commissioner Adam succeeded to Blairadam in 1792 there were 1,144 acres of plantations and the estate extended to 3,590 acres. The areas purchased in the interval were Dullomuir and Kinnaird.

Commissioner Adam's father suffered financial loss through the failure of the Ayr Bank in 1772 and during the year he was in London endeavouring to straighten out the position the son was left to carry out plans for the improvement of the estate. This was excellent training for the future laird.

In 1786 the family suffered another severe loss through "fresh distressing occurrences" in the affairs of the Commissioner's uncles who lived in London. As a result the estate was advertised for sale. In that year the Commissioner was "by the interest of Seaforth" elected Member for Ross-shire. On his way South he visited Blairadam and was so impressed by the improvements that he prevailed on his father to suspend the sale. He determined to devote the surplus profits from his profession (he had a considerable practice at the Bar of the House of Lords), to the payment of the debt that burdened the property. This he continued to do after his succession and in 1795, when he ceased to be a Member of Parliament there was such an influx of profitable business at the Bar of the House that he was able to commence making improvements in the estate.

He divided the plantations on the estate into five categories:

(1) Woods of Succession.
(2) Woods of Selection.
(3) Woods of Ornament or Policy.
(4) Clumps.
(5) Woods open to pasture.

The Woods of Succession were to be managed by clear felling; Woods of Selection by selection cutting.

In 1834 descriptions of these woods and instructions for forming plantations were written. The need for draining was stressed, loppings were to be removed and burned, rides for inspections should be left through the woods, "wood lanes" or roads for the transport of timber "should be directed to the shortest distance from point to point, and they should be, as far as possible, so conducted as not to be a funnel or conductor for the south-west or west wind".

Owing to the low price obtainable for the timber a sawmill was erected and since there was an annual return of £600 certain improvements in the machinery and water supply were to be made which would ensure the continuation of this. Metalled roads were to be made between the plantations and the sawmill. The method of planting was described in a letter to Sir John Sinclair and so was the method of pruning. In planting, a system whereby the trees were set obliquely was recommended since the wind had less effect on it. Many of the observations in this section are worthy of interest today.

Of special interest is the description of Peerie's Burn Wood. The following refers to the section that is now planted with Sitka spruce and Scots pine:

> "There is in the centre of this plantation a part in which the trees have never succeeded. This vacancy should be immediately replanted. The heath in it is very strong, the soil is wet, and the surface mossy. To secure the growth of the trees to be planted, those impediments to growth should be entirely removed. This vacant spot is near the place where an attempt was made, in 1778, to drive a level to the Craigencat coal. The drains to be made for the new planting should be led into this level, as an easy means of getting rid of the water."

It is not known whether or not this wood was replanted, but excepting a few small spruces, there were no trees or tree stumps on it when the Forestry Commission acquired Blairadam. Draining had been done and the result of this is seen today.

Woods planted by Commissioner Adam existed till recently when extensive fellings began. At the conclusion of these the Estate had almost assumed the appearance it had when Commissioner Adam's father succeeded to it in 1748. In its history there are lessons for foresters who appreciate the value of continuity in forest management.

SAVERNAKE: HISTORY OF THE FOREST

Compiled for the Working Plan by South West England Conservancy Staff

There is circumstantial evidence that it was created, or re-created, as a Royal Forest soon after the conquest. It is not so referred to in Domesday, but there were recorded extensive woods in Bedwyn (also a grove—Southgrove?), Ramsbury, Clatford, Huish and Mildenhall. It is thought Norman Savernake extended from Martinsell to Bedwyn Common, and at its widest from Marlborough to Easton Royal; the numerous small coppices lay on the perimeter and at the centre and to the west was an open expanse. Woods at Hippenscombe, Brail and Southgrove were perhaps outlying forests. The large wood at Collingbourne Ducis is also recorded in Domesday (and distinguished from Chute) with woods appurtenant to Ludgershall, Shaw and Standen (Sunton?).

Savernake Forest was expanded in the 12th century when its perambulation followed the Kennet from Marlborough to East Kennet; south and south-east to Pewsey; east to Easton, south to Collingbourne; east along the Causeway and north to Vernham Dean, and on by Buttermere and Inkpen to the Kennet; west by Hungerford and Ramsbury to Mildenhall; south by the Roman road to the "Kings Way" (now Bath Road) and west to Marlborough. This was organised in five Bailiwicks. West, west of Burbage, Leigh Hill and the Roman road; Southgrove, between Collingbourne, Burbage and East Grafton; Hippenscombe, between Wexcombe and Vernham Dean and continuing up to Hungerford; Le Broyle, between the last, Wilton, Bedwyn and Hungerford; and La Verme (the "Farm" of the Warden) in the centre and north.

Chute Forest similarly embraced most of Wiltshire east of the Avon between Salisbury and Upavon, with a further vast extent in Hampshire, and the north boundary was Savernake Forest.

Contraction was ordered in the 13th century (after 1215), but little was achieved; in 1301, four-fifths of Savernake were to be disafforested, but it was not carried out until 1330 when Le Broyle and Southgrove were reduced to two small wooded outliers and a similarly reduced Hippenscombe was transferred to Chute. La Verme contracted to the east part of the present Old Forest and adjoining outliers, and only West Bailey still covered much of its former ground. In the same year, Chute in Wiltshire was practically "disafforested"; it appears that the Collingbourne woods continued in private ownership—though they had been subject to forest law, they had not formed part of the King's demesne.

The wardenship of Savernake has passed by inheritance since Norman times. Norman Esturmeys were established in the office, probably by William I before 1086, and after the last died in 1427, it passed to a Seymour son-in-law. Crokes were similarly hereditary wardens of Chute until 1215, when this office also passed by a daughter. Henry VIII visited the Savernake Seymours at Wolfhall on three occasions and included a daughter among his wives. The succeeding Warden, her brother, became Duke of Somerset and Protector, and had the ownership of the forest transferred to himself, probably in 1548. Uniquely, the title of Forest, and not Chase, was still retained. After the Duke's execution, the Forest was retained by the family by devious means, excepting (by 1553) Le Broyle and Southgrove, which went to Lord Pembroke.

The Owner/Warden Seymours continued as Earl or Marquess of Hertford, and eventually again Dukes of Somerset until 1675. By 1575, the first house at Tottenham was built, replacing Wolfhall as the residence.

No longer a Royal Forest, the old system of forest law had ceased to be applicable and the usual forest court of attachment fell into desuetude. A Forest Court, equivalent to a manorial court, had replaced it; this heard cases of stealing, damage to fences or unlawful commoning and imposed fines or impounded stock. The court came to be particularly concerned with control of the grazing rights claimed by the adjoining villages, but also with perambulations and a periodic deer census. Control was conducted through this court on a co-operative basis between the Warden and his staff on the one hand, and the commoning borderers on the other, to their mutual advantage.

During this period (the second half of the 16th century) most of West Bailey was enclosed in two ring fences; the Great Park lay between Martinsell hill, Hat Gate, High Trees and Overton, and Brimslade Park south of this, as far as Burbage. Smaller parks had already existed, including one at Tottenham and three (Suddene, Horse and Red Deer Parks) at Wolfhall. Now Tottenham park was increased to 760 acres (a third wooded), and at Wolfhall only Suddene (300 acres) remained. These enclosures no doubt reduced deer poaching and permitted larger stocks of deer without damage to neighbours. La Verme was now known as "the Forest Unpaled", though it apparently contained numerous coppices, enclosed by thorn hedges. Forest and parks stood at 8,500 acres.

Great Park (2,000 acres) included a few coppices in the north part (Panterwick), 300 acres of "heath and waste", and the balance "pasture". Brimslade may have contained some 200 acres of coppices and 1,300 acres of open ground. The Forest Unpaled "that nowe lyeth open for the deare" was c.3,000 acres, mainly heath, green ground and fern ground with woods amounting to some 800 acres. South-east of the Forest Unpaled was Havering Heath (580 acres) where rabbits were encouraged under the Keeper of the Conies (now part of Bedwyn Common). A nearby area was enclosed for this same purpose—now Warren Farm. The actual site of the woodlands is not identified, but they covered some 20 per cent of the whole—about half in the Forest Unpaled and the rest mainly in Brimsdale and Tottenham parks. These figures are from an undated 17th century survey.

Two Rangers administered the Parks and Unpaled Forest respectively—subsequently Head Keepers under an honorary Ranger. The Parks were divided into several Walks under Keepers, and the Forest east and west into Bagdon Walk and Braydon Hook Walk.

GUN LAW!

ALWAYS treat a gun as if it were loaded and NEVER point it at anything you don't intend to kill GUNS ARE MADE TO KILL AND USUALLY DO!

PLATE I Close your gun correctly

The photos on this and the following pages are reproduced from the Farm Safety Leaflet entitled *Guns* by kind permission of the Ministry of Agriculture. See the article on page 87

PLATE 2. Examine the barrels.

PLATE 3. Hold your gun in a safe position.

PLATE 4. Don't carry your gun like this.

PLATE 5. In situations like this—unload!

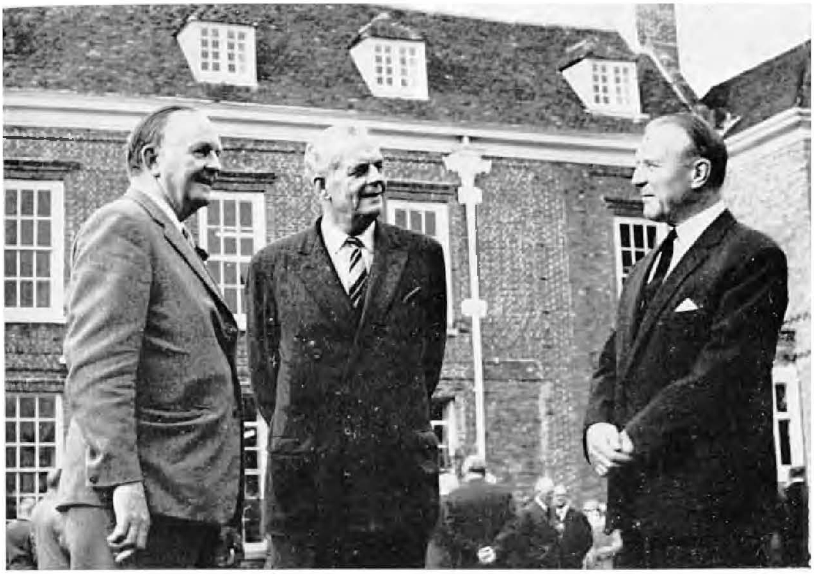


PLATE 6. At the opening of the Commission's new offices for the New Forest, the Queen's House, Lyndhurst, on 7th October 1966. *Left to right:* Mr. W A. Cadman, Deputy Surveyor of the New Forest, Lord Ashburton, Lord Lieutenant of Hampshire, and Mr. Leslie Jenkins, Chairman of the Forestry Commission.

PLATE 7. Mr. J. R. Thom, Director of Research, presents a farewell gift to Head Forester W. G. Gray, in recognition of forty-four years' service in the Research Branch, from 1922 to January 1967. Also in the picture are J. R. Aldhous (*left*) and M. Nimmo, both of Research Branch, and Miss Blanche Benzian of the Rothamsted Experimental Station.

PLATE 8. Lumberjills, Dean Forest, 1943.

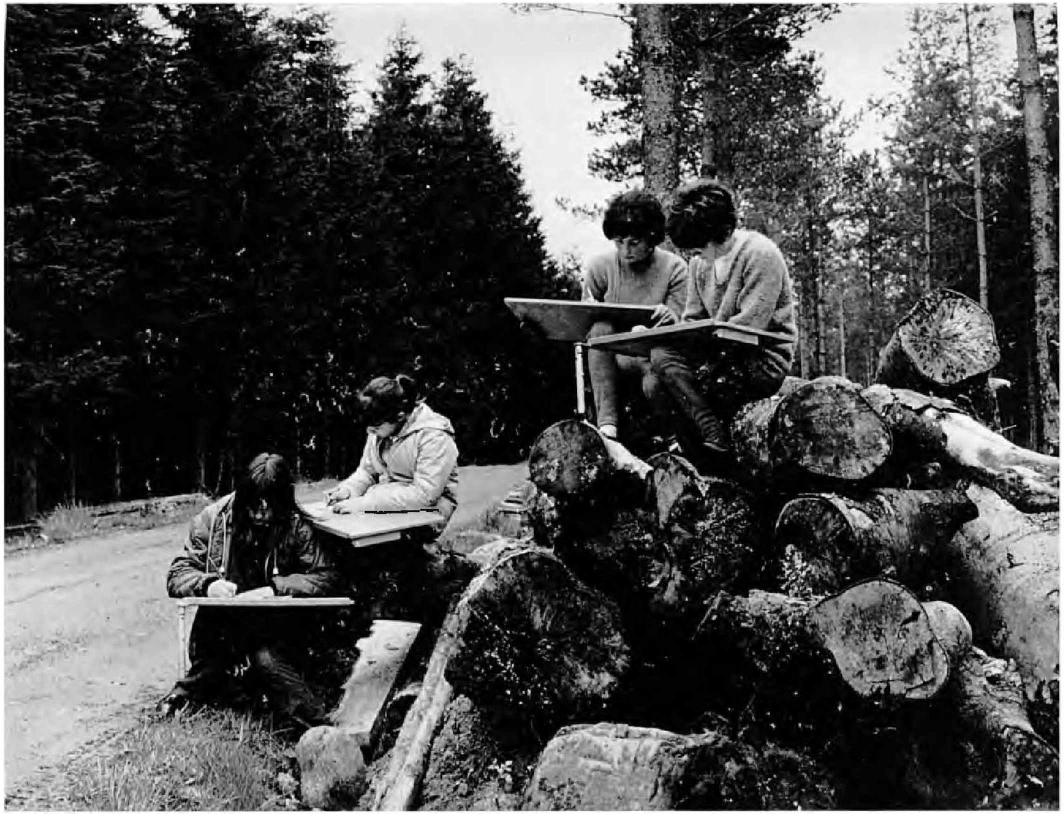


PLATE 9. Art work on the forest trail, Kielder Forest, 1966.

PLATE 10. Camping the hard way. A semi-permanent gypsy encampment in the New Forest, about 1910. The tents are the traditional "benders" made of sacking over bent hazel rods.

PLATE 11. It's easier nowadays! The Camping Club of Great Britain site in Grizedale Forest, Lancashire, summer 1966.

PLATE 12. Alice Holt Research Station in Hampshire. The present lodge built about 1820 on the site of the seventeenth-century Great Lodge.

PLATE 13. The Forestry Commission stand at the Game Fair, Bowood, Wiltshire, July 1967.

DEAN FOREST,

GLOUCESTERSHIRE.

TO BE SOLD BY

AUCTION

(By order of Viscount Duncannon, Sir B. Stephenson, and A. Milne, Esq., Commissioners of Her Majesty's Woods, Forests, and Land Revenues,)

By Messrs. WHITE and SON,

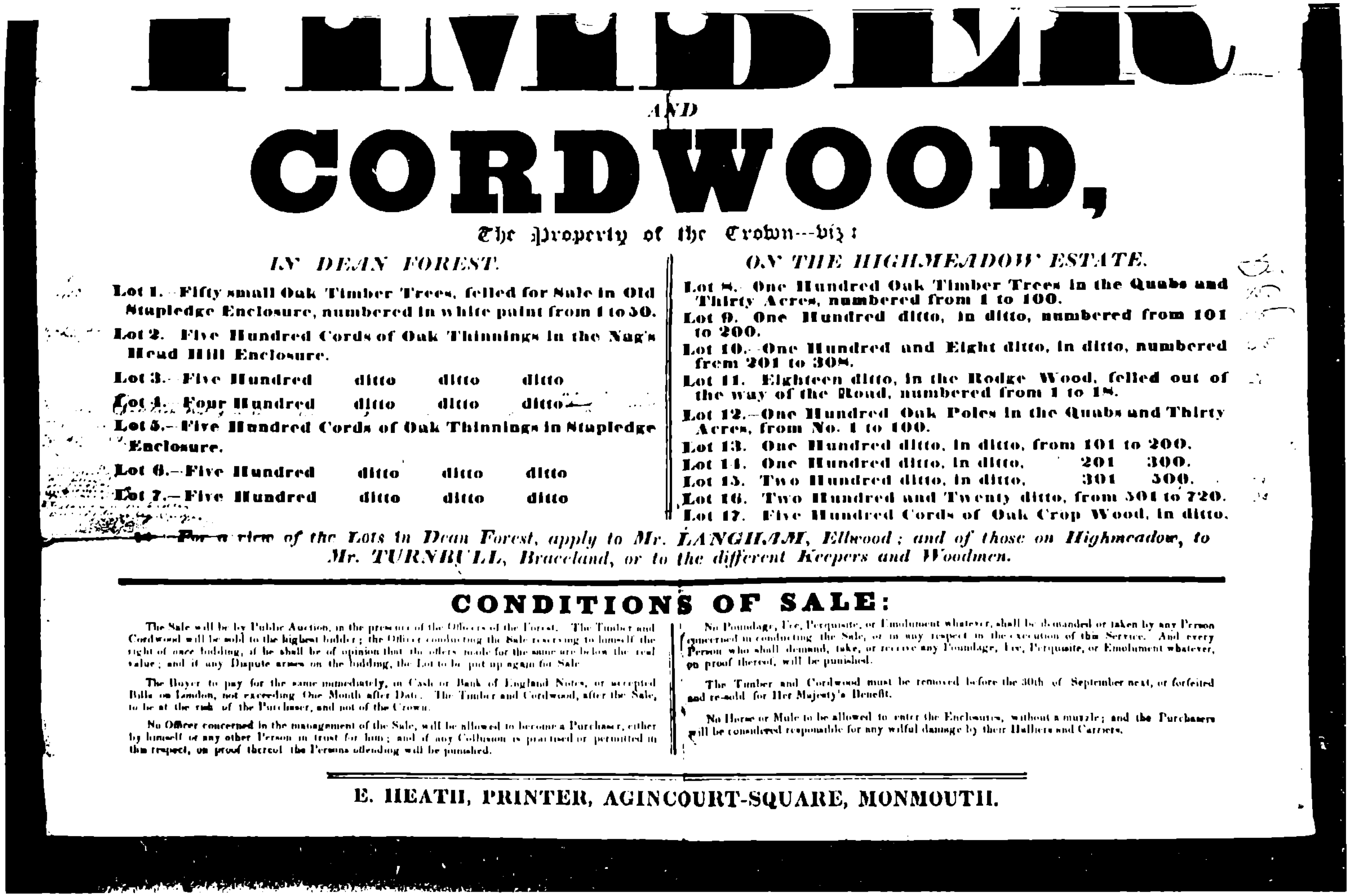
AT THE SPEECH HOUSE,

IN DEAN FOREST,

On Tuesday, the 7th of November, 1837,

AT ONE o'CLOCK PRECISELY,

THE FOLLOWING LOTS OF



AND

CORDWOOD,

The Property of the Crown---viz:

IN DEAN FOREST.

Lot 1.—Fifty small Oak Timber Trees, felled for Sale in Old Stapledge Enclosure, numbered in white paint from 1 to 50.

Lot 2. Five Hundred Cords of Oak Thinnings in the Nag's Head Hill Enclosure.

Lot 3.—Five Hundred ditto ditto ditto

Lot 4. Four Hundred ditto ditto ditto

Lot 5.—Five Hundred Cords of Oak Thinnings in Stapledge Enclosure.

Lot 6.—Five Hundred ditto ditto ditto

Lot 7.—Five Hundred ditto ditto ditto

ON THE HIGHMEADOW ESTATE.

Lot 8. One Hundred Oak Timber Trees in the Quabs and Thirty Acres, numbered from 1 to 100.

Lot 9. One Hundred ditto, in ditto, numbered from 101 to 200.

Lot 10.—One Hundred and Eight ditto, in ditto, numbered from 201 to 308.

Lot 11. Eighteen ditto, in the Rodge Wood, felled out of the way of the Road, numbered from 1 to 18.

Lot 12.—One Hundred Oak Poles in the Quabs and Thirty Acres, from No. 1 to 100.

Lot 13. One Hundred ditto, in ditto, from 101 to 200.

Lot 14. One Hundred ditto, in ditto, 201 300.

Lot 15. Two Hundred ditto, in ditto, 301 500.

Lot 16. Two Hundred and Twenty ditto, from 501 to 720.

Lot 17. Five Hundred Cords of Oak Crop Wood, in ditto.

For a view of the Lots in Dean Forest, apply to Mr. LANGHAM, Ellwood; and of those on Highmeadow, to Mr. TURNBULL, Braceland, or to the different Keepers and Woodmen.

CONDITIONS OF SALE:

The Sale will be by Public Auction, in the presence of the Officers of the Forest. The Timber and Cordwood will be sold to the highest bidder; the Officer conducting the Sale reserving to himself the right of once bidding, if he shall be of opinion that the offers made for the same are below the real value; and if any Dispute arises on the bidding, the Lot to be put up again for Sale.

The Buyer to pay for the same immediately, in Cash or Bank of England Notes, or accepted Bills on London, not exceeding One Month after Date. The Timber and Cordwood, after the Sale, to be at the risk of the Purchaser, and not of the Crown.

No Officer concerned in the management of the Sale, will be allowed to become a Purchaser, either by himself or any other Person in trust for him; and if any Collusion is practised or permitted in this respect, on proof thereof the Persons offending will be punished.

No Poundage, Fee, Perquisite, or Emolument whatever, shall be demanded or taken by any Person concerned in conducting the Sale, or in any respect in the execution of this Service. And every Person who shall demand, take, or receive any Poundage, Fee, Perquisite, or Emolument whatever, on proof thereof, will be punished.

The Timber and Cordwood must be removed before the 30th of September next, or forfeited and re-sold for Her Majesty's Benefit.

No Horse or Mule to be allowed to enter the Enclosures, without a muzzle; and the Purchasers will be considered responsible for any wilful damage by their Halliers and Carriers.

E. HEATH, PRINTER, AGINCOURT-SQUARE, MONMOUTH.

PLATE 14. Timber marketing 130 years ago. A poster displayed in the Dean Forest. Contributed by Chief Forester R. J. Jennings.

PLATE 15. Commission workers planting the Aberfan Memorial Plot, given by the pupils of Spelbrook Infants School, Bishops Stortford, Hertfordshire, to commemorate the tragedy of October 1966 when a coal mine tip engulfed the village school. St. Tydfil Forest, Glamorgan.

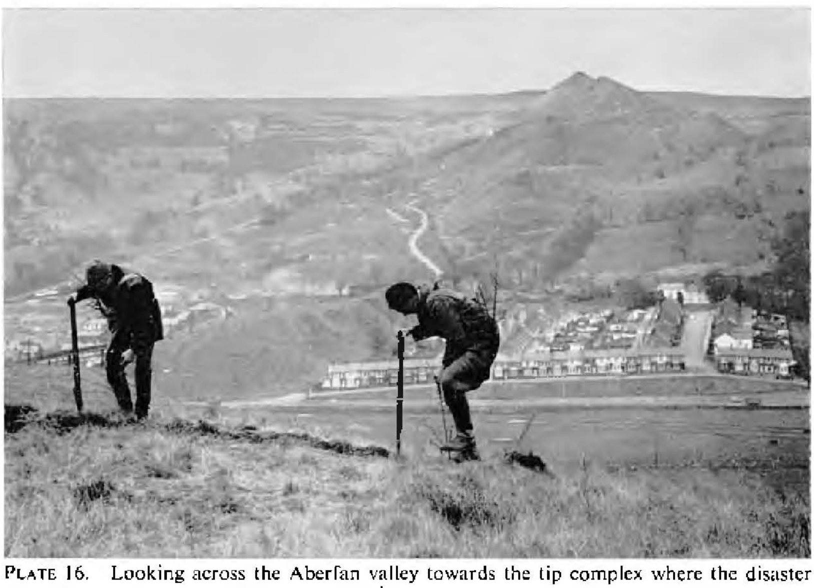


PLATE 16. Looking across the Aberfan valley towards the tip complex where the disaster began.

PLATE 17. Mountain ash growing in a block of granite 1,000 feet above sea level, on the Black Mount road between Glencoe and Bridge of Orchy, Argyll. Contributed by R. J. Jennings.

PLATE 18. A photo safari high seat in Grizedale Forest, Lancashire. This overlooks a favourite haunt of red deer and a newly created tarn which wildfowl now frequent.

PLATE 19. Royal Engineers rafting a Priestman Cub excavator down Loch Shiel for the construction of the new Commission road from Glenfinnan to Glen Hurich Forest in Argyll. The excavator, weighing twenty-four tons, was floated for six miles down the loch, during the summer of 1962.

PLATE 20. Landing the excavator, from the specially built pontoons, at Glen Hurich. Photos contributed by Mr. J. V. Dishington of the Engineering staff.

PLATE 21. A general view of the new Thames Board Mill at Workington, Cumberland, opened by Mr. Harold Wilson, the Prime Minister, on 9th June 1967. Stacks of unbarked poles are seen on the right, with the de-barking drums on the left; a conveyor system links the two.

PLATE 22. The Kelley Ripper, a tractor-mounted device used for sub-soiling at Allerston Forest, Yorkshire. Contributed by Chief Forester J. Weatherell.

PLATE 23. The great oak at Fredville, Nonington, near Dover, Kent, photographed in 1921. It was then 35 feet round, but now scales nearly 38 feet. Possibly the largest maiden oak (i.e., not pollarded) in Great Britain. Contributed by A. P. F. Hamilton, a former Commissioner, and one-time Inspector General of Forests for India.

PLATE 24.

Two views of an oak chest carved by Forester W. J. Wilson, of Arden Forest, Warwickshire, who comments as follows:

'This chest was made out of some oak I bought at a timber merchant's near Bagot Forest, Staffordshire. It was oak out of Bagot's Wood and had been bought by the merchant at the last great timber sale of the Bagot Estate before the last war.

It seemed very appropriate to carve on the panels of this fine English oak some of the tools used by the forester. An oak tree and a cedar tree, represent the woods used and on the ends are carved a fox and a tawny owl, pets which we kept while at this forest.'

Further carvings and comments by Forester Wilson fill the next three pages.

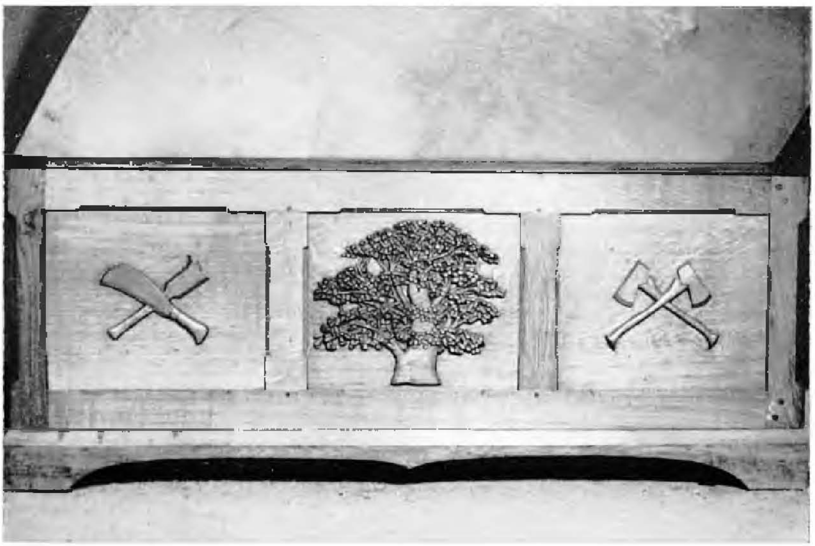


PLATE 25.

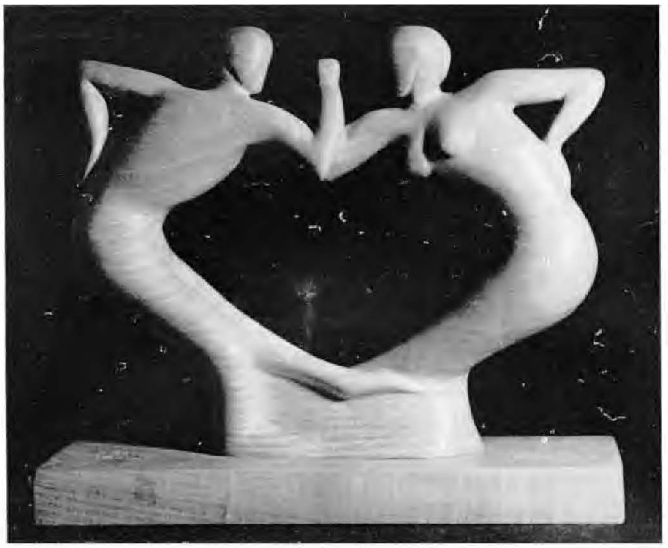


PLATE 26. THE DANCERS.
While depicting a modern dance pose, the rhythm of the grain of the acacia wood of which it is made, flows beautifully with the rhythm of the bodies. It is ten inches high.

PLATE 27. THE FAMILY.
This is in lime wood and is fifteen inches high. It depicts bracken fronds as they appear out of the earth in early spring.

PLATE 28. THE DIVER.

This is in yew wood and is thirty inches high. It represents the growth of grass and brings out the vivid colour of yew.

PLATE 29. VARIATIONS OF A DOUGLAS FIR CONE AND A SCOTS PINE CONE.

These are wall plaques, the cones being cut from cedar boards and stuck on to panels.

PLATE 30. MOTHER AND SON.

A mother, whether human, animal or insect, is always concerned for her children. This mother snail climbing this plant in search of its offspring gives one the feeling of concern. It is carved in acacia wood with walnut base and stake. The snail shells are superimposed on acacia, sycamore, walnut and box wood.

PLATE 31. THE SEEKER.

This is twenty-four inches high and carved from lime wood. It is symbolic of our day with mini-skirted girl, microphone held in the hands, singing pop with great sincerity. It could be mistaken so easily for youth appealing, but perhaps there is no difference.

PLATE 32. SWANS' MEETING.

This is carved out of lime wood and is sixteen inches high. It is minus its spur-like stalk and is the flower of the columbine, but how like swans having a tête-à-tête!

PLATE 33. INTO THE STORM.

This is in beech wood and is nine inches high. All foresters experience this homeward plod through wind and rain.

In 1675, the Estate passed to the Bruce family (Earls of Ailesbury), under financial difficulties tracing from support given to the Royalist cause. Tottenham House was destroyed between 1672 and 1676. The parks were no longer kept up, the two main ones and Suddene being turned over to agriculture, and after 1685, 400 acres of Tottenham were likewise converted.

The coppices may have been chiefly oak and hazel (standards over coppice) but these were in bad shape from neglect—an Admiralty surveyor at this time "wondered to see so much Timber suffered to decay for want of cutting, and upon a very strict view of the whole could finde but 3 or 4 Trees fitt for his use".

The 18th century was a period of improvement. In the first quarter, Tottenham House was rebuilt and adjoining woods (including Haw Wood) were replanted. Land near Warren Farm was disafforested—most of Havering Heath probably went for farming. A Woodward was employed to see to the coppices. Three keepers, each with horses and a small "cry" of hounds, were at Bagden, Bradon Hook and Furze Coppice, charged to keep the deer in the forest from the outliers, and to control the borderers' grazing. Several hamlets claimed grazing rights over defined areas of the forest for sheep and cattle. Inhabitants of Marlborough for a fee could depasture horses in the forest; this old practice was put on a firm basis in a document of 1728.

It appears that the Estate was now prosperous and expanding again, and that it included Collingbourne Woods, where there was a second Woodward. During the second quarter of this century a start was made (1723) on the great beech avenues, including the south part of the Grand Avenue.

In 1747, the forest passed to a nephew Thomas Bruce Brudenell, who added the name Bruce to his own—Brudenell-Bruce. He extended his uncle's Long Plantation into today's Grand Avenue, re-created Tottenham Park, and with advice from Capability Brown continued the improvements, including a scheme to make the forest "one great whole". From c.1765 areas between the existing coppices were planted up mainly with oak, and the forest tracks were lined with beeches. Open spaces were preserved at Woolslade and Savernake Lawn, and especially at Lewdon's Lye in which was the centre of the Eight Walks radiating through the Forest.

Ashlade Coppice was extended to form Savernake Wood, Birch Copse was created from a small nucleus and Bedwyn Common was planted up. Haw Wood was extended by the Bloxham plantations. At the same time, the rights of common were extinguished—how is not certain, but probably by grants of land. Much of the present Old Deer Park and the Savernake outliers must two centuries ago have been pioneer broadleaved plantations. Timber surviving from previous enclosures was then of great age, but still conserved. c.1795 Bagden Lodge was rebuilt as a mansion (Savernake Lodge is a conversion of the old stables); this was burnt down 50 or 60 years later and the surviving conifers of the ornamental grounds and Savernake Wood date from before c.1850 (probably before 1814).

The great period of afforestation in the modern sense ended in 1814. The two succeeding Wardens (1st and 2nd Marquesses) turned to enlarging the mansion and other improvements. In 1870, the second Marquess created the great deer park, adding all the main forest (except Savernake Wood and Birch Copse) to the already great Tottenham Park, within a ring fence. There had been no planting here for at least 60 years and prospects of regeneration or further planting were now practically excluded by the deer. The ways of the first two marquesses, the decline in agriculture, and the short but financially disastrous life of the 4th Marquess had almost ruined the Estate by 1894. The 5th Marquess in the ensuing 17 years put the Estate in a better condition and resumed planting on a small scale; this was mainly in the outliers where the planting of ¾ million broadleaves and conifers suggests at least 150 acres restocked. Some ornamental planting, including horse chestnuts and rowans, took place in the "Old Forest", making use for the first time of wire netting and barbed wire for protection.

The post 1914–1918 war period found the forest in a state of decay and the means lacking to restore it. Active forestry in the two succeeding decades was confined to the introduction of conifers to parts of Birch Copse and Bedwyn Common, and this period ended with the lease (after abortive negotiations in 1930) to the Forestry Commission in 1939. What Marlborough College cadet force failed to do, a brigade of infantry accomplished—the deer were driven out from the "Old Forest", back to the old Tottenham park.

ALICE HOLT LODGE

Reproduced by kind permission from the "Farnham Herald", 31st March 1967

The present Alice Holt Lodge, that charming residence which has been transformed into a headquarters for the Research Centre of the Forestry Commission, was built in or about the year 1820. If, from this, it seems to have had too short a time in which to accumulate much of a history, it is certainly true that the Lodge has had a long and interesting ancestry.

The Lodge is, of course, the focal point of Alice Holt Forest. It was that for many centuries before the Forestry Commission was even dreamed of, so, in the matter of history, let us first consider the Forest.

Considering its nearness to London, and its importance to the nation, Alice Holt has been curiously little described, and, in years past, almost unmapped. In spite of being a Royal forest for many centuries, it remained almost a *terra incognita.*

Even the Romans, who clapped a Roman name upon almost everything which they came across, had—so far as we know—no name for Alice Holt. Yet the Romans knew it well enough! Major A. G. Wade, of Bentley, has written a fascinating little monograph about the multitude of Roman remains which he unearthed there.

During the Roman occupation it is clear that Alice Holt became a most prolific pottery-producing area. In passing, it is interesting to note that the basic conditions which induced the Romans to build their kilns in Alice Holt were those which, two thousand years later, led to the founding of the Wrecclesham Potteries. Geology is one of the more stable influences in the affairs of man!

When the great Domesday survey was in progress, the surveyors and their scribes found endless trouble in assessing the district. So far as we can understand their plaints, these stemmed from two sources. In the first place there were no written records whatever, and in the second local pronunciation was so varied and bucolic that they could make neither head nor tail of most of the place-names!

By the time of Henry II things had been sorted out, and in 1171 there was published the first known survey of Alice Holt and the sister forest of Wolmer.

At least from this time forward Alice Holt was known as a Royal forest. It is likely that it held this rank even earlier. Its importance grew greatly with England's expanding interest in the sea and ships.

Why this was so, was summarized centuries later by Gilbert White of nearby Selborne in describing the difference between Alice Holt and the neighbouring Wolmer Forest. He wrote: "The Holt consists of a strong loam of a mirey nature, carrying good turf and abounding with oaks that grow to be large timber . . . Wolmer is nothing but a hungry, sandy, barren waste."

It was the oaks, and the ship timber they yielded, which gave Alice Holt its exceptional value.

The next survey of Alice Holt of which we have record was carried out in the year 1635. It is in this survey that we begin to hear about the Great Lodge—the predecessor of the present Lodge, and the official residence of the titular head of the forest.

This official was variously known as the Ranger, the Lieutenant, or the Warden. Because of the importance of the post, and the difficulty of supervising it, it was usually given into the hands of some trusted friend, or perhaps some distant relative, of the reigning monarch.

So The Great Lodge certainly saw much social life, as well as administrative activity. Round the periphery of the forest were smaller Lodges, the headquarters of district or subsidiary officers. Goose Green Lodge and Old Close Lodge were two of these.

Before moving on from the survey of 1635, two points about it are worth remark. Its date was two years after the birth of the remarkable Samuel Pepys, who was destined largely to reform all the shore establishments of the Navy—as well as to write a diary!

The second point is of more purely local interest. In the survey is a list of the Forest Officers, including one Allen Beldham, Deputy Woodward. Now that is an uncommon name; was he an ancestor of Wrecclesham's one-and-only "Silver Billy"—the great cricketer?

There was another survey in the following century, with more mention of The Great Lodge. But we are in the dark as to the fate of this great house, and all we really know is that its successor—the present Lodge—was built, probably on the same site, in or about the year 1820.

It is an unusual and quite charming house, but the unique thing about it is its setting. A drive curves its way to the front door, but, apart from this, the house is simply set down on the turf and among the trees of the forest.

Some of the trees are truly magnificent; there is, for instance, a splendid Wellingtonia less than fifty yards from the house, a shapely giant now some ninety years old. Yet all this sylvan beauty is no more than half a mile from the Farnham-Petersfield road, between Holt Pound and Bucks Horn Oak.

As you approach the main entrance of the Lodge you see that it was built of yellow brick under a slate roof. It is only two storeys high, but has a generously wide frontage.

The very wide portico links two wings, of unequal breadth, but with one unusual feature in common—the quite exceptional height of all the windows on the ground floor. They reach, in fact, almost from floor level to the high ceilings and suggest that whoever designed the house appreciated the exceptional beauty of its setting.

Inside, the house is full of character. Naturally its use as a Forestry Headquarters has taken some toll, but in general it has been kindly dealt with and generously preserved. The preservation has not always been easy. Some time ago the death-watch beetle became a serious menace. It had probably been brought into the house in old timber used in some previous rebuilding or extension. The original timber of the Lodge would still be far too young to really please this pest, which is said to like its oak at least five hundred years old!

The great hall, immediately within the portico, is an extraordinarily splendid and spacious room. The major reception rooms lead off it, as does the wide and gracious stairway.

The hall, and much of the rest of the interior, is now panelled. This was not so when the Lodge was built, but was installed by the Fisher family, one of several private tenants to whom the Lodge has been let at various periods.

It must have been an exceptionally pleasant home. The major rooms are light and comfortable, spacious rather than vast, and from each of them is a new vista of the encompassing woods. Upstairs, things are on a smaller scale; the ceilings are much lower for one thing, but they are equally gracious.

Following a period of neglect, during which many English woodlands were allowed to deteriorate sadly, there came a revival of interest in forestry after the first World War. The year 1919 saw the beginnings of the Forestry Commission, and Alice Holt Forest—and, of course, The Lodge with it—passed into their keeping in 1925.

So once again Alice Holt Lodge has become the active centre of forest management.

Which prompts an odd reflection: We incline to look back on our ancestors of a century or so ago with some degree of condescension. Yet it is surely doubtful if any of the new buildings of our generation will last as well, or be so readily adaptable to new and yet unthought-of uses, as Alice Holt Lodge has proved to be.

A photo of the Lodge appears as Plate 12 *on our centre pages.*

NOSTALGIA

Amongst the earthy woodland scents borne lightly in the breeze
I sometimes catch nostalgic whiffs that stir up memories;
Then if I stand and close my eyes I recall men I know
And incidents, emotions, friends of many years ago.

Tobacco from an old clay pipe, the smell of fresh turned soil,
A smouldering bonfire, rotting leaves, fried bacon, diesel oil,
The odour of a sweating horse at work in rainy weather
Or turpentine in fresh-peeled pine and scent of blooming heather.

When old campaigners sit and talk round a fire of crackling logs
And conversation turns to sport with hounds or gun and dogs
Spells are released and chords are struck amongst the country folk,
Then visions of the past are conjured up in puffs of smoke.

R. J. JENNINGS

RECREATION AND WILD LIFE

GUNS

From the Farm Safety Leaflet of the Ministry of Agriculture

There is only one correct way of handling a gun—that is the SAFE WAY

Every year farmers, farm workers and others are killed or injured by shot guns.

The elementary rules for the safe handling of guns set out in this leaflet should always be observed.

Make a habit of using your gun as described here. You will win the respect oj your companions in the shooting field, safeguard others and yourself as well.

When first handling a gun

First open it and see that it is unloaded. On hammerless guns, see that the safety catch is at "safe". Most safety catches are automatically put on "safe" when the gun is opened, but on some guns (mainly those of foreign make) the safety catch has to be manually operated both "on" and "off".

Check that the barrels are not dented, badly pitted or rusted and that there is no foreign matter lodged in them. If you are not familiar with the gun, check the effort required to press the triggers, using dummy cartridges. Familiarize yourself with its handling and if it is in any way defective, *don't use it.*

With a hammer gun, make certain that the hammers are right down and not at "half-cock".

In the field

When out with shooting parties and companions before a shoot always have your gun "broken", i.e. show that it's empty. It gives confidence. Don't load until you are taking up position for the drive or unless you are starting to "walk-up". When closing your gun, raise the butt to the barrels and keep them pointing downwards.

Keep the safety catch on "safe" until the moment you raise your gun to fire. Is is easy to acquire the habit of pushing the safety catch forward with the thumb at the time of raising the gun to the shoulder.

Should you not fire, then the same habit should be put into reverse and the safety catch moved to "safe" as the gun comes down.

When putting cartridges into the breech make certain that they go in easily. Damp cartridges swell and, although it may be possible to force them into the gun chamber, they may be very difficult to get out again—even if they have been fired.

Accidents can happen when trying to get a jammed cartridge out of the breech. The safe way to remove a jammed cartridge is to use a proper extractor.

If possible learn to shoot with *both eyes* open. Never shoot where you cannot see, for example, through hedges and bushes, or anywhere where another "gun" or other people (especially children) might be.

Walking between Drives

When walking between drives, unload the gun and have it "broken" over your arm.

When carrying it over your shoulder make certain that the muzzle points upwards and not horizontally or downwards.

It can be embarrassing for a friend to tell you that he can see what number shot you are using; in other words "he can see down your gun barrel"!

Always hold your gun in a safe position when it is loaded.

Obstacles

Before getting over a fence or stile or going through a hedge, crossing a brook, or on a steep bank, ALWAYS UNLOAD. It is not sufficient to open the gun and leave the cartridges in. Neither is it safe (if it is a hammer gun) to let the hammers down. A gun with faulty firing mechanism may go off if it is dropped. Hammers and triggers can also be caught on twigs and nails. Shooters lose their lives every year through accidents of this nature.

When shooting in woods and bushes make certain you know where the other shooters and beaters are, and see that the triggers and hammers are kept clear of twigs and brambles.

For Safety's Sake

NEVER take a loaded gun into a house or building.

DON'T carry a loaded gun on a tractor, combine or any other farm machine or vehicle.

Keep your gun (and cartridges) in a safe place and out of reach of children.

Clean and oil it and *put it away*.

Earn yourself a good name, as a safe shot, even if you are not a good shot. Don't be impatient; relax (you will shoot better). Be proud of your gun, look after it, and remember that it is a lethal weapon,

Care and Maintenance

Damaged and defective guns and those with excessively light trigger pressures are a menace to all concerned. It is a good idea to have your gun overhauled annually—before the shooting season begins. Gunmakers and gunsmiths are skilled and competent people and you can rest assured that when your gun is returned it is as safe as it can be, having regard to its age and general condition.

All guns should be able to stand the "proof" test, and advice on this will willingly be given to you by your gunsmith. It is now unlawful to sell a gun which is "out of proof".

See the photos in our central inset.

PUBLIC RECREATION IN FORESTRY COMMISSION AREAS IN NORTH-WEST ENGLAND

By MARTIN ORROM
District Officer, Headquarters

Forests offer more opportunities for varied outdoor recreation than any other form of land use. They have not the formality of farmland, they are generally easy of access and they have an unrivalled capacity of containing large numbers of people without obvious overcrowding.

In the North-West of England recreational facilities have been provided at selected forests near industrial and holiday areas. For example these forests include Cannock Chase in Staffordshire and Grizedale in the Lake District.

Many of the facilities provided and the booklets which describe them, have been designed so that visitors may not only enjoy the solitude of the woods but learn a good deal about them.

The opening up of forests near industrial areas assumes a great importance as the population becomes more mobile. Roads to the coast are often jammed so that the forest has a unique attraction.

Many people have always enjoyed the open parts of Cannock Chase so there is a steadily increasing desire to explore the relatively new 30–40 years-old forest. Recently the Commission has made a picnic site near a viewpoint, opened a deer museum and forest garden and built an observation tower from which the public may watch the local herd of fallow deer and other wild life. In addition, and perhaps most important now that the trees have grown on, the public is able freely to walk through the woodland rides. Cars, however, are not allowed in the forest.

For the sportsman a limited number of the necessary annual cull of deer are shot under daily permit, so that the woodland "pest" of a few years ago is now integrated into the conservation scheme and brings a revenue to help offset the cost of control.

In the Forest of Arden a joint project by the County Council and Forestry Commission has resulted in the laying out of a highly successful nature trail, much used by schools, and visited by over 5,000 people a year. Surprisingly little or no litter is left and vandalism is non-existent.

In the Lake District the Forestry Commission owns 31,000 acres of woodland. Here there is much open fell to walk upon but as the forests grow up they are increasingly attractive for holidaymakers and the many students who wish to study the varied aspects of this compact region.

The forests in the north of the area are on steep slopes and lend themselves most readily to providing sheltered viewpoints for the visitor who may leave his car in a layby and walk a short distance for them and a picnic site. Several of these laybys have been made in co-operation with the County Council at Thornthwaite Forest and elsewhere.

Further south, at Grizedale Forest, between Lakes Coniston and Windermere the valley sides above agricultural land are still carrying oak woods and these form a beautiful lower edge to the mainly coniferous forest, lending a natural appearance to the landscape. The valley has always been out of the main tourist stream, making it possible to develop the recreational advantages of the forest with the least disturbance to the forest management.

Grizedale holds a great variety of birds and animals and is notable for its roe and red deer. Part of the plan has been to allow the public to enjoy the sporting and educational possibilities of this fauna. A "linear recreation zone" has been created which attracted more than 7,000 people in 1966.

The heart of the zone falls naturally around the forest centre where there is the forest office and research nursery, a few forestry houses and a farm. Here a deer museum and wild life centre have been opened to the public. In the grounds of the now demolished Grizedale Hall a camp site has been leased to the Camping Club of Great Britain. This was recently described as the nearest approach in Britain to the best continental camp sites. The site of five acres is licensed to carry 60 tents which may accommodate 200 people. The Forestry Commission perpetuates the parkland effect by maintaining an arboretum of all the best known conifers and hardwoods. At the southern end of the site there is a meteorological station from which data is obtained for determining the daily fire danger in the forest.

A nature trail commences from the heart of the camp site and traverses some of the old woodland before returning to the car park. On the trail charcoal pitsteads recall the former important Lakeland industry of iron smelting, which influenced local woodland management for centuries.

The camp shop is in a stone building on one side of a walled courtyard to the old Hall, and this is gay with picnic tables in summer. In addition to the annual total of 6,000 campers, Grizedale attracts 2,000 schoolchildren and students, young and old, who are conducted in parties around the wild life centre, the nursery and nature trail.

By careful planning the majority of our visitors are content to enjoy no more than 40 or 50 acres, i.e., less than one per cent of the forest, enabling us to offer keen naturalists and sportsmen a variety of pursuits deep in the forest. For instance the recently formed Angling Club, limited to local membership with visitor permits, offers fishing for sea and river trout. The regular culling of the deer herds offers a limited number of deer to be shot under daily permit. A wildfowl rearing scheme on the near-by tarns will soon offer sport on the outlying tarns which will pay for the rearing. The series of enclosed and comfortable high seats, which are cabins built on towers or in large trees, include Treetops—a twelve-seater. These offer possibilities for photographing deer, wildfowl and other fauna unequalled in Britain.

Finally the person who wants a day of peace in the forest can now park, picnic and walk on round routes specially waymarked in an area well away from the more highly developed natural history interests.

Many questions remain to be solved both nationally and locally. There is no doubt however that the public demand for recreation is there and that a well-planned recreation scheme in a forest can fill a growing need without sacrificing even one per cent of the maximum yield of timber in the process.

WILDLIFE AND THE FORESTER

By **P. F. GARTHWAITE**
Conservator, Headquarters

Reprinted from the 1965 *Handbook of the Society for the Promotion of Nature Reserves*

Although this paper deals with wildlife conservation in relation to forest management in the Forestry Commission, it is in many aspects also applicable to managed woodlands in other ownership. Management here implies a permanent regime of tending, up to maturity and replacement, of mature stands as they are felled. Indeed, just as in the past the flora and fauna of the countryside have been enriched and preserved because of the habitats created by woodlands planted for landscape value, or for game coverts, rather than timber production, so the new woodlands planted mainly since the war, and mainly to supply the industrial needs of timber of this country, are creating new habitats for wild life whether the woods are in private or public ownership.

Two world wars in less than half a century brought demands on our timber resources which have given a false picture of forestry—a picture of indiscriminate fellings, followed by a long period of dereliction, followed by vast and monotonous replantings. Only now, forty years after the first large scale plantings of the Forestry Commission started, is the real pattern of sustained forest management beginning to emerge. This is a pattern of diversity of structure, of age and of species, for the forester must aim to maintain a steady flow of timber from his forests, and a steady flow of work for a permanent skilled labour force dependent on the permanence of the forest for its livelihood.

This diverse structure which the forester deliberately creates and maintains gives just those conditions most favourable for a rich and varied flora and fauna; there is change, but it is gradual; gaps in the canopy are created as mature stands are felled, and these scattered sunlit pockets are focal points for wild life; as also are the broad rides the forester makes through the woods, first for fire protection and then for extraction of timber. Thus the forest, from a relatively even mass becomes, in the natural course of management, broken up into intricate patterns of canopy levels and edges, and it is this sort of structure that attracts and holds birds and other animals.

All this arises as part of normal forest management for timber production. But with multiple use now the accepted objective of forest policy, more positive action can be taken for conservation, and added emphasis given to the recreational and educational value of the forest as a habitat and reservoir for wild life. Timber production must remain the dominant objective, but, without prejudicing this, many things can be done to assist conservation and give added facilities for the naturalist.

For many years, with the co-operation of ornithologists such as Doctor David Lack and Doctor Bruce Campbell, bird nest box schemes have been run in many of the Commission's forests, significantly increasing the population of tits and flycatchers, redstarts and other hole-nesting insectivorous birds in the new habitats that the forest has created. Many of these nesting-box schemes have now been taken over by local Natural History Societies or County Naturalists' Trusts, a development which the Commission greatly welcomes.

It is also nearly always possible to leave some natural vegetation to form an ecological reserve for wild life along streams or other suitable places. Brakes of oak, birch, alder or other broad-leaved species suitably sited, make a contribution to the variety and population of the flora and fauna out of all proportion to the area they occupy.

Most foresters are field naturalists by habit, and the natural sciences make up a large part of the curriculum of their training, both at the foresters' schools and also at the university. Thus it is not surprising to find among them some of the leading local authorities on badger, deer, birds and wild flowers. Based on the observation and knowledge of foresters and other members of the staff, the Commission is able to control deer in its forests selectively and humanely without the use of shotguns or deer drives, and to give a close season for roebuck, though this is not provided in the Act. One of the Commission's foresters developed the "badger-gate" techniques to such a degree of skill that he was able to maintain twenty-seven active badger setts in a three-hundred-acre wood, with seventy-seven badger gates in the perimeter fence all in regular use. Knowledge of this sort is now being used in laying out nature trails and forest walks in many of the Commission's forests for the benefit of the many visitors who want to know more about their surroundings. Field museums are also being made, particularly in conjunction with campsites to display items of local historical and archaeological interest, as well as the natural history and the forest history of the area.

The Commission seeks to reconcile the need to control animals and birds which damage trees or neighbours crops or domestic stock, with the Commission's responsibility for conservation, and with the increasing use of the forests for recreation of various kinds. Among other things this policy extends selective rather than indiscriminate control to most species, abolishes bounties for killing mammals and birds except foxes under certain circumstances, and encourages the improvement of the forest habitat to increase the population of harmless and beneficial mammals and birds.

In implementing these policies, it must be remembered that the Commission has not got the full control of all the land on which it is growing trees. Some of it is leasehold, and the agreement of the landlord must be obtained therefore before, for instance, public access can be granted or a nature trail laid out. The sporting rights may be reserved to the original owner or let to a tenant, whose rights must be respected.

It is, however, true to say that in a country where the natural habitats for wild life are constantly being eroded or adversely affected by development of one kind or another, the 1½ million acres of forests managed by the Forestry

Commission, increasing by nearly 50,000 acres per year, form an outstandingly important reserve for wild life under a secure and enlightened policy. The dire results of large-scale afforestation periodically predicted since 1920 have not happened. Everywhere it is being realized that the forests, as they develop, are creating habitats often richer and more varied than those they replace. Under assured and permanent management, these forests and woodlands will preserve and regenerate much of the wild life of this country that would otherwise be exposed to the danger of destruction.

IMPROVEMENT OF SPAWNING STREAMS FOR BROWN TROUT

By **K. FRYER**

Forester, Planning and Economics, West Scotland

Introductory

Although trout, when adult, will adapt themselves to and often flourish in a wide variety of habitats, it is in the earlier stages of their development that they become more exacting, particularly of the right conditions for the successful reproduction, and therefore survival, of the species. They need pure, well-aerated water flowing over an adequate depth of clean gravel of suitable size, with little danger of excessive silting during floods.

These conditions are best found in upland streams away from centres of population, with consequently less risk of pollution from industrial and household effluent, the only danger perhaps being the undue silting caused by hill draining for farming or forestry. Trout will of course spawn in conditions which are far from ideal, even on the bed of a lake if nothing better is available, but this will result in such poor survival rates that the value of such spawning is negligible as a means of increasing the stock.

It is often the case however that the best angling potential lies in waters which, by the very nature that provides better feeding and therefore grows bigger trout, do not have the best facilities for the trout to spawn in. The reason for this is purely geological and topographical. These waters are often alkaline by nature and lowland in character, and any tributaries they may have are usually the subject of drainage operations which are very necessary to lower the water table and improve the run-off from the surrounding, low-lying land. The drainage caused by this and other factors, if neglected, will lead to the deterioration of what spawning facilities there are, with a subsequent lowering of stocks.

Since these fisheries, where exploitable, are potentially valuable, every effort should be made to achieve the maximum productivity of all spawning facilities in order to maintain a healthy and balanced stock of trout in the waters.

Scale Reading and Growth Rates

If there is some doubt about the degree to which the fish stocks in a river or lake require building up, the growth rates of existing fish should be examined. This can be done by putting scales from the fish under a microscope, where it will be seen that the scales have concentric "rings" or ridges on them, very like the annual rings in a tree stem.

In the winter, when food is scarce and the fish tend to be dormant, little growth is put on and the rings are closer together; winter rings form darker bands than those caused by the summer rings, which are further apart owing to the increased growth that results from more food being available. From the number of summer and winter bands, the age of the fish can be estimated, and if compared with the weight and length of the fish a fair idea of the growth-rate can be had. The distance between the winter bands will also indicate the amount of growth the fish has put on each summer. The first year or two will probably show a poorer rate of growth while the fish was in the nursery stream, but if food is plentiful in the main fishery a dramatic increase in the rate of growth often results when the fish migrates to it.

If growth rates are shown to be good, the fishery will stand an increase in population, especially if the numbers of fish caught have fallen off in recent years. Poorer growth rates will suggest that the population may be more than sufficient for the available food supply.

Effects of Drainage Operations

Where fisheries lie within the influence of our plantations, their tributaries may be involved in drainage operations, initially for planting, and periodically thereafter when the drains are repaired. The increase in silt caused by this is the biggest single danger that can affect the survival of the young trout, at all stages of their development from egg—to alevin—to fry, with lessening effect as the fish grow larger.

The parent trout does its best to choose a spawning site where the dangers of silting will have the minimum effect, and in normal conditions there is a fair chance that the spawning will be successful and will escape a disastrous deposition of silt. If excessive silting does occur however, and reaches the egg pocket deep down in the gravel of the redd (spawning site), the eggs become coated with a layer of silt, making it difficult for the emerging alevin to rupture the egg membrane, and this usually results in death. Newly hatched alevins can withstand damage from silt a little better, because the movement of their pectoral fins and later their tails will keep the silt from settling on them. Their mouths have not opened at this stage, and their gills are not in use for breathing, so there is no chance of the silt blocking their respiratory system. About twenty-four hours after hatching, however, their mouths and gills begin to function, and when silt is taken in with water through their mouths, and passed over their gills, the resulting irritation will cause mucus to form on the gill surface in which the particles lodge. When the quantity of silt present is not too great or too prolonged, the silt-laden mucus will pass gradually through the gill openings and will normally not prove fatal. But heavy and continuous applications eventually inflame the gills to such an extent that they will cease to function and death will follow. Laboratory experiments have shown that continuous applications of even small quantities of silt are more dangerous than occasional exposure to greater amounts of short duration, as in natural floods. Since the former situation is likely to apply during drainage operations over several weeks, it is easy to imagine the heavy mortality that is likely to be caused amongst the spawn and young trout if the draining happens to coincide with these stages of the fish's life cycle.

Where the spawning tributaries of a particularly valuable fishery are involved in drainage operations, it would seem advisable to arrange, if convenient, that these should not take place during this critical period, which would be from the beginning of October throughout the winter until March, when the alevins usually begin to emerge from the gravel. The period may fluctuate in duration, depending on the severity of the winter. A long, cold winter may delay emergence, for as much as eight months, until May, but an exceptionally mild winter will cause an early emergence; for temperature is the controlling factor in the rate of development of the young fish. Thus nature conveniently arranges that the young trout do not emerge before the increase in the food organisms that they rely on is brought on by the warmer weather. In the meantime they subsist on the contents of their yolk sacs until they are ready to emerge.

Drainage operations have another detrimental effect when carried out on the spawning streams themselves. The ditch-like water channel with uniform gradient of bed, that is favoured by drainage engineers, does not, unfortunately, provide very suitable spawning conditions for trout. If left to their own devices, the streams will eventually regain much of their former character, as obstructions occur and pools and shallows are formed by erosion of the bed of the stream. However, since these streams are the "leaders" in the drainage system, it is essential that they are kept in an efficient state of repair; fortunately a reasonable compromise can be achieved between the demands of drainage and the needs of the trout.

If the stream is made deep enough to lower the water-table sufficiently, there is no reason why the bed should not regain its natural form of a series of pools and shallows which, providing there was ample gravel, would provide the trout with their spawning sites. After all, the formation of the bed of a drain does not affect the volume of water that it can carry, only the speed at which it can be removed, depending on gradient. Even then the slowing-down effect will only occur in the initial stages of a flood as each pool takes time to fill up and spill over into the next. Once the flood is in full flow the overall speed will be constant.

The ridges of gravel thrown up by the spawning trout do not constitute an obstruction that will impede drainage, and may even result in maintaining water-tables at a more satisfactory level in times of drought. When clearing a stream for drainage, care should be taken to leave the gravel in situation, and only actual obstructions, such as lop-and-top that may have fallen in the stream and become lodged there, should be removed, as these will also obstruct the passage of trout upstream.

Flash floods of great severity often result from improved drainage, if carried out too thoroughly and these will cause the spawning gravel to be washed away, and the ova with it if the floods occur at spawning time.

Once again care can be taken that this danger is minimized, by siting the drains so that the run-off is no more rapid than is necessary to adequately drain the ground. Contour draining can best achieve this, and the reduced velocity of run-off will result in there being less danger of erosion, with consequently less silting.

Water Velocities and Gradients

The velocity of a stream depends on the gradient, and the speed at which water flows over the stream bed is a prime factor in influencing the trout in their selection of a spawning site. It not only determines the size of material that will be available to them, but faster rates of flow over spawning areas will prevent silt from settling readily.

Varied conditions occur naturally when a spawning tributary resembles a miniature river which can be divided into three zones, starting high on the hill-sides as a mere trickle.

Here the gradient is steep and the water drops from pool to pool in a series of falls, often wearing deep pockets out of the bedrock. Only the larger stones and boulders resist being swept away by the force of water during floods, and the smaller material is carried on to the next zone. This will resemble the river valley, and gradients will become more gentle, allowing a progressively finer grade of gravel and stones to be deposited as the velocity is reduced. The fine particles of sand and silt will mostly continue in suspension until the third and final zone is reached, where the flow becomes sluggish as the stream meanders across the more level countryside (coastal plain), that usually borders a river or lake. The fine particles will finally settle, creating a muddy bottom that is completely unsuitable for trout to spawn in.

It is the middle zone that the trout choose as their spawning habitat, and this obviously varies in extent according to the length of the stream and the topography of the countryside it flows through. Trout make full use of the fringe conditions as well as the ideal, but with correspondingly less success. If the velocity of the normal flow is marginally too great, redds will be washed out by floods; conversely, too slow sand deposition will cause heavy mortalities.

Trout have spawned in velocities of flow reaching 8 feet per second, and down to practically nil, but the ideal range would be somewhere between ·75 and 2·5 feet per second normal flow, which would be sufficient to prevent silt from settling but would allow also for increased velocities, during times of flood, that would not destroy the redds.

Although the general gradient determines the overall velocity of flow, the strength of current that flows through the gravel of a redd can be increased by

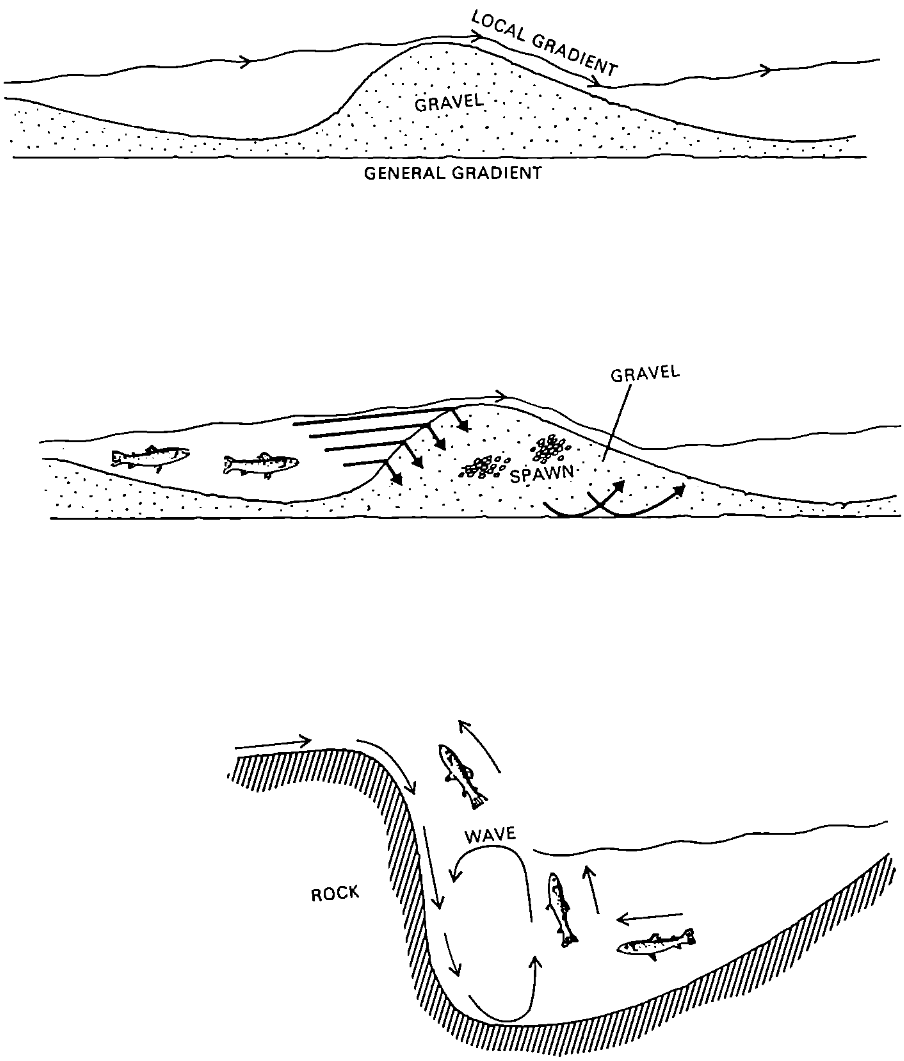


FIG. 3. Spawning grounds for salmon, and how fish jump up waterfalls; arrows show water flow, and the darker arrows indicate currents carrying air through a gravel bank.

the difference in water level above and below the redd, creating a local gradient that is steeper than the general gradient. (See Fig. 3, top.) This means that suitable spawning sites can be created where they might otherwise be unsuccessful, because the general gradient is a little too gentle.

Function and Productivity of Spawning Streams

The function of a spawning stream is two-fold. Not only should it provide the trout with adequate spawning sites, but it should contain areas suitable for the continued development of the fish once they have hatched and emerged from the gravel. The maximum productivity of a stream depends on having the right proportion of spawning area to nursery area, for no matter how many young fish hatch out the number that will survive to maturity will be determined by the ability of the stream to support them. Some may stay as long as four years in the nursery stream before migrating permanently to the main river or lake. At least half will stay for two years, unless the stream is too small and the food supply too inadequate to support them at that size, in which case they will migrate during the winter following their hatching, when they are approximately one year old. So it can be seen that any increase in stocks in the fishery to be improved may not be noticed for about two years after the improvements are started.

If suitable conditions are available, survival from egg to fry stage can be expected to be as high as 90 per cent, but it is after emergence that the greatest losses occur as the small fish fall prey to predators, even their larger brothers. It can be taken that approximately two square yards of spawning ground are required for each pound weight of female trout. Since trout will, on average, produce 800 ova per pound of their body weight, this will result in a figure of 400 ova per square yard being deposited. With a survival rate of 90 per cent from ova to fry, this will produce 360 fry, of which probably only a further three per cent will survive to the yearling stage. Therefore, each square yard of spawning ground will produce about a dozen one-year-old trout. The fish will require a little more than a square yard of nursery area each to support them, provided the stream is reasonably rich in food, so a proportion of 15 square yards of nursery area to one square yard of spawning ground will be necessary. This will widen to as much as 30 to one in poorer streams. Double these figures of nursery area will be required if the trout reside in the stream until they are two years old.

Improvement of Spawning Areas

Since the young trout spend the first six months or so of their life actually in the gravel of a redd, the condition, size and depth of gravel is all important to their survival. The female trout always tries to choose a site for making a redd where the current flows down through the gravel. This is because oxygen is obviously necessary for the young trout to survive after they have hatched out deep down in the gravel. If aerated water is not getting down to them, mortality will be 100 per cent. This might happen when large quantities of silt settle on the surface of the gravel, forming a crust through which the water cannot penetrate.

The downward current is created by the fact that water currents always flow at right angles to any obstructions in their course. (See Fig. 3, centre). If gravel is banked up, it will assume a natural angle of repose of 45 degrees to the stream bed, and the current will flow downwards at right angles to this, with the strongest currents at the apex of the mound. The female trout creates these conditions when she heaps up the gravel with her tail while cutting the redd, and again in covering the eggs after the male has fertilized them. Sometimes areas of gravel that are apparently suitable are ignored by the trout, usually because there is some impermeable obstruction in the gravel that prevents the current from taking its downward course.

Size of gravel is very important.

In natural conditions the velocity of the water will grade the size of gravel laid down, and since the larger trout will be able to use larger sizes of gravel a fairly wide range can be taken advantage of. The important factor however is the proportion of fine material that is present in the gravel. If this is too great, it will fill up the spaces between the larger stones, and the alevins will have greater difficulty in moving about in the gravel. More important still, the weight of water over the gravel will cause it to become compacted as the fine material "cements" the larger stones together and, if further aggravated by the deposition of silt, will prevent the aerating downward current through the gravel, thereby cutting off the oxygen supply from the young fish. It would appear therefore that there is a direct relationship between the proportion of fine material and survival rates. A suitable grade of gravel would include approximately 15 per cent of larger material, ranging from three inches to a maximum diameter of four inches, the balance being made up of all sizes below this with not more than 25 per cent of fine material, say less than a quarter of an inch. It would be preferable to exclude material less than three-quarters of an inch completely, but unfortunately trout do not always show a preference for clean, coarser gravel if more natural grades are also available. The depth at which trout deposit their eggs in the gravel varies with the depth of gravel available and the size of the trout, but in normal conditions it will range from six to 12 inches deep. It is essential that the gravel is deeper than two inches because it is in this layer that the creatures which might predate on the young fish also make their home, such as the large and voracious larvae of the stonefly (*Perla*), which attacks both eggs and alevins if these are within reach. In fact, the alevins do not enter this layer until they have absorbed their yolk sacs, so that being no longer encumbered they can escape from attack more readily. To make the gravel more usable for the fish, it is worthwhile going over the spawning areas in September, before the trout are due to spawn and to fork over any compacted gravel to a depth of 12 inches, also raking it up into ridges or mounds towards the tails of the pools. This is better done when the stream is above normal level after rain; by starting at the top end, the stronger flow will wash away any silt and finer material that is disturbed. If the stream is otherwise suitable for spawning, but has insufficient gravel, additional material can be introduced, graded on the sizes already described but excluding, if possible, all material less than one-tenth of an inch. This again should be placed in ridges or mounds rather than spread over the bed of the stream.

Where there is a danger of the introduced gravel becoming unstable during floods, it can be kept in place by putting wooden boards at least five inches wide across the stream, with the gravel heaped upstream of them. These should be spaced about five times the width of the stream apart, and care should be taken that the water can find its way beneath them so that the downward current through the gravel is maintained. The boards will have the effect of creating a series of pools, and if the water is made deeper in them this will also improve the stream for nursery purposes.

Improvement of Nursery Areas

The stream will benefit from having areas of deeper water for the young trout to develop in, after they have emerged from the gravel. Trout usually spawn in water varying from six to eighteen inches deep, but it is preferable if nearly half the nursery area includes water up to two feet deep. On the figures already given, this would be about six square yards, out of the fifteen square yards of nursery area, to every square yard of spawning ground.

If it is necessary to achieve this by building small dams, other than to create spawning grounds, care should be taken that the up-stream side is not left vertical; otherwise the fish will find it difficult to leave the pools downstream, especially in times of drought when the pools might become death traps for the fish. Stones and gravel should be raked against the upstream side of the dam, so that the sloping bed will assist the passage of the fish downstream.

The condition of the gravel is important even after emergence, because the fry will burrow into it to escape from attack by predators; so an eye should be kept on the state of the gravel through the spring and early summer, in case a heavy deposition of silt from draining has caused a "crust" to form through which the fry cannot burrow.

Undercut banks and large stones should be retained, as these provide further shelter from attack; in particularly exposed places old wire netting can be spread over the smaller streams if herons should prove a menace. Stream-side bushes should also be retained and even introduced to provide shade during the summer.

Improvement of Access

Sometimes valuable spawning grounds are denied to the fish by obstructions such as waterfalls, weirs or piles of debris, branches etc. Even obstructions that are negotiable, although with difficulty, may prove impassable at the very time the trout wish to ascend, if a convenient spate does not occur at that time. Although it may prove too expensive in some cases, every effort should be made to ease the fish's progress upstream, otherwise valuable energy will be expended that may result in the fish's death after being already weakened by spawning. This is especially important in the case of the female trout, who does all the hard work of excavating the gravel on the redds. The ability of a fish to jump over a waterfall depends on certain hydrodynamic principles and the height of the fall. When water drops over a fall it reaches the bed of the pool and bounces off it to create an upward thrusting current. This manifests itself in the bubbling, frothing bulge or wave that can be seen close to where the descending water enters the water of the pool. This is called the "standing wave". (See Fig. 3, bottom). The ideal balance, between the depth of the pool and the height of the fall, to create the maximum upward thrust, and therefore a well defined standing wave, is 1¼ times the height of the fall from the water level of the pool, if the fall is nearly vertical. The bed of the pool will eventually be eroded to this depth even in solid rock, but if the pool is shallower than this the "bounce" will become spread out in all directions, creating a confusing complex of currents.

The fish use this upward thrust to help them in their leap, but unlike human beings they cannot stand back and weigh up the distance they have to jump, and take a run at it; they just enter the influence of the standing wave and when they feel the upward thrust they probably leap blindly and hope for the best.

Complications arise however if the water is flowing down an incline as in a weir. Then the fish's leap, which tends to be more vertical than horizontal in direction, will probably only land it part-way up the incline, and it will be swept back by the force of the water. The horizontal distance between the standing wave and the lip of the fall is just as important therefore as the height of the fall. The fish must reach the lip of the fall at least with its leap before it can propel itself into the haven of the pool above.

It is not known with any certainty how high trout are able to jump. Salmon have been known to leap successfully over nine feet high falls, but trout will probably manage to jump little more than half that height, depending on the size of the fish.

However, the determination of trout to ascend obstacles at spawning time has to be seen to be believed. I once came across a trout, one dry September, which was halfway up the sloping face of a weir. Its back was more than half out of the water and how long it had taken to inch its way painfully slowly up that far, or indeed how it had managed to do so at all, I find it hard to imagine. Its efforts would have been in vain however because the weir had a lip that would have prevented the trout from getting any further, so I took pity on it and carried it to the pool above.

Little can be done to improve access over falls which are too high for the fish to jump over, unless a fish ladder is built, which would be expensive. A well-placed charge of explosive might help in some cases to make two smaller falls in the place of one that is too high. Similarly, a "step" could be blown out of a sloping fall, enabling the trout to negotiate the fall in two stages. Weirs too would have to have steps or fish ladders built into them, but since the small streams suitable for spawning are unlikely to have weirs built across them, these are less of a problem.

Piled up branches and other debris should be removed where they block a stream, for although water might be able to trickle through them the trout would undoubtedly have difficulty in finding a way through. Walls that may cross a stream sometimes sink or collapse, blocking the stream in the same way, especially if debris collects at the back of them. This can remain undetected until the next time the drains are cleaned, especially if it occurs in the middle of a thicket-stage plantation, and two or three years valuable spawning may be lost.

Additional Methods of Re-stocking

If access upstream is blocked, the fish can usually pass downstream with little difficulty, and rather than waste potentially good spawning and nursery areas the spawn can be introduced artificially.

In recent years there has been an increasing use of slatted perspex boxes, the spaces between the slats at the sides being too small for the eggs to fall out but wide enough to allow the newly-hatched alevins exit. The ripe parent trout will have to be caught by netting before spawning and then "stripped" by hand; first the female to get the eggs, and then the male to fertilize them. The newly fertilized ova is placed in the perspex boxes and buried in suitable gravel at a depth of about nine inches. This method has the advantage of requiring a far smaller area of spawning ground than the female trout would otherwise use in making a redd. It would also be a considerable saving on the costs of artificial re-stocking of the fishery with hatchery-reared yearlings or two-year-olds.

If there is no suitable gravel available, but the stream is otherwise suitable for rearing purposes, trout fry and autumn fingerlings could be purchased, again far more cheaply, and "planted out" in the stream. These should be put in at a rate of approximaely 20,000 fry or 800 yearlings per mile for a ric h stream, and 10,000 fry or 400 yearlings for poorer streams. Every effort should be made to spread them out fairly evenly over the whole area. This would have to be done annually, in the late spring for fry, and autumn for fingerlings. When ready the fish will drop downstream into the main fishery, so providing a balanced and regular re-stocking.

Conclusion

As in forestry practice, success in any aspect of fishery management depends on so many inter-related factors that a breakdown at any one point could delay any benefit from the work for as much as several years. However, providing the basic principles are followed and any dangers avoided as far as possible, the amount of improvement should be significant. It must be emphasized, however, that improvements to spawning facilities must not be carried out where growth-rates suggest the trout stock is already too large for the food supply to cope with, as this would only result in a drop in average size.

A well managed fishery can be an asset, not only for the improved sporting and recreational value but for the increased revenue that should result. The present low incomes from many of our fisheries may not fairly reflect the potential value of them, but rather the poor quality of sport they offer for want of development. This is significant especially in the face of the steadily growing demand for good fishing.

Adequate and balanced spawning and nursery facilities are the foundation of all well-managed trout fisheries. If improvements are indicated no time should be lost in putting things right so that the future may be assured.

PINE MARTENS

Notes from Conservancies, compiled by the late D. Graham-Campbell, Assistant Conservator, Headquarters

The Commission recently published, through the Stationery Office, Forest Record No. 64 *Pine Martens*, price 2s. 6d. This was written for the Commission by an expert on martens, Mr. H. G. Hurrell.

During our investigations the following very interesting notes on Pine martens were received.

Conservator, North Scotland states: "Pine martens are most abundant in Slattadale Forest on Loch Maree side. This forest adjoins the Beinn Eighe Nature Reserve which has as one of its objectives the safeguarding of Pine martens.

The second area where these animals occur in considerable numbers is one which extends from Port Clair Forest on Loch Ness side westwards through Ceannacroc, Glenurquhart, to Affric Forest. In Affric and Ceannacroc they appear to stick pretty closely to the native Scots pine woods. In Glenurquhart and Port Clair on the other hand, the Pine martens seem to be quite at home amongst plantations of Sitka spruce.

Martens have been reported sporadically from such widely scattered forests as Farigaig, Oykel, South Strome and Strathconon.

There is no indication that they harm the forest in any way, indeed the reverse is the case as their diet appears to include red squirrels and rabbits when these are present. They must also take some toll of small birds. One Forester reports that Pine martens eat large quantities of rowan berries when these are in season and some have been known to eat fish. We have also received reports of martens doing extensive damage to domestic poultry.

Although these animals are associated with certain forests, there is no indication that they are restricted to a particular part of these forests. It would seem that when disturbed by felling or other operations they move away to other parts of the forest but seldom beyond the boundaries of a region."

Coming further south, **Conservator, North-West England** made the following comments on the marten:

"*Habitat.* The common features of places where I have found regular evidence of martens is that (*a*) they are prominent and (*b*) they provide concealment. Typical haunts are outstanding rocky tors or cairns on the skyline of hills, rough crags and scars protruding from wooded hill sides, and clumps of large trees in commanding positions amongst smaller growth, either partly hollow in the case of hardwoods, or evergreen conifers, such as old flat-topped Scots pines. I have no doubt that their liking for the latter, and the fact that red squirrels, also associated with pines, provide a major prey when plentiful, explain the origin of the name pine marten.

Such places are those on which birds of all sorts will regularly settle, and the marten hunts by lying up in crannies in the rocks, in the stubs of hollow branches, and amongst evergreen foliage, and leaping out on them by surprise. There are quite a lot of records of martens occupying the ruined roofs of deserted buildings for the same purpose and tracks show that they also follow the mazes of eroded peat haggs. The other evidence is in feathers, mainly discarded wings, and the characteristic pointed droppings, which also contain the remains of quills.

Each marten appears to use a series of these ambush points and moves from one to another in constant succession; the tradition in the Lake District, based on experience when they were regularly hunted, is that the individual circuit averages five or six miles. The young are born in similar situations: crannies in crags, enlarged woodpecker workings, burrows in peat haggs, and squirrel dreys, crow or magpie nests in old pine trees or other evergreens.

Damage to trees. None.

Role as predators. A number of sightings that have been reported to me have been of martens in hot pursuit of squirrels and quite oblivious to anything else, but I have never seen this myself. As you will know, Dr. Lockie at Beinn Eighe found that they depended considerably on voles, and such records as I have suggest that they spread on to the open moorland habitats mainly during vole years. Apart from these and a fairly regular diet of birds they are insectivorous and also eat fruit. I have found tree wasp nests broken up by them in Scotland, and bumble bee nests dug out in the Lake District. They have quite a passion for wild raspberries, and also eat bilberries.

To be quite objective in the matter one can only sum up by saying that they are at present so rare that they can have no significant effect on the forest at all. However I personally believe that they should be conserved not just because of their rarity, but as potential major predators of the red squirrel, in case this animal should again threaten to beome a serious pest.

Finally, as regards distribution in Commission forests, I have authentic records over the past 16 years from Kershope, Spadeadam, Greystoke, Thornthwaite, Ennerdale, Dunnerdale, Grizedale and Lindale. The Lake District generally is of course one of their main strongholds; there were a lot of reports from all parts of it during the late 1950's but since then there seems to have been a bit of a decline. This could perhaps be correlated with the fact that there has been no major vole plague since 1958; if so, since they are fairly long lived, it may reflect no more than that there is a greater chance of martens being seen in the open than in the woods.

One of the best means of conserving martens will be to retain clumps of old trees in prominent situations, and to put up suitable nest boxes. I think they are not likely to become in any way frequent until we have much larger areas of mature forest."

Martens have also been spotted in Wales. From **North Wales** came the following.

"Pine martens are very seldom seen and then it is usually an accidental and quick glance as they cross a road or open space; or dead in a trap. Even then it is usually on the edge or close to a forest rather than in the plantation proper. We do our best to avoid catching or killing Pine martens".

Mr. Best (retired Conservator, North Wales) went on record towards the end of his long spell in North Wales saying that he had never had the good fortune of seeing one himself and very few of the staff had either. "There is little doubt that the headquarters of the Welsh martens has always been the area of rocky mountains north-west of Dolgellau and the Snowdon mountains themselves. Reports of martens from this area have been very infrequent of recent years but they have been reported in (or near) our forests in that area".

Records of Pine martens seen in or near our forests

1937–38 *Beddgelert Forest.* Two killed, one by a Forester and another trapped by A. Griffiths Jones, Aberdunant, Portmadoc.

1939 *Gwydyr Forest*. One seen by two F.C. employees in Lledr Valley, Betws-y-Coed.

1940 *Beddgelert Forest*. One trapped in a fox-trap in April.

1946 *or about*. *Cwmeinion*. Animal reputed to be a marten seen by I. H. Griffiths, now a forest worker at Taliesin forest. 1957. Penymyndd, near Coed Pant Glas in Elwy forest. Animal shot by farmer and hung on fence.

1948 *Gwydyr Forest*. One trapped at Trefrw, reported in Press, and skin believed sent to the National Museum, Cardiff.

1948 *Coed-y-Brenin*. During a cold spell in February an animal broke into a hut occupied by Poles and left footprints on the table-cloth. One Pole identified them as of a "wood marten" which he claimed to know. This was at Maesgwm Camp, Trawsfynydd.

1948 *Deudraeth Forest*. An animal whose description fits with a Pine marten seen crossing the road near Hafod Fawr Block. Both had seen polecats and foxes and their identification is probably reliable.

1952 *Gwydyr Forest*. One seen by D. V. Nash, a junior student at Capel Curig Foresters' school.

1955 *Dovey Forest*. One was trapped by accident and the skin identified by Mr. Best.

1958 *Gwydyr Forest*. A pair seen by three forest workers.

1960 *Gwydyr Forest*. One found dead on the road at Penmachno about 12th April by a Northern Ireland forestry student—taking the skin with him.

There have been no reliable reports of Pine martens having been seen, dead or alive, since that date.

In his *Hunting Diary* Newton Wynne Apperley describes hunting the "Marten-Cat", by moonlight with a few older hounds. He was then describing a system of hunting in the past, and it was probably practised in North Cardiganshire in the first half of the nineteenth century.

There was a photograph of a marten taken by a St. Clears (Carmarthenshire) schoolmaster published in *Country Quest* about 12 months ago.

If I were commissioned to look for martens in Wales I would work on the areas of rocky mountain and heather, where I am sure they could be found in very small numbers. No naturalist, I think, would disclose a site and it's possible there are some that are known."

South Wales's only experience of the Pine marten was a report of a sighting at Llanddowror Forest (Pembrokeshire) in December, 1965. The forester concerned is a reliable naturalist, and has also received reports from three other local people.

Conservator, South Wales consulted the Keeper of Zoology, National Museum of Wales, who reports one record of trapping in Breconshire in 1950. He also has five reliable sight reports from Breconshire, Carmarthenshire, Monmouthshire and Pembrokeshire between 1950 and 1967.

THE LATEST ELSAN

A Lavatory Suitable for our Forests

By **M. H. ORROM**

District Officer, Headquarters

As the public are welcomed into our forests in ever-increasing numbers lavatories will have to be provided by us, or the local authority, at the most popular centres.

The latest Elsan system is a great step forward from the simple chemical closet used in caravans. The new system is being installed on busy trunk roads such as the A.40 and has proved successful.

The basic advantages of the system are that it requires no main water or main sewer and in many cases it can be made permanently self-draining. The installations are similar in type to the normal water-flushing pans but in the case of the Elsan it is self-cleansing by lifting and closing the lavatory pan lid.

The sewage deposited in this system is rendered an odourless 100 per cent sterile liquid which can soak away safely without possible harm to animal or plant life. On some sites, however, the soak-away may not be suitable and the closed system then has to be pumped out at regular intervals. However, the volume of treated effluent is only about one per cent of the liquid volume produced under a normal water-flushing system and therefore emptying is not a big problem if a sewage disposal lorry can be brought alongside the lavatory.

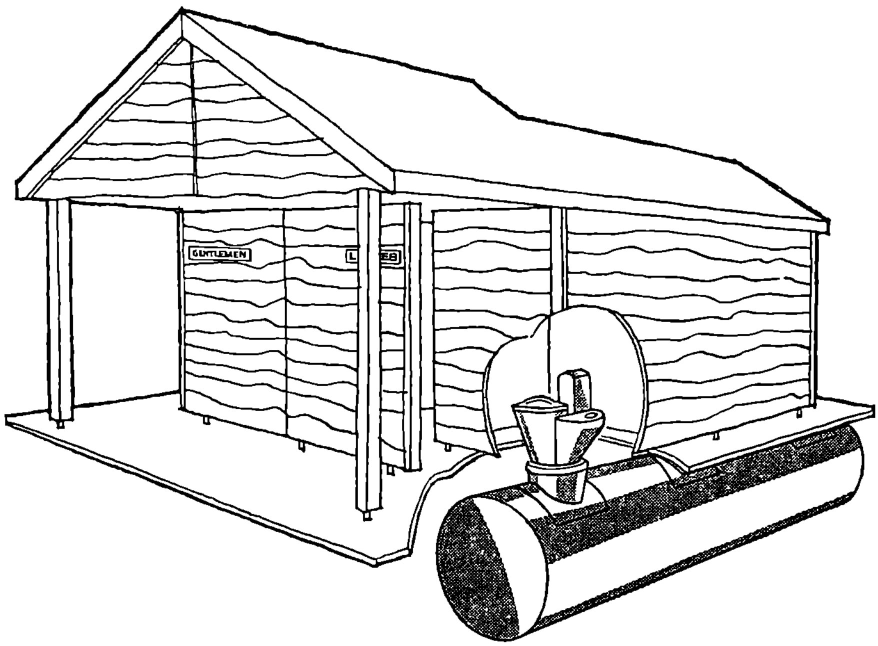


FIG. 4. The latest Elsan.

Normal maintenance of the building is required at least daily but chemical topping-up, in the case of a lavatory only having moderate use, such as in a forest rather than in a busy lay-by, will only be required weekly.

The system is usually built of stainless steel and this together with the very low freezing point makes the basic design very strong and resistant to vandalism.

The sketch shows the main design features. Sewage from the treatment tank only overflows into the soak-away at a predetermined level and then only at the same rate as sewage entering the system, so that the original chemical is only lost slowly and the soil in the vicinity of the soak-away is not heavily impregnated with chemical at any one time.

The cost of a simple installation erected with our own labour and housed in a timber building would be in the region of £1,000–£1,200 for two compartments for both men and women.

ANIMAL TRACKS

Most creatures in the wild you'll find
Leave a distinctive track behind.
Some when they pause to rest or feed
Will jettison a cone or seed,
Whilst others dig or scrape the turf,
Their claw marks then left in the earth
Resemble tyre treads on a car
That, splashed with oil or melted tar,
Enables you to trace them home,
Know what they are and whence they've come.
You may have seen the elder trunk
Ripped, torn and scarred where Brock has sunk
His pointed claws in wood and bark
To polish them and keep them sharp.
The squirrel nibbling seed or mast
Scatters the husks amongst the grass.
He stacks nuts in a secret hoard
Often forgetting where they're stored
And then a mouse or hungry vole
Removes them singly to his hole.
The prints of deer you'll recognize
From those of sheep by shape and size.
For Roebuck's toes dig in the ground
Superimposed where they are found,
Unlike the slots of grazing sheep
Whose rounded heels are pressed in deep.
But easiest of all to trace
Are members of the human race
At weekends when they leave the towns
And migrate to the woods and downs.
They discard tins and paper bags,
Old mattresses and dirty rags,
Dump their old bed or motor bike—
What must their living rooms look like?
For animals where'er they roam
Leave tracks just like they do at home.

R. J. JENNINGS.

LAND USE

THE MANAGEMENT OF WOODLAND NATURE RESERVES

By A. J. KERR

The Nature Conservancy, Edinburgh

(*Reproduced from the Edinburgh University Forestry Symposium*, 1967)

Introduction

The Nature Conservancy have declared one hundred and fifteen National Nature Reserves and twelve Forest Nature Reserves, together covering over 246,500 acres. Woodland is present on seventy-two of these reserves to the extent of nearly 12,000 acres. Sixty of the reserves have been declared wholly or partly on account of their woodland interest. This information and some of the following is presented on an England, Scotland, Wales basis in Table 9.

Only some 3,500 acres (29 per cent of the total woodland area) are owned by the Nature Conservancy. Of the other 71 per cent approximately 60 per cent is protected by agreement with the owners and the remainder is held on lease. The Forestry Commission or other Government Departments own over 2,000 acres of the land protected by agreement and in such cases the site is termed a Forest Nature Reserve.

The size of the woodlands ranges from under five to over two thousand acres with a national average of about one hundred and sixty acres. From Table 10 it can be seen that well over half the total number of reserves contain less than one hundred acres of woodland. The differences in size-class distribution between England, Scotland and Wales are to a large extent a reflection of the land-ownership and land-use patterns of the respective countries.

Apart from the coppice and coppice-with-standards woodlands of southern and eastern England, the series of woodland nature reserves has a predominantly western distribution. In England, an extensive area centred on the midland plain and stretching from Gloucestershire to Lincolnshire does not contain a woodland reserve. The counties of Denbigh, Montgomery and Radnor form the major blank in Wales. Another large area without representation stretches from Cumberland and Durham through the southern uplands and midland valley of Scotland to the counties of Perth and Kincardine. Figure 5 shows the actual distribution of reserves.

The main reason for establishing a National Nature Reserve is to conserve a representative sample of a characteristic biotic community. The woodland reserves should, therefore, contain samples of the range of semi-natural woodland types to be found in Britain and the relative acreages of these types might be expected to reflect their abundance.

In a few cases woodlands have been declared reserves because they contain rare tree species. An example of this is Glen Diomhan N.N.R. in Arran, which contains populations of two endemic species of the genus *Sorbus*.

Some of the woodland types in the national series, although characteristic, are far from semi-natural. This applies particularly to coppice. In south-east England the coppice woodlands contain a rich insect fauna and it is to conserve this fauna that the reserves have been established.

A further reason underlying the establishment of all National Nature Reserves is the provision of research areas for students of the British flora and fauna.

Obviously, in any reserve the major management objectives will be closely

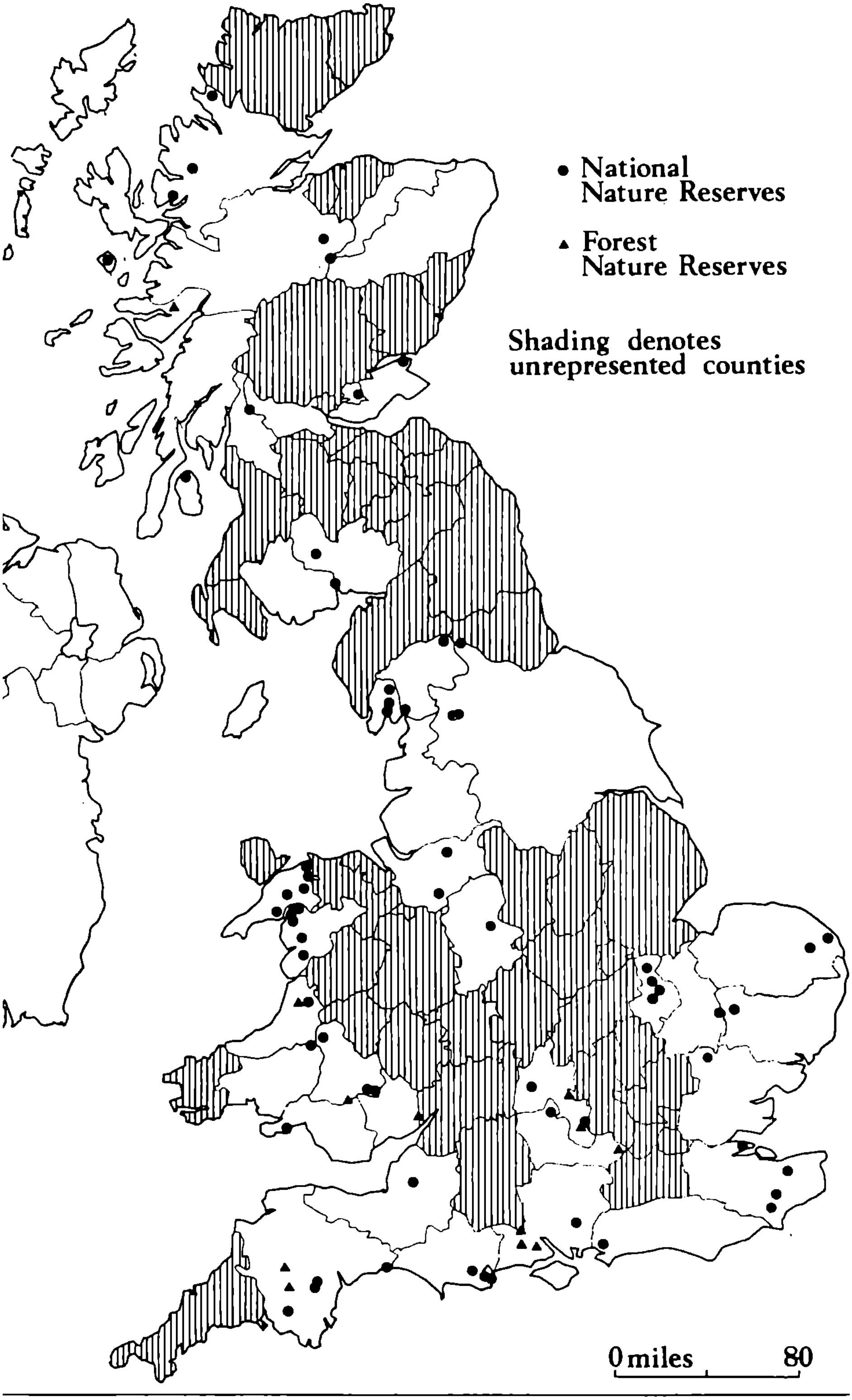


FIG. 5. Distribution of Woodland Nature Reserves.

related to the reasons for establishment. Thus, if an area is declared as a representative sample of an oakwood type then management will aim to perpetuate the existence of that type. Similarly if a reserve is established because of its rich insect fauna management will aim to conserve this.

With regard to the provision of research facilities it is often the case that the objective is achieved simply by declaration of the reserve. In other instances the provision of accommodation or transport may be necessary.

Apart from these two major objectives most reserves are expected to fulfil other roles. In particular, recent trends have necessitated critical examination of the extent to which reserves can fulfil recreational and educational functions.

In attempting to plan the management of any forest or woodland area consideration is usually given to supplying an adequate description, defining objectives and prescribing effective action. The management of any resource demands a sound knowledge of what that resource comprises; providing objectives is fundamental if management is to meet satisfactorily the demands made on the resource; and prescription of effective action requires a sound appreciation not only of the resource and the demands to be made on it, but also of the manpower, money, materials and techniques available for its management.

Management Plans for Nature Reserves are prepared by regional staff of the Nature Conservancy with help from experts as appropriate. In the case of woodland areas consultation is held with a woodland team who subsequently prepare a Working Plan if much silvicultural work is envisaged. Both documents are revised at five-year intervals. In the case of management plans, approval has to be given by the appropriate territorial committee. Responsibility for implementation rests with the Regional Officer.

The factors most affecting work under these plans have centred on the provision of adequate finance and of sufficiently skilled labour. Failure to carry out a prescription has usually resulted from one or both of these causes. In many working plans recording schemes form an important part of the prescriptive section. A major problem encountered here has been the development of satisfactory recording techniques—both in terms of measurements and of administrative methods of recording and storing data.

Management Practice

Much of the routine work on reserves takes the form of estate-management operations including work on fences, paths, ditches, bridges etc. All aspects of silvicultural work are also dealt with—from seed collection and nursery work to felling. The extent to which these operations are necessary varies considerably from one reserve to another.

An extension of both these main groups of activities lies in the provision or maintenance of special habitats. Thus ride-clearance can become complicated by the desire to have a range of ages of shrub species present along the margins. Similarly ditching can include work on small ponds. On the silvicultural side felling programmes may have to include creating glades and leaving a supply of dead standing timber. Additional complications are introduced by trying to provide recreational and educational facilities. This can range from establishing picnic sites to providing ski-ing opportunities, or from setting up a simple nature trail to maintaining an information centre.

Management Problems

The main reason underlying the wide range of problems to be faced in managing woodland nature reserves is that the end product is not a relatively simple economic commodity but an extremely complicated biological system. Admittedly an oak wood is an oak wood whether it may be used for timber production or wild-life conservation. However, when management concerns itself with not just the tree population but with the populations of all the groups of plants and animals in the wood it is to be expected that the problems will multiply accordingly.

Certain difficulties arise from the nature of the reserves. Many of the woodlands are relatively small and fragmented. This means that the populations of larger animals are only casual visitors to the area and one is therefore dealing only with a portion of the population. The viability of very small reserves such as the three acres of Wye and Crundale Down in Kent, or even the fifteen acres of Juniper at Tynron in Dumfries-shire, is open to question.

In a similar way drainage systems are seldom contained wholly within a reserve. Where the hydrology is important it becomes necessary to establish a completely artificial system. This is the case at Woodwalton Fen in Huntingdonshire, where successful germination of the food plant of the Large Copper butterfly is dependent on maintaining a suitable water level.

The ecological situation in any woodland is often determined by a number of extremely artificial influences. It is necessary to decide which, if any, of these may be allowed to continue. Grazing is one example of this situation and the decision to fence cannot be taken too lightly. Experience at Rassal in Wester Ross and elsewhere has shown that the rank growth of grass resulting from cessation of grazing is often as much a hindrance to the establishment of natural seedlings as is the grazing itself.

The need for adequate description of the resource raises a whole host of problems concerning survey techniques. How does one describe an ecosystem? The standard parameters for describing the population dynamics of living things are well known but the methods of obtaining the necessary information have not yet been developed for many groups of plants and animals. Quite apart from the lack of methods there is a lack of staff competent to carry out surveys of the more difficult groups.

Even if one decides to tackle only the tree and shrub species, problems abound. Girth at breast height, though an exceedingly useful measurement, is quite meaningless and very tedious to obtain when dealing with coppice or under-storey species. This is true also of trees such as yew or juniper. Information on pattern and structure is also desirable but is not readily obtainable by simple sampling techniques. This means that the definition of desired stand types for a given reserve is not possible in any great detail; it must await the development of suitable techniques and their application to a range of characteristic woodlands.

Another large group of problems is concerned with the lack of knowledge of the effects of various operations and activities on wildlife. A direct result of this has been that many planning prescriptions have formed the basis of experimental treatment. This combination of research and management has not been without its administrative problems but has proved a valuable approach. It has been used in establishment trials and grazing investigations on many reserves; for mowing of rides and cutting of scrub fringe at Monks Wood in Huntingdonshire; and for methods and cycles of coppicing at Blean and Ham Street Woods in Kent. Much has been achieved but much remains to be done.

The effects of educational and recreational activities likewise require to be assessed. The standard problems are channelling and restricting access, arranging for litter collection, and providing camping facilities. At Beinn Eighe in Wester Ross, as on many other reserves, nature trails have been established. The immediate problems associated with these have on the whole been satisfactorily solved but the long-term effects of this type of activity remain to be seen.

One practical silvicultural problem derives from a policy of using on reserves only plants or seed of reserve origin. This means that plant supply is dependent on the occurrence of good seed years in particular localities. Another aspect of this policy, viz. that the range of genotypes should be maintained, necessitates extensive seed collection from a variety of trees.

Pest species cause as many problems on nature reserves as they do in other woodland areas. Control of pigeon, squirrel, rabbit and deer may prove necessary. Similarly Dutch Elm disease can be a serious threat as happens at High Halstow N.N.R. in Kent, where a heronry is situated in the elms. A recent outbreak of fireblight necessitated the removal of scattered hawthorn scrub at Wye and Crundale N.N.R. However, the main "pest" problem is the spread of alien species. In the majority of cases these are laurel, rhododendron or sycamore—all of which regenerate freely. Many of the woodlands in North Wales have a rhododendron problem. Sycamore has proved specially difficult to control particularly in the New Forest area of Matley and Denny F.N.R.

Last, but by no means least, are the administrative problems. With so many records to be kept—species lists, population dynamics, silvicultural operations, phenological and ecological observations etc., there is an obvious need for streamlining the recording, handling and storing of information. Stored data have to be easily retrievable and the information should be capable of being reduced to a readily assimilable form. This is no mean task but one which has been greatly facilitated by recent developments in the data processing field.

Conclusion

I have sought to illustrate the complexity of managing a woodland for the purposes of nature conservation. The intensity of management is the result of the basic demands made on the reserves, i.e. the conservation of a great number of inter-related plant and animal populations.

In view of the numerous gaps in our knowledge an experimental approach has proved useful. The wide range of ecological problems presents a stimulating challenge and necessitates both extensive and intensive experimentation. At all times there is a need for adequate recording of operations and of their effects on as wide a range of organisms as possible.

TABLE 9

NUMBER AND ACREAGE OF RESERVES BY COUNTRIES

		England	*Scotland*	*Wales*	*Total*
National Nature Reserves	No.	56	32	27	115
	Acres	43,332	180,371	17,690	244,393
Forest Nature Reserves	No.	8	1	3	12
	Acres	1,641	288	225	2,154
Woodland Nature Reserves	No.	32	12	16	60
	Acres*	4,468	4,228	1,141	9,837
Woodland owned by the Nature Conservancy	Acres	2,374	1,058	212	3,644
Average area of Woodland on Reserves	Acres	139	352	71	164

* Acres of Woodland only.

TABLE 10

SIZE CLASS DISTRIBUTION OF FOREST AND WOODLAND RESERVES

Acreage	*England*	*Scotland*	*Wales*	*Total*
Less than 25	13	3	3	19
25–100	9	2	11	22
100–500	14	6	5	25
500–1,000	4	1	—	5
Over 1,000	—	1	—	1

HILL SHEEP

By **A. R. WANNOP, O.B.E., F.R.S.E., B.SC.(AGRIC.), B.ENG.**

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Though the present pattern of Scottish hill sheep farming is barely two centuries old, sheep have grazed our hills and mountains very much longer. Records indicate that in the twelfth century the Cistercian and Benedictine monastic houses on the banks of the river Tweed grazed their sheep during summer on the surrounding hills—the Cheviots, the Lammermuirs and the Southern Uplands. Wool was the important sheep product and it is said that some flocks were up to 10,000 strong. In the thirteenth century these religious foundations were exporting wool from the east and south of Scotland to Flanders. to France and to Italy, a trade that continued for several centuries.

By the beginning of the eighteenth century there had been many changes. The abbeys had gone and large privately-owned landed estates covered the countryside. In the valleys and glens there were large numbers of small tenanted farms practising subsistence farming based on cattle and sheep. Gradually it was realized that this was not the most profitable form of hill land use for the estates, and for almost a hundred years from the mid-eighteenth century these small units were consolidated into large farms dominated by sheep, giving more or less the pattern of hill farms we have today. Sheep have been the mainstay of hill farming ever since, cattle being regarded as merely complementary for the benefit of the hill sward, their numbers fluctuating according to the type of hill and the economic returns from cattle breeding.

Today there are just over 3,750,000 breeding ewes in Scotland, of which 70 per cent belong to the hill breeds and almost all the other 30 per cent are bred from them. Scotland has, in fact, a highly stratified sheep industry based on the two hill breeds of sheep—the Blackface and the Cheviot. On the higher and poorer hills, these sheep are bred pure, most of the female lambs being required to maintain the breeding stock from which an annual cast of ewes of either five or six years of age is made, while the male lambs are castrated and sold for fattening on lowland farms. On the better and lower hill grazings some of these pure-bred hill ewes may be crossed by a long-wool ram, usually a Border Leicester. Again the cross male lambs go for fattening and slaughter, but the best of these first cross ewe lambs become breeding flocks on arable farms. These ewes which are called Half-breds (Border Leicester × Cheviot) or Grey-faces (Border Leicester × Blackface) are noted for their high productivity per ewe and per acre of arable grass on which they are maintained. Mated to rams of the Down breeds, e.g. the Suffolk or the Hampshire or the Dorset Down, they produce quick-growing lambs of good carcase quality.

The Blackface

Of the two hill breeds the Blackface, sometimes called the Scots Blackface, is more numerous, there being about 1,900,000 ewes. It is found in every county in Scotland, though at the two extremes—in the Cheviot and Galloway hills in the south and in Sutherland and Caithness in the north—it yields pride of place to the Cheviot.

Its appearance indicates that it had an Argali ancestry. It first came to Scotland from the north of England, where there are other breeds of the same type. The chief characteristics are black or black-and-white face and legs; horns in both sexes, the rams having a pronounced spiral; and the white fleece being coarse with a long staple and classed as carpet wool. Of all the breeds of this type in Britain, the Scots Blackface has been subject to most selection so that today it produces a lamb of good conformation, yielding a desirable carcase when slaughtered at from four to nine months.

The Cheviot

Though the Cheviot breed is less numerous, with only some 500,000 ewes, it plays a more significant part in breeding first cross ewes for arable farms, where the Half-bred is the favourite in Scotland and also highly popular in England. In the south of Scotland the Cheviot is invariably found on all the greener hills where heavier stocking densities occur. Though with a common ancestry there are now two breeds each with its own Society—the South Country Cheviot and the North Country Cheviot. The latter are descendants of Cheviot sheep taken to the north of Scotland a century and a half ago. Recently there has been a reverse trend and flocks of them have actually been established on better hill and upland farms in the south. As a result of selection and possibly environmental conditions the two types are recognizably distinct, though both are white in face and legs, both are hornless, except for occasional horns in rams, and they have similar wool. The North Country is bigger, less compact in appearance and without the alert, erect ears of the South Country.

The Soay

Though it is said that there are two hill breeds in Scotland, two other breeds should be mentioned. These are the Shetland and the Soay. The latter belongs to the St. Kilda group of rocky islands in the Atlantic, now uninhabited except for military personnel in temporary residence. These sheep are feral, having been untended since the evacuation over thirty years ago. The numbers of all sheep—male and female of all ages—fluctuate between 600 and 1,500 according to the season. They are a Mouflon type, small, much more primitive than any other sheep in Scotland and probably akin to those prevalent before the invasion of the Blackface and the development of the Cheviot.

The Shetland

Much more significant, but still occupying a minor place, is the Shetland breed of approximately 100,000 ewes and found in the Shetland Islands. Though many of these are pure-bred Shetland sheep, others are merely of Shetland type having an admixture of Cheviot blood to give more size and more wool. The true Shetland is small and gives a fleece of only 1¾ to 2 lb., but of very high quality. White wool is favoured, but a few have brown (moorit) pigmentation and still fewer, black. Rams are horned and small erect horns occur on some ewes. Though there are no mountains in Shetland there is much moorland on which the sheep graze as well as on the improved pastures of farms and crofts.

Types of Farms

Of the two and a half million hill ewes, about half are kept on what might be called true hill farms, of which there are only about 1,500, with on average about 850 ewes on some 4,000 acres of land. These farms are predominently moorland or hill or mountain, with only one or two per cent of their area fit for tillage or hay making. They are farms primarily suited to breeding and rearing sheep and cattle which must be sold in store condition for finishing elsewhere. Sheep predominate and the basis of flock management is low density, all-the-year-round set stocking, the ewes being mated and wintered on the hill where they also lamb and rear their lambs. To some extent the ewes graze at higher altitudes in summer than in winter because of the effect of altitude on seasonal herbage growth as well as snow cover in winter, and also because shepherds guide the grazing of the flock to preserve suitable areas for spring grazing and to utilize the various plant communities at their optimum. This is a management system which determines the stock-carrying capacity of the hill by the number that can be maintained in late winter and early spring when plant growth is minimal and surplus growth from the previous summer has become fibrous. This restricts the flock size, and the hill in summer, despite the addition of a lamb crop and the return to the hill of ewe hoggets usually wintered elsewhere, is under-grazed. Over a long period this has resulted in a slow but inevitable deterioration of the herbage, coarser, less palatable plants having increased at the expense of the more palatable which are regularly eaten.

The other half of the national flock of ewes of the hill breeds is on farms of diverse types, all with some hill ground but also with varying acreages of more productive land on which it is possible to do more than merely breed and rear store animals. On these farms there may be a flock of ewes kept entirely on the hill as on a true hill farm, or a flock which spends all the year on the hill except for late winter and the period of lambing, or a flock managed on a system which integrates the hill and improved pastures. In these latter cases the ewe productivity is very much higher and it is customary to breed cross lambs.

Over this wide variety of conditions involving a range of altitudes, rainfalls, soil types and plant communities, the stocking rate varies. It has been estimated that the majority of hill ewes are maintained under conditions that provide from two and a half to three acres per ewe, but at one extreme there is one acre per ewe on good Agrostis-Fescue swards on the best farms in the Cheviot hills and at the other 15 to 20 acres per ewe in the wilder parts of the north-west Highlands. Under all conditions it is a system of low inputs and low outputs, and no technique has yet been found whereby more than very small parts of these extensive natural grazings can be improved economically.

Productivity

The ability to live under the environmental conditions of hill country, to survive the winter without any supplementary food, except for a little hay when there is too much snow to allow grazing, and yet to produce a lamb, is characteristic of hill ewes and is a tribute to their versatility and their hardiness. The latter is a definite but unmeasurable character, which cannot be assessed visually and includes the capacity to forage and to nurture a lamb before and after birth at the expense of body reserves. In winter they appear to suspend wool growth and devote all the nutriment in their intake to the developing foetus. Under these environmental conditions productivity cannot be high, but nevertheless varies considerably. On the better hills in the east of Scotland ewes may produce, rear and wean as many as 120 or more lambs per 100 ewes mated, whereas on the poorer hills of parts of the west Highlands as few as 50 to 60 lambs may be weaned. The average for the country is estimated to be around 85 per cent, so that the typical ewe produces four lambs in the five breeding years she spends on the hill. They lamb for the first time at two years of age and the majority are cast for age at six and a half years, unless other causes require them to be drafted earlier.

Where productivity is low the principal reason is high mortality in lambs at birth and during the weeks following. While some deaths are due to disease, most are due to under-nutrition. There may be 10 per cent barren ewes, seldom more and often less. A few lambs are lost during pregnancy but most that succumb are born alive but are too weak to adjust and to survive the rigours of life under exposed conditions with, possibly, an inadequate supply of milk from the ewe due to slow growth of herbage. Where productivity is so low most ewes have lost 10 to 15 per cent, and sometimes it may be 25 per cent, of their weight between mating and pre-parturition despite carrying a foetus. Such ewes cannot produce the most vigorous lambs. This is recognized by farmers who are gradually losing the traditional antipathy to supplementary feeding; and because these losses occur in areas where the farm cannot produce sufficient hay to feed the ewes, there is a growing practice of giving a cubed concentrate or grain for four weeks or so before lambing is due to begin. It is fed on the hill ground at ¼ to ½ lb. per day and a common experience has been that this ensures the survival of an extra 8 or 10 lambs per 100 ewes.

Sizes of Sheep and Lambs

Ewes vary in size according to locality and breed. An average November weight (pre-mating) is 105 lb. in good season, but varies from 90 to 120 lb. North Country Cheviots are about 10 per cent heavier than the South Country breed, while the strongest Blackfaces are found in the Lanarkshire and the Lammermuir hills, with the regional type of the south-west—the Galloway or Newton-Stewart—distinctly smaller, and the Blackfaces of the Hebrides smaller still. As with ewes, so with lambs. An average birth-weight of single lambs born to ewes which have had little or no supplementary food is about 7·5 lb. and the weaning weight 55 lb. but there are wide variations and some lambs at weaning on good farms might be 70 lb. or over and be ready for slaughter. Even within individual flocks there is a wide range. Lambing usually commences about mid-April, but is 7 to 10 days earlier in the north-east. Mid-April coincides in an average year with the spring onset of growth of hill grasses. An earlier lambing would mean a shortage of milk in the ewes, while lambing later would mean too many small lambs at the lamb sales in August and September. As hill farms sell store lambs to lowland feeders for autumn fattening a well grown lamb by September is important.

The Heft

Most hill sheep in Scotland are "hefted". A heft is an unfenced area of hill, large or small, with natural boundaries such as a stream or a ridge beyond which sheep seldom stray. On a heft are a group of ewes which have been born there and live and breed there. The shepherd knows the ewes of each heft and if any stray he returns them to the heft where their immediate relatives are. It is common for an older ewe on a heft to have grazing near her one or two daughters and grand-daughters. Each sheep acquires knowledge of its own heft through following its mother during the suckling stage and tends subsequently to prefer this part of the hill with which it is familiar. At the same time it acquires the knowledge of where to move for shelter when storms arise.

Wintering

On most hill farms the ewe hoggets are wintered off the hill, as the average hill is not good enough to ensure that sheep in their first winter, 6 to 12 months of age, will be sufficiently well grown to mate at a year and a half. To leave them on the hill would mean the average sheep would not produce its first lamb until it was 3 years old. Wintering off the hill, but at home, may be possible if the farm has a good acreage of "inbye" land in improved grass or tillage crops. If not, the hoggets have to be sent away to lowland farms which winter them for an appropriate fee. In recent years the cost of wintering away from October to April has increased relative to other costs and some farmers, though still a small number, have resorted to housing their hoggets in adapted buildings or in specially erected sheds and feeding them on hay and concentrates. The results are satisfactory, hoggets so wintered making ewes which breed and live as successfully as those wintered traditionally. Relative costs must be the factor which decides how to winter.

The Fleece

While the principal sale product from a hill flock is wether and surplus ewe lambs, wool is often a close second. Shearing of ewes nursing lambs takes place in early July, ewes without lambs and ewe hoggets having been shorn in late June. An average fleece is 4½ lb., but again there is district variation. Blackface fleeces from Central Scotland are 5 lb. on average, and consist of strong, long-stapled wool of carpet type, much of which is exported. The Galloway Blackface fleece is fully 1 lb. lighter, and though less strong is still a carpet wool. Fleeces from the Hebrides are much softer in texture and are used for blending with other wools in the manufacture of Harris tweed. At one time North Country Cheviot fleeces were lighter in weight than those of the South Country Cheviot, despite the smaller size of the latter, but there is now less difference in both weight and quality of fleece. Cheviot wool is used in the manufacture of tweeds and woollens.

Disease and Infestation

It would be surprising if the nutritional and climatic stresses to which hill sheep are subject did not involve a certain degree of ill-health. This varies with the locality, it being estimated that in the east the average annual mortality among ewes is around 4 per cent, whereas in the west it is about 8 per cent. Some loss is attributable to the management system, and that due to chronic debilitation may be as serious as that from troubles causing death. Though hill sheep suffer very much less than lowland sheep from helminthiasis, this is balanced, particularly in high rainfall areas, by greater losses due to liver fluke infestation (fascioliasis) and to diseases transmitted by the sheep tick (*Ixodes ricinus*), namely louping-ill, tick-borne fever and tick pyaemia. Losses also occur from clostridial infections and from mineral and trace element deficiencies. Hill farmers and shepherds invariably adopt preventive treatments where these are available, but despite these, seasonal loss occurs too frequently.

Management Changes

Though this pattern of hill sheep management has prevailed for nearly two centuries, it would be wrong to assume that it will continue unchanged. Competition for farm staff and the increasing value of land are making it essential to secure greater productivity from hill land and increased output per man engaged in each enterprise. Otherwise better incomes cannot be provided for those who work on hill farms or a better return secured for capital invested. As has been shown by the Hill Farming Research Organization it is possible to increase both the number of ewes carried and the lamb crop by departures from traditional management. On one of their hills twice as many lambs are now available for sale as ten years ago, apart from increased wool sales and more cattle, a result achieved without introducing any female sheep from outside. Corresponding results have been got on other hills by different techniques, indicating the diversity of possible methods.

The weakest feature of existing hill sheep management is the two-fold effect of wintering on the hill. It imposes on the ewe a period of under-nutrition when she is developing a foetus and in her early lactation, and at the same time punishes the hill grazing by using up every spring the first growth of the earlier and more palatable grasses, exhausting their reserves and handicapping them in their competition with coarser less palatable plants. On farms with ample inbye ground the flock can be, and often is, removed from the hill for February, March and April and such farms carry more ewes and get bigger lamb crops. Most true hill farms, however, have inadequate inbye land to do this, and to achieve corresponding results they would have to house the flock indoors from say, January to early May. If this were done, when the ewes returned to the hill in May, there should be enough growth to enable the ewes to milk their lambs well, and probably to nurse twins on a hill that at present only makes a good single lamb. In fact, if the costs of housing and additional food involved in such a policy are to be recovered, there will have to be both more ewes and more lambs per ewe. This is a possible development that needs and is getting thorough investigation.

New Facilities

Undoubtedly hill farming needs more capital injection, despite all that has been done under the Hill Farming Act of 1947. Housing for wintering hoggets and ewes, roads, shelter belts to help both stock and pastures, more hill cattle and still better handling facilities and shearing sheds would all be advantageous. Little will be provided, however, without a better return on capital than is at present realized. Unless there is a marked increase in sheep prices, which is highly unlikely, this will be achieved only by the adoption of management techniques that blend the best of both traditional and new ideas so that there are more and better lambs. At present it is considered that the minimum number of ewes per shepherd should be 500–600, which means on the average farm about 500 lambs. We should be lifting our sights to 1,000 lambs per shepherd and planning hill farm management so that both the standard of living that shepherds enjoy and the returns to everyone concerned will be as attractive as in any other section of either agriculture or industry.

The author is a member of the Commission's Advisory Committee on Forest Research, and was formerly Director, Hill Farming Research Organisation, Edinburgh.

THE STRATHOYKEL PLAN

By **T. B. MACDONALD, F.R.I.C.S., N.D.A., C.D.A.**

Department of Agriculture and Fisheries for Scotland

Reproduced, by permission, from "Scottish Agriculture", Autumn, 1967

This plan, initiated in 1947, was produced at the request and under the direction of the Highlands and Islands Advisory Panel. It was the first attempt to prepare a comprehensive plan for an area, the boundaries of which were selected for the purposes of forming a planning entity. The area was chosen partly because of the variable nature of the terrain, which gave the opportunity to prepare a plan which could be used as a basis for helping other areas. The area was selected also because certain parts of it were rapidly becoming derelict and population and employment were at a low ebb. The area dealt with in the plan is roughly that bounded on the north by Loch Shin, on the east by the River Shin and the Kyle of Sutherland, on the south by the River Carron and on the west by the western boundaries of Glencalvie, Corriemulzie, Lubcroy and Benmore. Dalchork Estate is also included.

The Aims and Objects of the Survey

The aims and objects of the survey may be summarized as follows:

(*a*) The increase of cattle production by the erection of cattle rearing units.

(*b*) The development of sheep farms to create economic units.

(*c*) The improvement of grazing areas by shelter blocks, arterial drainage and land improvement.

(*d*) Afforestation under normal forest units, including replanting of old woodlands and the planting of other areas reasonably suitable for timber production.

These stated aims set out almost 20 years ago, remain virtually unchanged from the aims of current land use surveys. For this reason alone it is important to see how the plan has developed and what changes in principles and techniques of planning have taken place over the years.

The plan suggested that a total of about 22,000 acres could be used for commercial forestry with, on balance, little loss to economic sheep and cattle units. This acreage was made up by a large number of plantations—from large ones down to 100-acre blocks—situated on 17 different estates. The land now planted, or fenced prior to planting at the beginning of 1967, is just over 18,000 acres. This would give the impression that over 80 per cent of the land originally designated as suitable for forestry has, in fact, been so used: but the reclassification of poorer areas of hill land, which are now regarded as plantable, means that in fact 70 per cent of a larger area has been planted or prepared for planting. This reclassification is due to some extent to new techniques in preparation for planting and to the continued improvement of these techniques in their application to the poorer classes of land. Even more important is the introduction of new cultivars, in particular new sources of Lodgepole pine (*Pinus contorta*). This has altered the forestry possibilities on poor land so completely as to make it the big element of change in planning technique. Clearly, if today's knowledge of forestry techniques had been available when the plan for the area was prepared, the sections suggested for afforestation would have been considerably increased. A good example of this is seen in the Strathkyle and Inveroykel area and in the area adjoining the crofts just upstream of Inveroykel.

The whole estate of Strathkyle and Inveroykel was acquired by the Forestry Commission for development by the Commission and the Department of Agriculture in terms of the survey plan. Subsequently it was found that much more extensive afforestation on poor land was possible. An additional 2,000 acres is now being planted, all this additional area being on land that could not have been afforested without our new knowledge. This additional planting has not in itself caused loss of agricultural production, but it has allowed for the planning of a mainly forestry area. The slow rate of agricultural development is not the result of forestry, either in terms of the plan or as increased, but is caused mainly by crofting difficulties which may well be overcome in time. The forestry development at Strathkyle and Inveroykel is one of the most satisfactory in the whole area. It is pleasing visually; it could well become a tourist road, though it was quite unused by tourists in the past. This side of the valley was dying fast when the plan was made; now it is active and productive with a relatively high labour demand. Though part is still relatively unproductive in the agricultural and crofting aspects, there is hope that the whole picture will be very pleasing within a few years.

The change in planting possibilities would have had another effect on the plan, of which there was some criticism to the effect that forestry might have contributed more to the provision of shelter with related pasture improvement. It was also said that if the whole area had been looked at from the landscaping point of view, the forestry pattern would have been rather different and would have provided a greater number of visually-striking forestry blocks planned, at least partly, in terms of the landscape. This is probably a valid criticism, but much of the land in the area is very poor and the sections where trees might fit the scene are often of that class of land which was formerly unplantable. Much more would have been possible from the landscaping point of view using present-day knowledge and techniques. It is perhaps a matter of some regret that of the areas designated for forestry but not yet planted, there are many where the plantations would effectively improve the landscape.

Present Position in Forestry

The forestry position in the area of the survey is now estimated to be:

1.	2. *Planted by 30/5/67 within survey*	3. *Restocking Portion of Column 2*	4. *Reserve for Planting*	5. *Restocking Portion of Column 4*
Shin	6,530	1,180	—	—
Balblair	5,380	2,000	1,910	1,200
Oykel	3,700	1,100	290	—
	15,610	4,280	2,200	1,200

The area scheduled for 1967 is 1,050 acres but in 1968 this will fall to 600 acres. The planting programme thereafter depends upon future achievements in nearing the target figure for forestry; in certain sections of the area no afforestation has taken place. This, with the replanning of poorer land, means that there still remains a large forestry potential.

The Forestry Commission's working areas do not entirely coincide with the survey boundaries. It is estimated that they have employed about 50 men within the area but this number is likely to fall rapidly as the annual planting programme decreases. Thinning by Commission employees, and felling and extraction by contractors or timber merchants, continue at the rate of about 5,500 tons annually and give employment to 12 to 15 men.

The Forestry Commission have built seven houses and reconditioned two at Achany. The Local Authority built houses for forestry workers at three centres—ten at Lairg, eighteen at Rosehall, in what is really a new small village community, and six at Oykel Bridge, Although only a relatively small number of these houses are at present tenanted by forestry workers, this is not necessarily the long-term pattern. The general policy of having residence in the area is sound. The small village at Rosehall is a centre for work of all kinds in the outer Oykel area and this has clear advantages over long travel and partial desertion of the outer areas except during the working day. This difficult problem has been met in a decisive manner in the survey area. Whether the solution is one which could be followed elsewhere is not yet clear, but the principles are sound.

Agricultural Development

The agricultural development has on the whole been quite considerable, if less spectacular. A comparison of the stock carried in the area between 1947 and 1966 is as follows:

	All Cattle		*Sheep*	
	Cows	*Others*	*Ewes*	*Others*
June 1947	384	472	15,933	17,929
June 1954	726	690	16,119	19,372
June 1958	859	810	17,107	20,910
June 1962	802	959	17,281	20,184
June 1966	869	803	18,192	20,118

This comparison shows a substantial increase in both breeding cows and breeding ewes within a planning area which has provided some 18,000 acres of forestry, most of which was grazing land. Obviously, in a partly-developed area, results must vary on different farm units. Some have surrendered no land to forestry, some only a very small area so far, while two have been planned and used almost entirely for forestry. On this type of terrain, the hill grazing—for the most part poor, made up of wide-ranging farm units and carrying on average less than one ewe to five acres—it was not be to expected that agricultural development would be either spectacular or would increase the labour demand. Rather was the emphasis on the creation of viable economic units and there has been some quite satisfactory movement towards this. Twelve schemes under the Hill Farming and Livestock Rearing Acts have contributed towards achieving the economic streamlined hill farm units envisaged under the plan. A rise in stock numbers has accompanied a decrease in the number of hill farm units and this, together with permanent improvements and pasture improvement, has increased the economic working of a number of the units. While some farm units originally thought to require reorganization have not changed much over the period, the agricultural development is, on the whole, not far short of the target. Perhaps the most striking example of integration of forestry and agriculture can be seen at Achany. On this farm, or estate, the sheep stock numbers have been maintained and the cattle stock increased. The total increase in livestock production is even greater, thanks to effective management. This has been achieved although the forestry area already planted extends to almost the 1,600 acres envisaged in the plan.

Crofting Development

The plan recognized the difficulties which would arise in carrying out developments where crofting settlements were involved. Perhaps a good many years must pass before this aspect of the plan could be advanced, but some townships are quite productive agriculturally.

Sport

Sport was covered in the original report and its value to the region was stressed. This value remains. Fishings continue as a high-value attraction and the main deer forest areas are untouched by developments on their fringes. The plan, therefore, has not interrupted or depreciated this source of amenity and value.

Eighteen Years After

After 18 years the plan is not completely fulfilled, but this is inevitable without imposition. In one sense it was perhaps as much a strategy as a plan and, if so regarded, the results must be regarded as satisfactory. It has demonstrated that a large increase in total production from the land can result from planning in this way. It has shown that dying areas can be revived and that renewed life and employment can be brought to the countryside. It has shown that these benefits can be the result of looking at a large area as a whole, collecting and assessing all the necessary information and planning, without sentiment or prejudice, to achieve the best land use.

A HELICOPTER FLIGHT OVER TOWY FOREST

The sound of slowly swirling scything blades
Tremble through the craft in rhythmic cascades;
Tall grass and bracken with outstretching frond,
And dancing, then bending, then flattened to ground
    As faster flayed the furious fan.

Hovering hawk-like over humble hills
That yesterday taxed all my walking skills,
Streams are stilled and rivers gleam in silver threads
Of patterned palm along their peat edged beds
    And melting, mingle in the mystic plan.

The tumbling Towy torrents tamed by height
And rocks of Pysgotwr transformed in delight,
The Camddwr winds smoothly its crag-ridden way
Its pillars of granite eroded away
    Though proud in their power ere people began.

The sheep small and silent on Esgair Dolgoch
The years of plantations from Soar to Graig Goch,
The scars and the patterns where mankind has been
Are placed in perspective as part of a scene
    That mirthlessly mocks the measure of man.

EUROS JONES

TIMBER UTILIZATION

SCOTTISH PULP AND PAPER MILLS AN ACHIEVEMENT OF HISTORIC IMPORTANCE

Contributed by the Wiggins Teape Company

Seen from any angle, Scottish Pulp and Paper Mills are an achievement of historic importance. Seen from Britain, the mills' produce from home-grown materials will contribute millions of pounds every year to the crucial balance of payments. Seen from Scotland, the mills signify the industrial resurgence of a nation. In the Highlands the mills are seen as a reversal of a trend, turning emigration into immigration and bringing opportunity and hope to a neglected land.

And Wiggins Teape? What do the mills mean to the company which pioneered them? They represent an important investment in a growing industry whose product is in greater demand year by year, and more particularly they show a confidence in British pulp makers, British paper makers and British forestry.

The story of the mills begins 15 years ago and runs through the successful start-up of both pulp mill and paper mill in March, 1966, to the official opening on 15th September, 1966.

It All Began With An Idea

The mills began with an idea, an idea in the mind of a Wiggins Teape man holidaying in the South of France in 1950. He was struck by the reforestation which was then taking place in the Mediterranean hinterland and it occurred to him to wonder what was being done in Scotland where (he knew) growing conditions were even more favourable than in the traditional forest lands of Scandinavia. Back in Scotland there were discussions between the Company and the foresters and these brought out two vital facts: there was not yet sufficient wood to sustain a pulp mill but a vigorous programme of planting had assured that there would be enough in a few years' time.

So there was time to find a suitable site. Everyone thought there would be several possible places and the problem would be one of selection. It was not so. Remarkably, only one place in all north Scotland emerged as acceptable. It was at Annat Point, hard by the tiny village of Corpach, four miles from Fort William in the heart of the Western Highlands. Annat Point is on the Northern shores of Loch Eil, dominated by Ben Nevis and alongside the road and railway from Fort William to Mallaig, the classical road to the Isles.

What were the requirements of a pulp and paper mill that could be found only in this remote corner of Lochaber? Annat Point was in the centre of the forests of the Western Highlands, and just as important, it was in the middle of countless acres of bare land that could be planted in the future. It was within piping distance of an abundant supply of clean, fresh water, for paper is made from a mixture that is one part solid in 99 parts of water and the process uses enormous quantities of water. Then, tidal water in Lock Eil could take any outflow straight out to sea and the loch could also give access to the forests of the Western Isles and beyond, across the Atlantic to Canada. Finally, there were the road and railway line on the spot.

£20 Million Is The Cost

So Wiggins Teape now had the trees (in prospect), the fresh water, the site and the communications to add to the foresight of the planners and a corporate determination to go ahead. Money was also necessary, a lot of money. The economics of production dictated that there should be a pulp mill feeding two paper machines and the cost would be about £20 million. It was decided to build the pulp mill and install one paper machine first at a cost of £15 million, and then add the second paper machine in a few years' time, about 1970.

The usual Government grants, as they were assessed, were not suitable for the project, and Wiggins Teape had to pay for the mills. However, the Chancellor of the Exchequer announced in his Budget speech in 1963 that the Government would make a loan and a special Act of Parliament enabled the Government to lend up to £10 million, to be repaid within a short and specified period. A loan of £8 million for the first phase was made free of interest up to the end of 1966 and after that interest will have to be paid and repayment of the loan will be spread over 10 years.

Great News for Scotland

The Budget speech was the first confirmation that Wiggins Teape's Highland enterprise, about which Scotland had been speculating for years, would definitely go forward and the news was received with acclamation. The people of Lochaber, leaders of Scottish opinion everywhere, the local authorities, the Scottish press and television as well as both Houses of Parliament in Westminster were almost unanimous in welcoming Wiggins Teape to the Western Highlands. Tributes to the Company's pioneering spirit came from all sides, and pictures of what the mills would look like went round the world.

The then President of the Board of Trade said in the House of Commons, "The great contribution of this project will be to provide a new point of lively and developing industrial activity in the West Highlands. It will create in the forests and in transport even more jobs than those created directly in the mill itself. It is, however, in some ways a pilot undertaking for our paper industry. Nothing on these lines and of this scale has been done in Scotland before. It is also a very large undertaking". The Secretary of State for Scotland of the day said Wiggins Teape had shown tremendous determination to get into the operation and went on, "I welcome it (the mill) for four main reasons. In the first place, it gives considerable employment this year in an area which needs it. Secondly, we have a steady build-up for the next three or four years. Thirdly, I believe that it will be an encouragement to other industries to come to Fort William and round about and will encourage industrialists of other sorts to think that the Highlands are not an impossible place in which to develop. Fourthly, and perhaps most important of all, I think that it will play a most significant part in the psychological effect it will have in the Highlands where people will think something really important has come which will provide lasting employment there".

"Wiggins Teape Very Enterprising"

In the House of Lords, Lord Derwent said, "Wiggins Teape . . . have been very enterprising in this matter. They are extremely efficient, and I hope they will make a very great success of it".

Lord Polwarth, Chairman of the Scottish Council which had been a constant source of encouragement, sent this message, "This is great news for Scotland. It is twelve years since the Scottish Council first discussed the possibility of a pulp mill in the Highlands with Wiggins Teape, and for the last five years we have been in constant and close touch with them over its planning. Now this great British company, with mills in four continents, has chosen to come to Scotland and invest in Highland people and Highland natural resources. But I have no doubt that this enterprise is only a beginning. Confidence is catching. Other interests, I hope, must see the advantage which the future offers in Scotland".

First Time in 250 Years

It was Lord Polwarth who cut the first sod in July 1963, taking out the first of 100,000 cubic yards of peat which had to be dug out in the ensuing months. He used a bulldozer as befitted the start of the biggest industrial development in the Highlands of Scotland since the war, and he had a pipers' escort as he drove his bulldozer across the empty fields. Highland dancers from Lochaber defied the rain to mark the occasion. "For the first time in 250 years, we will see repopulation and not depopulation in the Highlands", commented Lord Polwarth. Great and tangible benefits to Scotland were quick to come. The building contract worth £3 million went to a Highland firm and nearly all the building workers were Scots. The same firm was commissioned to run a pipeline from outside Fort William for £$\frac{1}{4}$ million, build houses for staff at a cost of another £$\frac{1}{4}$ million, and won contracts from the local authorities for housing mill workers worth nearly £2 million. Scotland provided more machinery than any other country: boilers worth £800,000 came from Glasgow and digesters for cooking the wood to make pulp were made in Leven.

In a site of 80 acres, purposely large enough to allow for further development, the buildings came to occupy 320,000 square feet. The pulp mill was built 400 feet long, the paper mill 540 feet long and a building for finishing the paper ready for printing is 530 feet long. The tallest building is the power house, 170 feet high and a landmark for miles around. In addition, there are large engineering workshops, a chemical conversion building, offices, laboratories and a restaurant. It took nearly 5,000 tons of steel and 30,000 cubic yards of concrete to make the mills, which have three miles of their own railway track running off the main line and two miles of roads. A water reservoir holds $\frac{3}{4}$ million gallons.

A Magnet for People

The mills came to act as a magnet, attracting people back to an area which they had been steadily moving away from for centuries. At one time, there were 1,600 construction workers concentrating on the mill and connected projects. Fort William became a boom town benefiting from over £30,000 a week going into the pockets of the builders. Ripples of prosperity spread further afield. The West Highland railway line had been in danger of closing down and contract to transport wood, chemicals, and oil to the mills, and pulp and paper out of the mills, in all 300,000 tons a year, saved it. Road hauliers saw a great opportunity. A big programme of road improvement was put in hand by the local authorities and the first major development on the Caledonian Canal since it was built provided a new quay and a mechanical lock in Corpach basin for the unloading of wood from the Western Isles and from abroad. New schools were built to cater for the new population and 450 new houses were built for mill workers.

Water from Beyond Ben Nevis

Three aspects of the construction work are of a special interest—the laying of a water pipe three miles long, the eruption of artificial islands in the middle of Loch Eil and the floating of five digesters weighing 40 tons apiece by sea and canal from the other side of Scotland.

The new mills get their water, soft spring and rain water ideal for making paper, from the aluminium works outside Fort William. A concrete pipe 113 inches round runs over the river Lochy, through a peat bog and under the

Caledonian Canal in its three-mile course. It can deliver every day up to 25 million gallons of water, which has already been brought 14 miles to the aluminium works, through pipes which pass under Ben Nevis and take their supplies from a vast catchment area high in the hills.

Man-Made Islands

While the mills were being built two new islands appeared in the middle of Loch Eil, 1,500 feet off Annat Point. They were man-made, great slabs of concrete set on steel piles, having the beautiful technical name of dolphins. The steel piles were driven 70 feet through sand on the bed of the loch to rest on solid rock. The purpose? To enable a 16,000-ton ship plying between Canada and Scotland to unload its cargoes of wood chips. Two cranes with electro-hydraulic grabs stand on the dolphins and each grabs two tons of chips at a time out of the ship's hold. Control is by closed circuit television. Cameras watch the chips coming out, and the picture is transmitted to the crane operators in their cabs. In addition, there is radio communication between the cranes, the ship's deck and the pile of wood chips brought out. The chips then have to be taken 1,500 feet to the mill, and they are blown there, blown with 1,000 horse-power behind them through a 22-inch pipe in what is thought to be the largest blowing system of its kind in the world.

No less exciting is the story of the arrival on site of the six 40-ton digesters. They were made on the East Coast of Scotland, sealed and launched into the North Sea and floated 230 miles north to Inverness where they tacked South West for 60 miles down the Caledonian Canal. Towed two at a time, the digesters carried navigation lights in the North Sea, one on a 600-foot tow and the other on a 1,200-foot tow. Four-fifths of their great bulk was out of the water during the voyage and four tons of obsolete Scottish railway line were fitted as keels to keep them steady. All six reached Corpach basin intact.

What Integration Means

So much for the building. What had the Company got at the end of it? They had something unique. They had the only pulp and paper mills of their kind in the United Kingdom. They had an integrated mill, a paper mill alongside a pulp mill so that pulp and paper are made in one continuous process and it costs nothing to transport the pulp to the paper makers. This is unusual in this country which buys most of its pulp from abroad and has to pay to have it transported.

At Annat Point the pulp is pumped straight from the pulp mill to the paper mill and there is no costly drying of the pulp for transportation. Trees (or chips) come in one end and paper comes out the other. This is what integration means in the paper industry. This is what makes Scottish Pulp and Paper Mills competitive with the big integrated mills of Scandinavia and North America with great forests on their own doorsteps.

New Swedish Process

The pulp mill uses a new Swedish process to turn wood into pulp with great efficiency. Chemicals arrive in tankers ready for bulk handling—molten sulphur and caustic soda for the digesters and chlorine and chlorate for bleaching. The digesters act like giant pressure cookers and cook the wood chips in the chemicals to release the fibres for papermaking. The digesters are the only part of the mills to produce in batches, all the rest is in continuous flow. The part of the wood which is no use for paper is recovered from the digesters and burned to provide nearly enough fuel for the pulp mill. The chemicals are recovered as ash and can be used again. The process also enables the mill to pulp all kinds of wood, the yield is higher than that obtained by other processes and there is no pollution of the Highland air. The pulp is bleached to a high degree of brightness and cleanliness. The annual output is over 100,000 tons of pulp. In the first years of operating, 40,000 tons of pulp will be going to the paper mill and the rest will be used elsewhere. Later on, when the second paper machine is at work, there will still be pulp available for other mills.

The mill's first paper machine was made in Britain and it makes paper of medium weight, or thin board, over 15 feet wide as efficiently as it can be made anywhere. Like the rest of the plant, it runs night and day throughout the year, except for the summer holidays, and turns out paper in bulk quantities, in direct competition with big foreign mills. In both pulp mill and paper mill, the latest proved methods and machinery were installed, but no attempt was made to experiment with new concepts not proved in operation.

Power and steam come from two boilers and two turbines. One of the boilers uses, for fuel, concentrated spent cooking liquor and the other is fired by fuel oil and burns bark in addition. The power house could provide all the power needed by a town of 15,000 people.

What sort of paper do the mills produce? Cartridge papers, printing papers, cream wove writing papers, bonds, duplicating papers, as well as fine boards. These papers and boards are used by printers and paper converters who get their supplies from approved merchanting houses.

A Giant in Aluminium

But there is more to this great industrial complex than that. The people of Lochaber awakened one morning and found a giant clad in aluminium in their midst. They knew the Royal Fine Arts Commission for Scotland had been consulted about the design but no one could visualize exactly what the giant would look like. This is what Professor Robert Grieve, Chairman of the Highlands and Islands Development Board, though of it. "It is a fine sight. The structure gives an immediate impression of good architecture. I was thoroughly taken by it as a well thought-out building of intelligence and refinement, and I stopped the car to take photographs. Its appearance matches all the hopes for its economic contribution. It is an example of what can be done." So it was a gentle giant which had come to the shores of Loch Eil, as one Scottish newspaper put it.

Most Pulpwood Comes from Scotland

The last part of the story concerns an aspect of the impact on Scottish economy and employment greater than the mills themselves—the supply of wood. For most of the wood is coming from Scotland; Highland forests are supplying about two-thirds of the total.

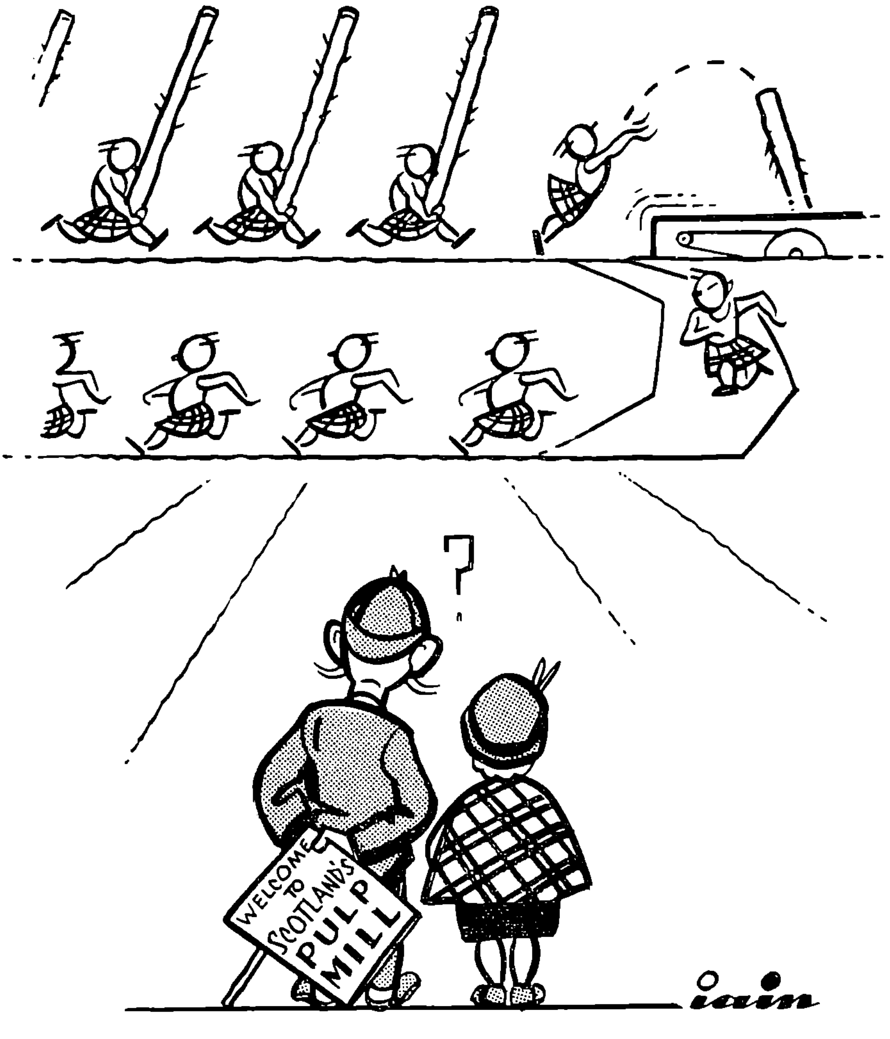
The present supplies are the result of the foresight of the foresters of an earlier generation. Many of the trees used are between 20 and 30 years old. Today is the harvest time for plantings made a quarter of a century ago. Today is also the time for planting for a quarter of a century hence. There is no question of despoiling the countryside, as for every tree felled there is room to plant more. The cycle of planting and growing and felling and pulping is one where artifice complements nature to yield prosperity at every turn.

Ten Thousand Trees a Day

There is work in the forests for 1,500 men feeding the pulp mill with its raw material. Ten thousand trees, including thinnings, are cut every day. There is more spruce than anything else, plenty of pine and larches and some Douglas fir and other species. It comes from forests in Inverness-shire, Argyllshire, Perthshire, Ross and Cromarty and the upper Spey valley as well as from the Western Isles. Wood from the forests to the south of the pulp mill is taken by road to rail-head at Crianlarich and the rest is brought all the way by road or sea. It is all soft, coniferous wood. Hardwood comes from abroad, in the form of chips from Canada, or eucalyptus logs in 1,000-ton boats which come right into Corpach basin in the Caledonian Canal. The pulp mill uses 7,000 tons of wood every week and a third of it is hardwood from abroad.

Every day a train of 20 specially-made waggons carries 350 tons of logs to the pulp mill. While one train is loaded at rail head a second train is being unloaded 63 miles away at Annat Point and the trains pass one another during the night. About 100,000 tons of wood a year are transported in this way. In order to know the problems of felling and transporting the wood, the Company has purchased standing trees in the area and the latest equipment for loading the wood on to lorries. It was decided, however, not to set up a transport fleet, but to give independent Highland hauliers the opportunity to do the work.

On arrival at the pulp mill the wood from both railway waggons and lorries, up to 80 vehicles a day, is unloaded by 12-ton gantry cranes. Six debarking machines strip the bark off the logs, which are eight or ten feet long, at the rate of $2\frac{1}{2}$ tons of wood a minute. One thousand tons of debarked wood are produced daily and there are over 100 tons of bark for fuel.



A chipping machine takes less than a second to reduce a ten-foot log into thousands of chips three-quarters of an inch long. Its ten knives, which have to be sharpened every 12 hours, have 550 horse-power behind them. The chips are blown 1,000 feet through 15-inch pipes to a chip pile where there is room for 50,000 tons of softwood chips and 35,000 tons of hardwood chips—12 weeks' supply for the pulp mill.

Today there are about 700 people employed at the mills, including a number of returned Highlanders. The number is rising as the tempo of production increases and it will jump to 1,000 or more when the second paper machine is installed. It is expected to go up again considerably in the 1980's when there will be enough Scottish wood to feed a second pulp mill with its own integrated paper machines. Present layout and mill services allow for just such a development.

There are plans, even, for triplication about the year A.D. 2000.

All from an idea in the mind of a Wiggins Teape paper maker. His identity? Dr. Theodor Frankel, Managing Director of Scottish Pulp and Paper Mills.

THE SUCCESS STORY OF FORESTRY
MAJOR ROLE IN FORT WILLIAM PROJECT

By **J. L. DAVIDSON**
Assistant Conservator, Marketing Division

The story of forestry in Scotland goes back far beyond that of the pulp mill, but it is only in the last half-century that this major rural industry has gained the measure of stability and continuity of purpose so essential to its success. In earlier days forestry depended for its existence on a thin line of enthusiasts and far-sighted private landowners, some of whom came and went with the times. Nevertheless that line was held unbroken, and it is thanks to those pioneers and enthusiasts that there were woodlands in the country which were able to make a valuable contribution to the nation's resources in the first world war. Indeed it has been said that Britain might well have lost that war without the timber that came in great quantities from the home woodlands. The inevitable devastation of large areas of woodlands, however, opened the eyes of many in authority to the parlous state of the country's timber resources compared with those of almost every other country in Europe, and gave weight to the growing conviction that the country was in need of a stable forest policy, properly supervised by a forest authority assured of sustained support from government and public alike. The position of forestry in Britain was examined by the Acland Committee during the first world war and in 1918 they published their report, which was the real starting point for the steady, healthy growth of a home forest industry.

The Visionaries

It is rewarding to recall something of the Committee's observations.

"We desire to record our convictions that, quite apart from the considerations already advanced (replacement of war fellings to re-create the nation's strategic reserve of standing trees) a policy of afforestation is justified by the great benefits it would confer on the United Kingdom.

Those districts which would benefit most are those which are now poorest and most backward, . . . most of all the Highlands of Scotland . . . when the woods extend to several thousands of acres the new values they create become a potent factor in the development of the district, justify the building of roads, railways and telegraphs, and serve to support churches, schools, doctors, shops, and many of the comforts and amenities out of reach of the ordinary crofter".

The Committee went on to express faith that forests would give rise to an expanding industry based on the raw material they would provide, and pointed out that for a stable future there must be close co-operation between forest owners and the industrial organizations concerned.

Written at a time when no end could be foreseen to the widespread over-exploitation of the old woods, these were brave words, and perhaps most important of all, the Committee looked far beyond the creation of forests to a vision of a countryside which, as a consequence, would achieve a rising level of prosperity and in which the neglect associated with steady depopulation would be reversed. The men who wrote the Report were no idle dreamers, and their views persuaded the government of the day to set up the Forestry Commission by Act of Parliament in 1919, constituting it as the forest authority for the nation, charged with the duty of promoting the development of afforestation and the production and supply of timber in Great Britain.

Early Days of Tree Planting

The Forestry Commissioners at once set about the acquisition of land and started to establish new plantations. Although the rate of progress was slower than had been hoped, mainly due to the cutting back of expenditure during two periods of national financial crisis in 1922 and 1931, by 1939 there had been built up an estate in Great Britain of over a million acres. Of this, three-quarters of a million acres were classed as plantable land and 434,000 acres were actually under trees—about half was in Scotland, mainly in the Highlands. At the same time private estates were encouraged to replant the large areas of woodland which had been felled during the war years, and for this planting grants were made; but although 126,000 acres had been rehabilitated by 1939, progress fell far short of what had been envisaged by the Acland Committee. High taxation and low timber prices were blamed as serious deterrents to replanting.

Forestry "Know-How"—Scotland a World Leader

Although, in these first 20 years, the area of woodland created seemed disappointingly low, the period was one of great advancement in technical knowledge. Most of the land acquired for planting was poor hill land, ill-drained and infertile. It required a form of treatment very different to that on which most private estate woodlands had been planted; it differed also from Continental conditions in which foresters of the day had received their basic training. The old saying "Ye can aye be sticking in a tree; it will be growing while you are sleeping" was clearly not good enough unless accompanied by measures to improve the poor moorlands on which trees were to be planted. Some innovations had been made by private planters, notably a method of planting trees in upturned turf which had given promise on the Corrour estate of Sir John Stirling Maxwell in Inverness-shire. Profiting from these, and as the result of extensive research under the driving force of the late Lord Robinson, who became Director-General and Chairman of the Forestry Commission, there was gathered a wealth of information which has since made Scotland a world leader in the afforestation of poor moors and mountainsides.

The Use of Giant Ploughs

The main needs of much of the poor ground being planted in the Highlands were drainage, the breaking up of hard morainic knolls left by Ice Age glaciers, and application of phosphatic fertilisers. These were met through the development of giant heavy ploughs—some able to open up drains and at the same time provide the upturned turf on which the trees could be planted over wet, peaty ground, others able to rip open the compacted knolls and permit tree roots to penetrate more deeply. With the steady improvement of this equipment and of tractors to haul the ploughs, much land previously thought to be useless for tree planting has been made to grow profitable woodlands. Linked with improvement of planting methods there also came a better understanding of the requirements of the different kinds of tree, their susceptibility to frost, exposure, and other climatic and pathological conditions, so that a firm base of silvicultural knowledge was laid by 1939. This proved of enormous value in the creation of very much larger forests from 1946 onwards. It has enabled costs of establishing plantations to be cut, and choices of species and methods of management to be made which will ensure the maximum yield of timber.

War-Time Demand for Home Grown Timber

The second world war brought home even more urgently the need for a rapid expansion of the country's resources of home-grown timber and for a sustained and co-ordinated forest policy. To meet the needs of the war effort, when the limited shipping space had to be given over to the carrying of essential cargoes less bulky than timber, output of wood from the country's own woodlands was once more brought to a very high level. But this was only achieved at heavy cost to the reserves of standing timber which had survived the first war twenty years earlier. Felling was even more intense and more prolonged than before, and since the plantations established in the inter-war years were still too young to provide much useful timber, the private woodlands again bore the brunt of the felling. Not only was nearly all the coniferous timber of mature age felled, but there were also heavy inroads into the middle-aged stands.

Post-War Developments

In a Report to Parliament in 1943 the Forestry Commission recommended that after the war there should be a substantial increase in the rate of afforestation. The Commissioners' views were accepted, and in 1946–47 the Commission embarked on substantial and steadily increasing planting programmes. Impetus was also given to the replanting of privately-owned woodlands by more liberal grants, the provision of free technical advice, and support for associations and co-operative societies of woodland owners. To encourage improved long-term management of woodlands the now eminently successful Dedication and Approved Woodlands schemes were introduced. As a result of practical experience in the intervening years, there was the renewed conviction of the importance forestry could have in stemming the drift of population from the countryside, in providing healthy and large-scale rural employment, and in the value of forests in providing a diversity of recreation and enjoyment for the public. Of tremendous importance was the growing awareness that these benefits need not stop at the forest gate, and that there should be the closest co-operation between the Commission, private growers, and the timber trade in order to encourage the establishment of new industries. It was forecast that there would come about a re-growth of the timber industry in a new direction, calling for initiative, new methods, and new plant, and that, provided problems were approached in a scientific and business-like way, the pre-war prejudice against home-grown timber could be completely removed.

Increased Planting Programme for Scotland

The Commission has acquired over one and a half million acres of land in Scotland alone, of which 800,000 acres have been planted, with further planting continuing at a rate of 30,000 acres a year and destined to rise to 50,000 acres a year from 1976 onwards. In addition, private growers have more than 400,000 acres of well-managed woodlands in the country and planting is proceeding at a rate of 20,000 acres a year. In the Highlands, within range of the new Fort William mill, the area of Commission woodlands is 400,000 acres, to which 20,000 are being added annually; this figure will increase to 26,000 each year from 1969, and later to 40,000. Private woodlands extend to 200,000 acres and about 8,000 acres are planted annually.

Harvesting the Forest Wealth

Just as the inter-war period was one of rapid change in the techniques associated with tree planting and forest management, so the past 10 years have brought in an equally radical new era for the harvesting and marketing of woodland produce.

The principal object in growing trees is obviously financial profit, and the best results in this respect will be achieved if the trees are grown to sizes suited to the sawmilling industry. For spruce trees in the moist climatic conditions of the west coast, where growth is fast, maturity may come at the relatively early age of 55 years, but under drier climates in the east of Scotland, where pine is the main species, it may take 80 years. To produce trees of good quality as well as size, and to gain the maximum total yield of timber, the procedure is to plant trees close together, usually 1,500 per acre, to provide an early cover of the ground, so suppressing competing weeds. From an age of 15 or 20 years the young plantation is thinned periodically to ensure that the best trees are given more space in which to develop. The produce from these thinnings is an important part of the yield of the crop. It usually amounts to half the volume of timber produced in the lifetime of the plantation; the other half forms the final crop, which is felled at maturity. Since the yield from thinnings is available early, it has a marked effect on the profitability of the plantation.

Future Spate of Timber

The Forestry Commission has been in existence for only 49 years—a short while in forestry terms—so that the time has not yet been reached when even its earliest plantations can be considered mature. But the amount of wood now being produced as thinnings is growing fast; it will snowball even more rapidly in the next few years, as the large post-war plantations reach the productive stage. This is illustrated by the following table showing estimated output of softwood in Scotland.

ESTIMATED OUTPUT OF SOFTWOOD IN SCOTLAND

Thousands of Tons

	1960	1965	1970	1975	1980	1985
Forestry Commission	234	300	555	787	1,134	1,616
Private Estates	413	434	477	533	587	640
Total for Scotland	647	734	1,032	1,320	1,721	2,256

Much of this timber is too small for general sawmilling. For example, about two-thirds of the current production from Commission woods and a third of that from private estates is under six inches diameter. Until a few years ago most of this wood was bought by the National Coal Board for pit props. Lesser amounts were used, as they still are, for fencing posts and rails. But with the closure and modernisation of coal mines, the consumption of pitwood has been falling sharply, especially in the Scottish coalfields.

The New Age of Wood

This has led to the setting up of a wide range of new industries to absorb the smaller logs in the manufacture of fibreboard, chipboard, and above all, paper.

Of these enterprises the Scottish Pulp and Paper Mills is not only the largest, but it occupies a unique place in the development of forestry and associated industries. It provides a means of revitalizing the economy of the West Highlands, a region that the Acland report had described in 1918 as one of the poorer and more backward parts of Britain.

Several years ago, the Forestry Commission, looking ahead to future marketing needs, organized special studies by experts on the feasibility of locating different types of wood-using industries in Scotland and particularly in the Highland area. This was approaching the stage of large-scale output from its forests, and it is of course remote from alternative markets in northern England. Subsequently, Scottish Pulp (Development) Ltd., was formed to study the problem further, and from this evolved the Scottish Pulp and Paper Mills who built the Fort William mill.

Liaison With The Company

From the very earliest stages the Company and the Commission have worked closely together. In the matter of supplies and the matching of the mill's present and future needs to the output of the forests surrounding it, specification of the raw material, organization of the transport system, sea, road and rail communications, the two bodies have worked in harmony. From all these studies there emerged completely new procedures which represent major advances on earlier methods. They are now being widely followed in other parts of Britain, with advantages to both timber-grower and timber-user. They include the mechanisation of the haulage of the wood from the forests and of loading it on to transport. Without these major improvements in techniques, the organization of pulpwood supplies to the mill would have been impossible.

The Torch Burns Even Brighter

The coming of Scottish Pulp and Paper Mills to the Highlands therefore has provided a necessary additional market in which timber growers can sell their small logs. This in itself is a stimulus to further planting. It has led to a whole new way of life in the woods by ushering in greater assurance of more and increasingly skilled employment. The mill is in fact taking its place with the forests in a well-balanced whole which, almost half a century ago, was envisaged by the founders of modern forestry in Britain.

That the torch which they kindled has not burnt itself out at this stage of achievement, but is in fact burning even brighter, is shown by the recently published Scottish Economic Plan. This says: "The Government fully recognises the importance of afforestation in providing employment opportunities in rural areas and in providing the raw material for home-based timber-using industry. In the Highlands forestry offers the best prospects of providing the necessary industrial core of the economy."

The Fort William project is an outstanding example of the ways in which forestry can assist industry in restoring prosperity to the Highlands.

WORKINGTON—BRITAIN'S FIRST FULLY INTEGRATED PULP AND BOARD MILL

Contributed by Thames Board Mills, Ltd.

A Brief Description of the Process

Introduction

Plans were laid for the integrated pulp and board mill at Workington early in 1960 when it was realized that the removal of EFTA tariffs in the future and the protection of certain established interests in paperboard would demand a product made in Britain from British raw materials. The location at Workington was selected after careful investigation and the site proved ideal from the point of view of availability of raw materials, labour and water supplies.

Wood Yard

Much of the timber used at Workington is supplied by the Forestry Commission from Northern England and Scotland and is of the order of 70,000 tons per annum. The logs are small diameter averaging around five inches and the maximum length is 7 ft 6 in. The logs enter the mill by way of the gantry crane and are slung in bundles. These bundles are lifted from their lorries and placed into storage areas under the gantry. The crane is designed with a special cab which can be lowered to ground level to allow the driver to carry out all his own handling. There is space for 6,000 green tons of logs under the gantry.

The next stage is to pass the logs through the drum barker where they tumble against each other in a revolving drum 16 ft in diameter. This action removes the bark from the logs, making them clean for further processing.

The logs now pass either to the bundling pocket for storage or on to the chipper which is a large circular disc set with knives which reduce the log to small chips. The chips are now blown to the chip equalizing pocket which evens out the flow before they reach the chip screen. The object of the screen is to remove any unsuitable chips.

After processing through the chip screen the chips are conveyed to storage area for further handling.

During the bark removal process a great deal of waste bark is obviously created and this is disposed of in the boiler house.

Pulp

The pulping process used at Workington is the refiner groundwood process which produces a pulp of considerably high strength and brightness. Chips are fed between two discs, one of which is revolving at high speed. The action of the chips rubbing against each other and the discs separates the individual fibres and produces pulp. This is a less destructive and more productive method of producing pulp than the stone groundwork method. Water is added during pulping. The pulping machinery is called the vertifiner and consists of a 42-inch diameter head driven by a 2,000 h.p. motor revolving at 1,500 r.p.m.

After the vertifiner the pulp passes to the surge chest where it is diluted in consistency. After this the pulp passes through the Cowan screens which remove any coarse fibres. Next the pulp is subjected to intensive cleaning by the Vorject cleaners which remove any particles of grit, dirt or bark. Finally the pulp passes through a thickening process before going on to the stock preparation plant.

The Machine

The treated pulp is held ready in the machine chests which feed the No. 12 Inverform machine at Workington. This particular machine was chosen for its ability to produce the board with improved formation, better cross machine sheet stiffness and a more bulky sheet with a good weight caliper profile. The pulp is fed to the machine through four Inverform units (there is provision for a fifth). The full wire width is 154 in. and board is trimmed to 131 in. at present but this will be increased to 135 in. in the near future.

After the pulp is laid on to the machine at the wet end it passes to the drying section which consists of three groups of 60 in. diameter cylinders plus an MG cylinder designed to impart a smooth finish to the board.

There is also a Jagenberg air knife coater fitted to the machine which scientifically coats the board with a clay coating for greater appearance and printability.

The board finally is fed through the calendering stack and transferred to either the winder or the cutter. The winder is designed to operate at a maximum speed of 3,000 ft per minute and is equipped with automatic reel ejector. Maximum roll diameter is 72 in. with a minimum width of 4½ in. The cutter is designed to take 135-in. wide reels direct from the machine. The unique feature of the Jagenberg cutter is the rotating fly knives which ensure a good clean edge to the board.

The Raw Material

This new market for home-grown softwoods draws its raw material from both private and state forests in the North of England and the South of Scotland, an area which includes some of the largest state forests in the British Isles. Here, major planting schemes undertaken by the Forestry Commission during the years immediately prior to, and after, the war are now reaching the thinning stage, and the volume of timber to be put on the market will increase each year.

A proportion of the total requirements of pulpwood has been guaranteed by the Forestry Commission; owners of private estates, timber merchants and forestry co-operative societies supplying the balance. The species most suitable for the manufacture of pulp are Norway spruce and Sitka spruce and it is these species that are more readily available in this area. In order to assist growers to market all of their thinnings a proportion of Scots pine, Douglas fir and the larches will be accepted.

The pulp produced from home-grown pulpwood is of high quality, but to achieve this, it is necessary to have a strict control over the intake of the various species. After consultation with the growers, the specification has been designed to permit the full use of mechanical methods of extraction of the wood from stump to roadside and loading on to road transport. Normally the square-cut lengths are seven feet six inches to allow cross loading of lorries, but to minimise waste, lengths down to six feet will also be supplied.

The diameter of the logs may be as little as 2½ inches over bark at the small end and up to a maximum of 16 inches. The wood must be freshly felled, unbarked, free from crooks, forks, swollen butts, rot, visible metal, deadwood and other physical abnormalities. Branches must be trimmed flush. The test for straightness is a straight line, drawn between the centre of both ends of the log, which must not pass outside the circumference of the log.

Local haulage contractors with their special knowledge of forest conditions in their areas load and transport the pulpwood to the mills. Mechanical loaders, mounted either on the vehicles or as separate mobile units, enable the pulpwood to be loaded quickly by the driver, without the employment of other labour. This ensures a quick turn-round of the vehicle under most weather conditions and releases labour, normally employed on this work, for the increasing volume of felling, cross-cutting and extraction that has to be undertaken during the next few years.

On arrival at the mills the pulpwood is weighed and inspected, prior to being unloaded by gantry crane. Special slings are used for this purpose which permit loads of pulpwood to be unloaded and placed to stock (or immediate consumption) in the minimum of time, thus releasing the vehicle for a quick return to the forest area.

The intake of pulpwood has been carefully planned to commence at a low level of supply and gradually building up to the total requirements over a period of more than a year, in order to assist growers, forestry contractors and haulage contractors to gear up for this new market without too much strain on their present resources.

The Product—Carton-X and Carton-Cote

Workington mill produces two grades of board: Carton-X a duplex folding cartonboard, and Carton-Cote, a duplex folding cartonboard with a clay-coated finish. The caliper range will be ·010 to ·020 and is currently offered in ·012 to ·018.

The advantages of these two products are many. The raw material of refiner groundwood ensures a longer fibre and greater strength. Continuity of raw material supply ensures consistent quality. Carton-X and Carton-Cote are made on the Inverform machine which produces a board with good cross-directional stiffness, and smoothness when combined with the MG cylinder; a very even weight and caliper profile is also evident. The finishing processes at Workington are extremely advanced involving a Jagenberg air knife coater, a fly knife cutter and fast, accurate winding equipment.

The Workington mill represents an investment of £6¼ million and is designed to produce a product meeting all of the needs of the converter. Carton-X and Carton-Cote are manufactured especially for the pharmaceutical, toiletry, perfume, cosmetic, cigarette, frozen food and foodstuff markets.

HOME-GROWN TIMBERS: LARCH

Contributed by the Forest Products Research Laboratory, Princes Risborough

Introduction

European larch (*Larix decidua*) was introduced to Britain around 1620 but was not planted on a forest scale before 1750. It has been a major forest species in Britain for a hundred and thirty years, particularly on private estates. Japanese larch (*Larix kaempferi*) has been planted extensively in upland areas for some fifty years. Both species are excellent pioneers, commonly growing at a rate of two to three feet in the second and third years after planting, a rate which generally exceeds that of other major home-grown species at that age. Furthermore they grow well at high altitudes, though they do not stand the most severe exposure.

Japanese larch is normally the faster growing species but has little advantage in the drier parts of the country where European larch may even outgrow it on the best sites. However, Japanese larch is superior in the moist western uplands and markedly so on the less fertile sites. It is an important pioneer because it suppresses ground vegetation so rapidly, and this characteristic makes it valuable for firebreaks. Japanese larch is not susceptible to the complex trouble known as "dieback", which has afflicted so many European larch plantations of other than the best-adapted provenances. For these reasons Japenese larch has been planted on the greater scale over the last few decades.

The hybrid between Japenese and European larch (*Larix* × *eurolepis*, commonly called Dunkeld larch) outgrows either parent on all but the very best larch sites, and its superiority becomes very marked under marginal conditions for larches.

In 1966 there were roughly 245,000 acres of larch in Britain, of which well over half were twenty years or less in age. New planting is proceeding at the rate of about 7,000 acres per year.

Both species—and the hybrid—grow rapidly when young and are decided light-demanders; it is therefore important that they are thinned earlier than most other coniferous crops. The highest yield classes noted in the Forestry Commission's *Forest Management Tables* show that the 40 largest trees per acre of the highest Yield Class of European larch have a mean height of 46½ feet at 20 years, while the 40 largest trees of the highest Yield Class of Japanese larch have a mean height of 48 feet at the same age. This rapid height growth culminates early, and crops of European larch exceeding 100 feet are rare and would remain so even if grown on unusually long rotations. Japanese larch was formerly believed to slow down in height growth even more, but this is not so; it probably continues longer than European larch, and although it is exceptional to find crops of Japanese larch older than 60 years, several stands are known to have reached a mean height of 100 feet. The larches attain their maximum mean annual increment significantly earlier than other conifers in the same Yield Class (*Forest Management Tables*, Table 7, p. 22).

To maintain uniform growth in girth, it is necessary to retain a high proportion of live and vigorous crown on the trees at all times, Stands of larch must therefore be thinned comparatively heavily, leaving the final crop at wide spacing. Hence the final volume of the crop is low in comparison with nearly all other coniferous crops.

There will be a considerable volume of thinnings to come for many years from large areas of Japanese larch planted since World War II, especially in Wales. There is little doubt that both species—and their hybrid—will continue to play a significant role in British forestry, if perhaps a less extensive one than in the past. Much is now known of the most suitable seed origins of European larch for this country, and with intelligent silvicultural application there should be no difficulty in producing healthy plantations in the future. The Forestry Commission's programme for the improvement of the larches through selection and breeding will, in the near future, supply seed of European, Japanese and hybrid larch of reliable genetical charcter and increased yield potential.

The relative merits of the timber of European and Japanese larch have long been a matter of controversy. The issue has been confused by the fact that experience of the European species is largely based on mature timber while most of the Japanese larch so far available has been the product of young trees with a large proportion of relatively low-grade core wood (juvenile wood). A recent investigation has shown that the two species have very similar properties and age-for-age there is little to choose between them as timber.

The decision which species—or hybrid—to plant will normally depend on silvicultural considerations and volume production at different ages. Radial growth in early life is usually more vigorous in Japanese larch than in European but after about 15 years the situation is reversed.

Larch is not normally imported in any quantity and then only for special purposes.

General description

Larch can generally be distinguished from other home-grown softwoods in common use by the relatively hard, dense, character of the wood and by the reddish brown resinous heartwood, sharply differentiated from the narrow, light-coloured, sapwood, 1–1½ inches wide. The annual rings are clearly marked by the dark summerwood zones, Douglas fir is somewhat similar but tends to be distinctly pinkish in colour.

Another characteristic feature, which distinguishes larch from the pines, is the irregular arrangement of the branches. When brashed at an early age, clear timber is obtained but much of the timber cut from young trees has numerous small, irregularly scattered and often dead knots. Trees growing in exposed situations often develop "swept butts", the base of the stem being bent away from the prevailing wind.

Because most of the Japanese larch on the market at present is rather fast-grown (wide-ringed) wood from young trees, while practically all mature timber is European larch, corresponding differences in the structure and quality of the wood, due to age and conditions of growth, are sometimes assumed to be real differences between the two species. When wood of comparable age and growth rate is examined, however, the two species are seen to be similar in general appearance and it is doubtful whether the slight differences between them are of

TABLE 11

SUMMARIZED RESULTS OF STANDARD TESTS ON SMALL CLEAR SPECIMENS (GREEN AND AIR-DRIED)

(For comparison with other species see Forest Products Research Bulletin No. 50)

Description	*Moisture content %*	*Nominal sp. gr.*	*Weight at*		*Bending*					*Compression*	*Hardness*		*Cleavage*	
					Static				*Impact*					
			50% m.c.	*12% m.c.*	*Modulus of rupture*	*Modulus of elasticity*	*Work to max. load*	*Total work*	*Max. drop*	*Max. crushing str'th*	*Side*	*Max. shearing strength parallel to grain*	*Radial*	*Tangential*
			lb/ft³		*lbf/in²*	1000 *lbf/in²*	*in. lbf/in³*		*inch*	*lbf/in²*	*lbf*	*lbf/in²*	*lbf/ 2cm width*	*lbf/ 2cm width*
European larch ..	green 12	0·46 0·48	42	34	7,700 13,300	1,140 1,450	13·7 18·6	39·5 29·8	34 30	3,530 6,780	550 820	1,000 1,800	50 53	55 62
Japanese larch ..	green 12	0·41 0·43	38	30	6,900 12,000	990 1,200	13·3 14·7	37·3 22·3	29 27	3,180 6,240	480 650	890 1,710	44 47	55 62
Douglas fir ..	green 12	0·41 0·44	39	31	7,700 13,200	1,210 1,520	11·3 14·0	33·3 24·9	27 27	3,570 7,000	540 770	990 1,680	48 54	58 65
Scots pine ..	green 12	0·42 0·46	39	32	6,700 12,900	1,060 1,450	10·1 15·0	31·0 19·5	27 28	3,180 6,870	500 670	860 1,840	47 59	54 74
Baltic redwood (Imported Scots pine) ..	green 12	0·41 0·43	39	30	6,400 12,100	1,120 1,450	10·1 14·2	27·0 17·4	27 26	3,040 6,520	440 580	860 1,540	38 56	43 62

any practical significance. Both show some variation in heartwood colour from pale yellow-brown to a moderately dark red-brown, the darker shade being more characteristic of Japanese larch. In both species there is a tendency to spiral grain which makes the sawn timber inclined to twist in drying and may give rise to some tearing of the surface in machining operations. Indications are that spiral grain is more extensive in European than in Japanese larch. As yet little is known about the timber of Hybrid larch.

With the exception of pitch pine, larch is the heaviest of the softwoods in common use. The average weight of mature, slowly grown timber (almost exclusively European larch) is of the order of 37 lb./ft^3 in the seasoned condition, 45 lb/ft^3 green (50 per cent moisture content). Wood from young trees of vigorous growth with a large proportion of sapwood (particularly Japanese larch) is considerably lighter, say 32–34 lb./ft^3 on the average.

In both species the fibres are relatively long, usually between 3 and 4 mm. in mature growth, that is somewhat longer than the fibres of Sitka spruce of similar age, but the presence of resin and other extractives is a disadvantage from the point of view of pulp manufacture.

Seasoning properties, shrinkage and movement

In comparison with Scots pine the sawn timber dries rather slowly when piled out of doors, with some tendency to twist, check and split. Twist is likely to be the most troublesome cause of degrade. Knots do not split badly.

In kiln drying, Schedule H appears to represent the most suitable treatment for larch. It dries fairly rapidly but with a marked tendency to distort, particularly in the form of twist, cup and spring; 2-inch material can generally be dried from the green condition to about 12 per cent moisture content in slightly less than three weeks. Experiments designed to compare the kiln-seasoning properties of European and Japanese larch of similar age showed that the Japanese seasoned with slightly less distortion than the European. In both species a little checking and extension of original shakes may take place and slight resin exudation is to be expected. Splitting and loosening of knots are not serious.

The average shrinkage values for timber kiln seasoned from the green to 12 per cent moisture content are:

Tangential	about $\frac{1}{2}$ in./ft or 4·0 per cent
Radial	about $\frac{11}{32}$ in./ft or 2·8 per cent

The movement of the seasoned timber in use is classified as small, the actual values being as follows:

Moisture content in 90 per cent humidity	19 per cent
Moisture content in 60 per cent humidity	13 per cent
Corresponding tangential movement ..	$\frac{13}{64}$ in./ft or 1·6 per cent
Corresponding radial movement ..	$\frac{3}{32}$ in./ft or 0·8 per cent

TABLE 12

ULTIMATE DESIGN VALUES FOR HOME-GROWN EUROPEAN LARCH, DOUGLAS FIR AND SCOTS PINE POLES OBTAINED FROM F.P.R.L. TESTS. THE VALUES FOR SCOTS PINE AND LARCH ARE QUOTED IN B.S. 1990:1953, WOOD POLES FOR OVERHEAD LINES

Description	*Modulus of rupture lb.f/in.^{2}*	*Modulus of elasticity lb.f/in.^{2}*
European larch	10,000	1,640,000
Douglas fir	9,100	1,860,000
Scots pine and Baltic redwood ..	7,800	1,520,000

Strength

Larch is generally regarded as the strongest home-grown softwood in common use though the results of laboratory tests on small clear specimens show that Douglas fir is superior in certain strength properties (see Table 11). The figures in Table 11 also show how larch compares with Scots pine and Baltic redwood. In general terms mature (European) larch is considerably harder than Scots pine and slightly stronger in bending strength and toughness.

The differences in strength between the two species of larch, as indicated by these test results, are believed to reflect the greater age of the European larch test trees. The Japanese larch test material was from smaller trees with a larger proportion of relatively low-grade core wood. The results of further tests specially designed to compare the properties of the two species at the same age—and necessarily limited to trees less than 50 years of age—reveal no difference of practical importance between them so far as strength is concerned, and it is reasonable to expect that this general conclusion will apply to mature timber.

In the new *British Standard Code of Practice* No. 112 "The Structural Use of Timber" where the principal types of softwood are classified for convenience in three groups, S1, S2 and S3, on the basis of strength, larch is placed in Group S1 with Douglas fir (home-grown and imported) and pitch pine. In the Code of Practice no distinction is made between the two species of larch.

The figures in Table 12 demonstrate the well-known strength of larch for use in the form of poles.

Durability and preservative treatment

Larch has a reputation for being naturally durable. In the Laboratory's standard field test, using 2 in. × 2 in. stakes, the heartwood has an average life of about ten to fifteen years and is therefore classed as only moderately durable. It can be expected to last longer than Scots pine or Baltic redwood but not so long as oak heartwood. The relatively small proportion of sapwood is perishable.

The durability of the heartwood can vary greatly. In the standard tests individual specimens have lasted from only about 2 to over 30 years. This is partly due to the fact that the outer heartwood is more resistant to decay than the central core of juvenile wood. This also probably explains why European larch is generally considered more durable than Japanese, since practical experience with the European species is largely based on mature timber, while most Japanese larch has been the product of young trees. The results of several field tests, however, have not revealed any significant difference between the durability of the two species.

Although larch is more durable than most softwoods, it is not sufficiently durable to use without preservative treatment for purposes where a long life is required under conditions favourable to decay. Tests have shown that Japanese larch is slightly less difficult to treat than European larch, but the heartwood of both species is resistant to impregnation. Provided a long pressure period is given, the timber can be satisfactorily impregnated to give a long life when used for fencing, piling, pit-props, sleepers or transmission poles. The sapwood is moderately resistant to impregnation, but can be treated effectively by the hot-and-cold open-tank process. It is well worth treating small-diameter larch thinnings or tops if they are to be used as posts. Service trials have demonstrated that with an open-tank creosote treatment they will have a life of over 40 years, whereas untreated they last only about five years.

Larch is one of the timbers allowed by the Ministry of Transport for motorway fencing provided it is treated with the appropriate loading of a highly effective preservative, such as creosote or a copper/chrome/arsenic formulation. Treated in this way it should last for at least 50 years.

Where required, the green timber on conversion can be treated conveniently by diffusion with a boron preservative.

Larch is not very susceptible to blue-stain either in the log or as sawn timber and special treatment against staining fungi is not usually considered necessary.

The sapwood of unbarked logs may be attacked by the forest longhorn beetle, *Tetropium gabrieli*, and Siricid woodwasps; but owing to the relatively small proportion of sapwood the damage is not usually extensive except in small poles. Converted timber with the bark on may be attacked by a species of furniture beetle, *Ernobius mollis;* the damage is unimportant and is confined to the sapwood immediately adjacent to waney edges. Note, however, that timber damaged by either Siricid woodwasps or *Ernobius mollis* is unacceptable by the Australian quarantine authorities unless it has been given a specified treatment. In buildings the common furniture beetle, *Anobium punctatum*, and the house longhorn beetle, *Hylotrupes bajulus*, may attack larch sapwood; but the damage is usually unimportant and in general preservative treatment is not necessary for interior use.

Larch used for the outer planking of boats or for harbour works may be attacked by marine borers unless it is suitably treated.

Working properties

Because of a tendency to spring on leaving the saw, larch is more difficult to convert than most species of softwood; losses in conversion tend to be rather high on account of the irregular shape of some logs.

In general the seasoned timber can be sawn without difficulty, using a circular plate ripsaw with 54 spring-set teeth and a 25° hook angle. Loose knots may cause trouble in sawing if they fall out.

Clear straight-grained material planes cleanly but the hard knots tend to damage cutting edges and the disturbed grain around knots tends to tear. Spiral grain causes tearing along one edge of boards (particularly in material from small-diameter logs) even when they are nominally flat-sawn. Arrises are liable to break away in moulding but larch usually works cleanly in other operations. It takes stain, paint and varnish satisfactorily but requires care in nailing to avoid splitting.

Pulping properties

Larch has not generally been considered suitable for pulp manufacture owing to difficulties arising from certain extractives, mainly in the heartwood. Some of these materials interfere with the pulping reaction in ordinary acid sulphite processes while others can cause high consumption of chemicals in kraft cooking.

Pulps with satisfactory physical properties have been made, however, from both European and Japenese larch using the sulphate process, and also by means of modified sulphite processes such as the two-stage Stora method. Pulps from wood with a large proportion of heartwood tend to show pronounced yellow to brown colorations which cause further difficulties in bleaching.

Summary of properties in relation to uses

Larch is notable for its superior strength and lasting qualities. It is traditionally regarded as a timber for out-of-doors use and for special purposes. It is a favourite timber for estate work—for farm buildings, gates, fences, poles, footbridges and the like—and in those parts of the country where oak is scarce the larch fence post is the standard by which other types are judged.

Now that preservative treatment is becoming more general natural durability is not so important as it used to be. Nevertheless the advantage of larch in this respect is still appreciated where treated timber is not readily obtainable.

In industry larch has been used for the floors of motor lorries and for ramps; it would probably be used more widely if it could be supplied in suitable sizes and grades. The same applies to the vat-making industry where larch is in competition with imported Douglas fir and pitch pine.

For boat building larch has been commonly used for many years for planking, beams, stringers and shelving, particularly in fishing boats, and it is still used extensively for these purposes in Scotland, where good supplies are currently available. Many boat builders, particularly in Scotland, consider larch to be more resistant to the effects of bilge water than mahogany; consequently it is considered good practice to use larch for planking from the lower turn of the bilge to the garboards. Larch is nearly always bought in the form of logs and often the whole tree is purchased. A good "boat-skin" larch should be at least 20 inches in diameter at breast height, straight, except that some butt sweep is not objectionable, and free of dote. In a well-grown larch scattered knots do not cause much trouble to the boat builder, particularly if the planks are sawn at an angle between true radial and true tangential.

Because it is harder to work and heavier than most other softwoods commonly available, and also tends to distort in drying, its use in building is limited mainly to exterior work such as cladding, gates and sills, greenhouse construction and other purposes where something stronger and more durable than ordinary deal is indicated.

Larch is among the timbers listed as acceptable for transmission poles in B.S. 1990:1961.

Large quantities of larch thinnings are converted into pit-props. Larch is popular for pergolas and rustic work in gardens.

For pulping, larch is accepted by some mills in consignments of mixed conifers, though the proportion of larch to other species may be restricted.

Although larch is more durable than most softwoods its service life can be greatly extended by preservative treatment, either in a pressure plant or by the hot-and-cold open-tank process. Treatment is well worthwhile if a long life is required under conditions favourable to decay.

A CHEAPLY BUILT DRIER

Contributed by the Forest Products Research Laboratory, Princes Risborough

Introduction

In recent years considerable interest has been shown throughout the world in a type of timber drying unit usually referred to as a predrier. This was in effect a relatively cheap drier, frequently of large capacity, operated at relatively low temperatures. Simplicity was the keynote and it was intended that the wood should be dried from the green to roughly the air-dried condition of about 25 per cent moisture content. This partially dried timber could then be taken to a more expensive precision drier or kiln where means would be provided for drying down to the required moisture content in service, and in a manner that yielded uniformly dried stress-free material.

The fact that far too much home-grown timber had been turned out in a thoroughly unseasoned state has in this country been a matter of concern to the Forestry Commission for some time, and they expressed the view that a relatively cheap drier, built largely of wood and simple to operate, could help solve the drying problems of many sawmills in this country. As part of a co-operative project therefore the Laboratory undertook to design, erect and operate what might be termed a do-it-yourself drying unit.

Design of drier

In the prototype drier built at the Laboratory the framework and weather-board cladding is of creosoted home-grown Scots pine mounted on railway sleepers embedded in the ground. To provide for good heat insulation slabs of 1½-inch thick expanded polystyrene line the walls and roof and on the inside of these is stretched polythene sheeting to act as a vapour barrier.

The air circulation is produced by means of a 4 ft 6 in. diameter fan situated to the side of the stack, and this normally is driven at a speed of 300 r.p.m. by an electric motor. No steam spray is provided and humidity control is effected by the appropriate setting of the fresh and exhaust air dampers. A canopy or pole barn has been built over both the kiln and the bogie track leading into it to afford them protection from the rain.

The cost of building a single unit 18 feet in length capable of holding about 400 cu. ft of 2-inch material complete with the canopy was estimated as being just £1,000.

Heating

In the prototype drier heat was at first supplied by means of both electrical heating elements and also steam pipes.

Electricity almost certainly would be available at sawmills but probably the cost even of off-peak electricity would be high; and if intermittent heating is employed difficulties arise in attempting to run the unit continuously in accordance with any scheduled set of conditions.

Steam on the other hand is more often than not lacking in a small sawmill and the cost of setting up a boiler and employing a full-time stoker would almost certainly prove to be prohibitive even if the fuel used were wood waste.

It would seem that some form of self-operating heating apparatus would be called for and that probably oil as a fuel would provide the answer. Automatically-fed oil burners then could be made to heat, say, a hot water system of radiators within the drier, or the products of combustion from oil burners might be used indirectly or directly as the heating media.

With this in mind the Laboratory, in collaboration with Shell-Mex and B.P. Ltd., has been carrying out experiments on the heating of this unit by means of oil-fired burners fitted to suitably arranged heating pipes within the drier and to one side of the fan.

Trial Runs

Trial runs on 2⅛-inch Scots pine and European spruce have shown that the former can be dried from the green in just over two weeks and the latter in from 9 to 12 days to a final moisture content average of about 20 per cent in a satisfactory manner. Temperatures were controlled by steps within the ranges 85° to 100° F. and humidities varied from initial values of 70 to 75 per cent down to final values sometimes as low as 30 per cent. Drying rates were of course dependent on humidity and both, it was found, could be sufficiently well controlled by manual adjustment of the fresh and exhaust air vents.

One test run was undertaken on a hardwood, namely beech, in board thickness of 1⅜ inch. This when dried to a final moisture content of 18 per cent was not badly distorted in view of its quality and there was little surface checking. An initial humidity of 85 per cent could be obtained and held and finally it could be lowered to 50 per cent. At 95° F. the schedule as a whole could therefore be regarded as mild and not too detrimental to the wood, despite the fact that outside temperature variations made it impossible to maintain really steady conditions inside for any length of time. Severe case-hardening stresses developed and in a drier such as this one, lacking steam sprays, no case-hardening relief treatment could be given.

Comments

A drier such as the one under consideration can be built relatively easily for a cost likely to be about half that of a more orthodox brick or metal kiln. To be run economically as a small unit, almost certainly some automatically operated heat source, such as can be provided by an oil burner or gas-heated hot water system, will need to be employed.

It must be stressed, however, that because this is a low temperature drying unit it does not follow that less heat will therefore be required to evaporate a given quantity of moisture. On the contrary, the overall heat efficiency tends to be greater at the higher temperatures, due to the fact that less air interchange is required in consequence of the increased moisture-holding capacity of the exhausted air.

This drier was built primarily for the part-drying of softwoods that were tolerant of variations in drying conditions generally, but, from the results achieved on the beech, there is reason to think that schedule control can be achieved sufficiently well to make the drying of more susceptible hardwoods not out of the question. As a rule, these would be destined for further precision drying in an orthodox type kiln to a lower uniform moisture content.

In some ways a drier of this kind can be looked upon as one which provides sawmillers with means of subjecting his timber to summer air drying conditions throughout the year. In winter time, when air drying rates are very slow and stocks of fully air-dried materials become depleted, he is then in a position nevertheless to fulfil customers' requirements.

IS SO AN ĀM BUAIN

This is the Time of Reaping

From new forests of Scotland, this is the harvest,
These are the logs of spruce, larch and pine tree
Grown on heath moors and on hillsides the hardest,
Then transformed to generate the pulp mill Banavie.

Fine-visioned were they who the first woods created,
Generous the legacy which they handed on,
For them were the years of toil unabated,
Restoring the glories of once forested Caledon.

Now the rewards of unselfish endeavour
Accrue to their land and the people it bore,
The fruition of dreams and faith in the future
Shall be taken away from Lochaber no more.

Henceforth, from this mill shall pulp and paper go streaming,
And tell to the world that the land lives again,
Hope for its wellbeing, now appears like the gleaming
Of sunshine on Ben Nevis, just after the rain.

ALEX. M. MACKENZIE

AVERAGE PRICE FOR EACH COUNTRY: CONIFEROUS TIMBER SOLD STANDING

Period 1st October 1966 to 30th September 1967

Contributed by Marketing Division, Headquarters

Average Volume per tree in hoppus feet	ENGLAND Volume h.ft	ENGLAND Total Price £	ENGLAND Average Price s. d.	SCOTLAND Volume h.ft	SCOTLAND Total Price £	SCOTLAND Average Price s. d.	WALES Volume h.ft	WALES Total Price £	WALES Average Price s. d.	GREAT BRITAIN Volume h.ft	GREAT BRITAIN Total Price £	GREAT BRITAIN Average Price s. d.
Up to 1½	253,796	14,949	1 2·1	165,841	6,130	– 8·8	186,363	13,518	1 5·4	606,000	34,597	1 3·7
Over 1½ and up to 2½	844,205	58,582	1 4·6	1,573,332	69,829	– 10·6	763,949	58,367	1 6·3	3,181,486	186,778	1 2·1
Over 2½ and up to 3½	771,379	60,136	1 6·7	1,782,763	90,763	1 0·2	567,593	49,738	1 9·0	3,121,735	200,637	1 3·4
Over 3½ and up to 4½	314,042	24,833	1 6·9	1,249,118	69,744	1 1·4	496,467	45,453	1 9·9	2,059,627	140,030	1 4·3
Over 4½ and up to 5½	189,856	15,919	1 8·1	877,249	59,896	1 4·3	377,323	31,006	1 7·7	1,444,428	106,821	1 5·7
Over 5½ and up to 6½	217,495	17,650	1 7·4	689,885	44,889	1 3·6	88,815	8,409	1 10·7	996,165	70,948	1 5·0
Over 6½ and up to 7½	158,946	10,009	1 3·1	308,163	19,478	1 3·1	49,959	4,461	1 9·4	517,068	33,948	1 3·7
Over 7½ and up to 10½	281,464	23,758	1 8·2	503,963	35,407	1 4·8	251,019	23,895	1 10·8	1,036,446	83,060	1 7·2
Over 10½	445,871	69,400	3 1·3	693,164	60,989	1 9·1	131,232	13,318	2 0·3	1,270,267	143,707	2 3·1
TOTAL	3,477,054	295,236	1 8·3	7,843,448	457,125	1 1·9	2,912,720	248,165	1 8·4	14,233,222	1,000,526	1 4·9
Year ended 30.9.66	3,714,592	303,511	1 7·6	7,232,481	427,371	1 2·2	2,548,093	212,272	1 8·0	13,495,166	943,154	1 4·8

MISCELLANEOUS

SOME ASPECTS OF LABOUR RELATIONS

By A. W. HUMPHREY
Forester, South-West England

(The introduction to a discussion held at Dartmoor Forest, 19th September 1967.)

Firstly, I would like to make it clear that I am not setting myself up as an expert on this subject, but have rather approached the matter as one of interest which we all practice every day of our working lives. Apart from the knowledge we gain from experience, there are books available on the subject and it is from some of these that most of the following points are taken. I can only hope that some of these points will be as interesting to you as they were to me.

There is evidence to show that man is a herd animal. Any one who saw a recent television programme by Hans Haas will have been struck by the ant-like activities of crowds of people when viewed on a film at a faster than usual rate. Another example which comes to mind is that of a group of, say, five strangers travelling in one railway compartment from London to the North. As far as, say, Peterborough, the first stop, there may be some slight conversation and possibly some sharing of papers, but there is little consciousness that any group spirit exists. At Peterborough the door opens and a stranger comes in. We all know what a wave of hostility rises against the newcomer. We know too that the next step depends on his behaviour. If he is aggressive he may not be absorbed; if he sits down inoffensively and conforms to type he will be accepted; but no matter which course is adopted, the original five will be more conscious of forming a group.

Groups are formed for various purposes; our main concern is with those formed on the forest, most of which come together because they are placed near each other.

The size of the group is limited by the need for face-to-face communication and there is some evidence to show that 12 is the largest number (examples of this are the 12 disciples, cricket and other games) and if more than one group is required for a single purpose they are linked by an executive unit.

A group should not be confused with a mob, the characteristic feature of which is that no personal inter-relationships exist between members.

The group, in its outward manifestations, may be immortal, or only change slowly. As some members leave, newcomers will take their place and will absorb the old attitudes of the group even though they may not have experienced, for example, the insecurity and unemployment of the pre-war years.

A group will become closer if it feels itself under threat from the outside. This fact is well known to some rulers on the international plane who will manufacture a threat to bring their nation closer together. Unfortunately a shield held up by one group may look uncomfortably like a sharp spear to another group, which naturally defends itself in turn.

Why do people work? What is work? The best definition I can find for the purpose of this talk is, "The application of effort to a purpose." Recalling the outcry which arose on all sides when it was suggested that unemployed men should do something for their dole, such as digging holes and filling them in again, is to realize that the normal individual does not need to be told that doing futile tasks is no "work" at all, but is felt as a personal insult.

I hope to show here that the piecework price is not the only incentive to work.

The reason that this may loom largest is probably that the Unions and Employers find it easiest to negotiate on Wages and Hours of Work.

A common remark made is, "All they are interested in today is the size of their pay packet" or more shrewdly, "All they are interested in today is the size of their neighbour's pay packet". But questioned more closely the person making the statement will admit that unnecessary chivvying will upset his workers and the implication is that other factors will affect the will to work. There is for example, a sense of belonging. This sense of belonging is probably more appreciated when it is absent, and is seen as a very potent weapon of the group when sending a man to Coventry. As most groups insist on each member doing his fair share of the work it will be seen that this is an incentive to work. Or there is a search for material acquisitiveness. The article acquired may be a delight in itself or something to increase the status of the worker. Maybe there is a pride in skill. This may show itself in a genuine delight in what is good. Possibly, in our case, this may be seen in tools upkeep when a forest worker will do more than make a tool useable but by various touches will make the repair as good as new. At the other end of the scale, a man will take pride in the fact that the amount of work to be done is less and the amount done is growing. Then there is a sense of order. A classic example of this concerns British Railways who have a multitude of regulations for running the industry. The railway worker has been aware for many years that if every regulation is applied literally, it will slow down traffic and result in waste. Only when he becomes frustrated for some reason does one read of the "work to rule". Being paid at a flat rate, in the short term, it would not matter to the worker whether he helped the industry or not, and no doubt the same sort of thing might be expected in our industry.

As we have seen there are three extra types of motive for working:

(1) The work may be done as an end in itself (i.e. as a craft).
(2) It may be carried out willingly for motives other than (1) but directly associated with the work situation (i.e. comradeship, status, power etc.)
(3) It may be carried out for extrinsic motives (i.e. to obtain money to be used for a hobby, for the family, or for a chance of getting out of that particular job and setting up in business alone).

It is evident that (1) or even (2) are the most satisfactory reasons for working, and it follows that if the supervisor feels that a sense of belonging is in the interests of production, then it can be strengthened by making sure that every newcomer to the group is not only examined for his ability to do the job but also for his ability to fit into the group. Similarly if pride in skill is useful to management then matters like the acceptance of less than 100 per cent stocking of plantations in the past must be explained very carefully. And again if a sense of order is of value then the worker must be given the opportunity to use his sense of responsibility. It is a truism to say that a person treated as a robot will act like one.

The system should be clear so that each worker knows to whom he must look for guidance and formal approval and on this subject the very word "criticism", which literally means assessment, has come to mean only depreciation. If the automatic response to praise is a demand for more money, then is this because praise has been given too sparingly in the past?

The system must also be fair so that in its formal and informal aspects it is accepted by the workers. A system of rewards and punishments should be capable of being clearly understood; for example, it is a mistake to introduce systems of paying employees which is so elaborate that only a financial genius is capable of understanding them. Punishment is a negative incentive. That is to say, whilst a positive incentive may be said to draw a man in the desired direction, a negative incentive pushes him away from the wrong direction.

It will be seen that communications between the supervisor and the group are of great importance but these are very often obstructed by a natural conservatism which is best described by W. Trotter, "The habit of mind likes a strange idea as little as a body likes a strange protein, and resists it with similar energy. It would not perhaps be too fanciful to say that a new idea is the most quickly acting antigen known to science. If we watch ourselves honestly we shall often find that we have begun to argue against a new idea even before it has been completely stated". He adds, "I have no doubt that the last sentence has already met with repudiation—and shown how quickly the defence mechanism gets to work."

With such a formidable obstacle to overcome I would like to offer the following factors which influence the real acceptance of ideas.

(1) The listener likes the speaker.

(2) The listener accepts already the speaker's authority in the field.

(3) The idea must be put in a way the listener likes.

(4) It must fit in, if possible, with some interest the listener already possesses.

(5) Since people vary widely in the ways they learn, visual aids may help.

(6) By such methods the listener may himself be helped to participate in the formation of a new idea which then becomes "our" idea.

(7) The listener's receptivity varies from time to time.

(8) Finally comes the value of the idea itself.

It will be appreciated that the subject is a wide and deep one and I have had to make some generalizations for the sake of brevity but finally I would like to quote from the South-West England News, issue No. 7. "According to Mr. Kenneth Hastings, M.A., Principal, North Cheshire Central College of Further Education, it could be said that a good manager should have the insight of a psychologist, the compassion of a saint, the looks of a film star, the strength of a leader and the wisdom of a sage."

I would like to acknowledge help from the following books:

R. F. TREDGOLD *Human Relations in Modern Industry*

J. A. C. BRONN *The Social Psychology of Industry*

FOREST WORKERS' DIET

Reproduced by kind permission of The Scottish Forestry Productivity Committee

It is now recognized by most European forestry nations that the diet of the forest worker is of the utmost importance, not only in respect of productivity but in regard to workers' general well-being and health.

From the point of productivity, an average man doing heavy work requires approximately 4,500 calories per day, of which 2,000 to 2,500 are needed for normal biological functions and the balance spent on his daily work. The importance of nutrition in relation to productivity is shown in the following example:—A worker undertaking heavy work needing and consuming 4,200 calories per day will be able to reach 100 per cent working output, but a supply of 3,000 calories per day will decrease his performance at the same job to 55 per cent, if the worker is to maintain his body weight.

Before considering diets for workers it is necessary to know into which category his normal work falls, and Table 13 can be used as a guide:

TABLE 13

Physical Heaviness of Job	*Kind of Operation*
Very High	Climbing trees. Carrying loads uphill. Pulling cable of winch. Spraying with portable powered machines.
High	Tree felling and cross-cutting with hand and power saws. Axe work. Breaking up loam soil with spade. Scything of weeds.
Moderate	Tractor driving in forest operations. Operation of crane. Manual planting of trees.
Low	Manual weeding in nurseries. Maintenance of tools and equipment.

In Table 14 examples of the daily food supply are given for workers performing moderately heavy or heavy work.

TABLE 14

	Moderately Heavy Forest Work 3,000 *calories per day*	*Heavy Forest Work* 4,500 *calories per day*
Milk	1·0 pt	2·0 pt
Fish, Meat	5·0 oz.	7·0 oz.
Cheese	0·75 oz.	0·75 oz.
Eggs	1	2
Butter and Other Fats	2·5 oz.	3·5 oz.
Bread	10·5 oz.	14·0 oz.
Cereals or Meal Products	2·0 oz.	3·25 oz.
Potatoes, Unpeeled ..	12·5 oz.	17·5 oz.
Jam	1·5 oz.	1·75 oz.
Sugar	1·0 oz.	1·5 oz.
Fruit	7·0 oz.	7·0 oz.
Vegetables	7·0 oz.	7·0 oz.

Calorific Values. While a certain amount of bulky food is essential for biological reasons, too much bulk can be harmful and restrict work output. A guide to the range of calories per pound is as follows:

Cheese	1,850	Potatoes	390
Nuts	2,900	Apples	190
White Bread	1,020	Shoulder of Lamb	1,510
Butter	3,440	Beef Steak	1,750

Distribution of Meals. Generally not more than 800 to 1,000 calories should be consumed at any one meal. This calls for four or five meals per day. They should be distributed as evenly as possible and with this in view the mid-morning and mid-afternoon breaks should if possible include a snack. Breakfast should be of a substantial nature, and only a light lunch should be taken if the break is only for half an hour. If a heavy meal is taken at the lunch break, a minimum of 15 minutes should pass before heavy work is taken up again.

Need for Warm Food. Ideally the lunch break should include warm food or at least hot tea, coffee or milk. In this context vacuum flasks are useful and should include soup in addition to the normal beverages.

Fluid. It is essential that enough is drunk during working hours—during hot weather between five and seven pints per day. (Water, not beer! – *Ed.*)

Composition of Diet. Apart from its calorific value, food should have a certain composition. Carbohydrates and fats are the main source of energy. Proteins are important as body-building substances. Furthermore, certain minerals and vitamins are needed. Although carbohydrates and fats can replace each other in practice, both should be present in the food pattern. If heavy work is being done, an increased proportion of fat is necessary because carbohydrates alone would be too bulky, but because fat is thought to be related to the problem of the heart and blood vessel diseases, excessive fat consumption should be avoided.

For heavy work the protein consumption should be related to the body weight of the worker and approximately 1½ times as many grammes as the worker's weight in kilogrammes; in terms of ounces this would mean 3¾ oz. for a person weighing 154 lb.

In addition, a daily supply of 0·8 grams calcium, 2·5 milligrams vitamin B1, 2 milligrams vitamin B2 and 80 milligrams vitamin C are necessary.

These requirements in nutrients can be satisfied by a wide range of different food that is found locally. Milk, cheese, fish and eggs are the main sources of protein. Fat will be available from plants (olive oil and coconut fat) and from animals (butter, cheese, fat meat). Bread, potatoes, flour and rice contain carbohydrates primarily. Vegetables and fruit are rich in vitamins. It is most important that the food consists of different elements, for instance protein and fat from both plants and animals. Generally the food should be fresh and varied, and if this is the case then no special provision is needed for vitamins and minerals, since their supply will be covered in the worker's diet.

Propaganda. A Continental study, made in households where one of the women had taken a course on "better feeding habits", indicated that the feeding habits had altered little because they were governed by the mother according to traditional concepts. Giving information is therefore not enough—the matter of nutrition must be tackled energetically and on more than one front, and particular attention must be paid to wife or mother actually in charge of the kitchen.

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Calorific Expenditure and Nutrition of Forest Workers. J. H. VAN LOON. F.A.O./E.C.E./I.L.O. October, 1964.

TREES ON TIP WILL BE A MEMORIAL

Reprinted by kind permission from the "Merthyr Express", 21st April 1967

On a waste tip which looks directly across the valley to Aberfan 1,500 trees were planted recently as a living memorial from a school in England to those who died in the disaster.

The trees, which are a mixture of larch, lodgepole pine, birch, alder and mountain ash, were planted in an acre of the St. Tydfil Forest, which is owned by the Forestry Commission. The saplings were bought with a cheque for £20. 16s. 4d. sent by pupils from Spelbrook Junior Mixed Infants' School, Spelbrook, Bishops Stortford, Hertfordshire.

In November last year, Mr. J. T. Fitzherbert, Assistant Conservator in South Wales, received a letter from Mrs. U. A. Broughton, headmistress of the school at Spelbrook who wrote:

"Following the Aberfan disaster, children of this primary school collected some money and after discussion they decided that they wished it to be spent, not necessarily in Aberfan itself, but on stabilizing and beautifying slag heaps."

On a cold and windy morning three Aberfan boys, Peter Bowen, Bryan Price and David Evans, all employees of the Forestry Commission, helped to plant the trees on the steeply sloping hillside.

Also present at the ceremony was Mr. I. O. Evans, head forester of St. Tydfil Forest and Mr. W. E. Powell, Head Forester of the nearby St. Gwynno Forest.

Mr. Powell told our reporter that the young trees have been grown from seed and have been two years in the nursery. They will probably now grow at the rate of 12 to 18 inches a year for the next five years. After this they will grow more rapidly, he said.

Mr. Fitzherbert thought the tribute from the school was a wonderful gesture and said, "If the pupils come to Wales the chances are they will come to see the trees—and that's what I want to happen."

The Aberfan Memorial Forest Plot is marked by a green and yellow notice board. Mr. Fitzherbert said, "I hope the vandals of the area will respect the sign and memorial forest. Perhaps a local school might adopt the plot and look after it on behalf of Spelbrook."

Photos appear as Plates 15 *and* 16 *on our centre pages.*

A RIDE WITH IANTO

By **R. J. JENNINGS**

Chief Forester, South Wales

Ianto the timber haulier who worked with me in the Welsh Marches had spent his life amongst horses.

He knew how to plough whilst still at school, but left farm work at the age of 17 and went down the pit where he drove ponies. After a while he began to miss the open-air life and joined the Royal Artillery as a driver. When the battalion was mechanized he took his discharge. For twelve months he did odd jobs in a racing stable, eventually settling down hauling timber in the woods because he wanted to drive a team of horses.

When asked why he left the Army Ianto would say, "Ah, well, see . . . they wasn't getting me inside an old tank or armoured car, mun . . . no, no, I did tell them . . . it is a horseman I am!"

Although Ianto pretended to despise engines and machinery he secretly envied the tractor drivers who hauled the heavy timber with crawlers. The huge yellow wheels and caterpillar tracks made him feel a little inferior and sometimes, during a meal break when the men were discussing the merits of their various motor-cycles, he would chip in with words like *transmission*, *ignition*, *fuel injectors* and *manifolds* to try and impress them, but this fooled no one.

"Push off Taff", they would say to him as they winked and nudged one another, "You can't tell the difference between a spare wheel and a sparking plug . . . get along and give your old mare a good feed."

One spring we were felling a wood on the borders of Radnor and Montgomeryshire. The trees grew on a hill side, a long narrow piece of land. The big sycamore and larches were extracted by men who drove crawler tractors with winches and, as usual, Ianto and his horses dealt with the smaller poles that were to be cut up into pitwood.

One part of the wood was on soft clay, too steep and wet to bear the weight of vehicles, so we laid down a narrow-gauge track on which was operated a small diesel rail trolley pulling steel trucks.

The crude steel track wound its shiny way up through the wood for over a mile, and several times a day the motor would grunt up the incline pulling empty trucks to the furthest end of the plantation. Later on skips of pitwood and timber could be heard rattling down on the return journey.

First thing in the morning the timber cutters would travel up to work behind the trolley, sitting on seats made from rough-sawn planks fitted up in one of the trucks. Promptly at four-thirty they would catch the last load down on the way home, with Ianto always seated by the driver.

It was on Whit Monday, when work had ceased for the week-end and Ianto was walking to the field that adjoined the top of the wood to water his horses, that he saw four well-dressed men draw up by a gate in a car near the entrance to the wood, One of them came across to Ianto.

"Are you employed here?" asked the man.

Ianto nodded. "Yessir" he replied. "A haulier I am".

"Where are the men cutting now?" asked the stranger.

"All off today, Sir" replied Ianto, "Bank 'Oliday!"

The man scratched his chin pensively. "Pity," he said, "How do we get to the top of the wood?"

"Follow the lines, Sir," said Ianto, pointing to the track. "Uphill, 'bout a mile."

The stranger looked down at his nicely polished shoes.

"That's a long stroll through all that mud," he remarked, "Can't you run us up in the motor trolley?"

Ianto stood still for a moment with his mouth open. He felt staggered. Run them up in the trolley. What an opportunity! He, Ianto, drive the trolley . . . The mere idea made his heart miss a beat.

But why ever not? He could do it. Inwardly he had longed for a chance to drive an engine for years. Any engine. But he could never get near one. He wasn't allowed to. Not really surprising, he supposed, because everyone knew that he couldn't drive a tractor or a car.

Diesels were different though. They were on lines . . . You couldn't go wrong. Besides . . . he had ridden beside Archie the regular driver for long enough to know every move that he made. He knew how to start the engine. You pulled out that little lever . . . turned the starting handle until she fired . . . put it in gear . . . opened the throttle and away . . . Nothing to it . . .!

Then when you were at the top you shut down. Swung the trolley round on the turntable to face downhill and you were ready for the return journey.

Run them up in the trolley. No sooner said than done. WHAT a tale he would have to tell tomorrow . . .

Ianto took a deep breath as he spoke to the official.

"Yessir," he said . . . "I'll run you up . . . that's no trouble," and he led the party across to the little shed where the engine was housed. The four men stepped in the first truck and made themselves comfortable on planks and a green tarpaulin.

Ianto watched them sit down and climbed into the driver's cab. Although he showed no signs of it he was bursting with excitement. Without further ado he cranked the starting handle a few times and the engine sprang into life.

After a little fumbling with the gears the wheels began to turn and the party was under way.

Ianto felt on top of the world and, gaining confidence in his driving, accelerated. The effect was disastrous.

There was a series of shuddering jerks and the men were thrown backwards from their seats.

The tallest of them fell on to the floor of the truck and sat in a heap of oily sawdust. As he started to rise to his feet the trolley plunged again on a bend. Three of the men were now crawling on all fours. The tall man, now about to stand up, again lost his balance, slid sideways and sat on the back of one of his colleagues on the floor.

Their heads came into contact with the side of the truck . . . one of them swore and closed his eyes with an excruciating expression on his face. The other rubbed his forehead in pain but in silence. Another convulsive leap as Ianto tried to accelerate gently drew a muffled curse from one of the passengers. "Blast you . . . take it easy driver!"

The tall man looked alarmed. Glancing over the side of the truck he saw beneath him a drop of fifty feet. He leaned forward towards Ianto. "Have you driven this engine before?" he asked.

But Ianto was too old to fall for that one.

"She's cold, Sir" he said, putting on his most intelligent expression. Remembering what he had heard other drivers say on various occasions.

"Cold be damned!" said the man. "You nearly fractured my skull . . . one more bump like that and you'll see me bale out!"

Ianto was reminded of his days in the Artillery. "Like riding on a gun limber it is," he said, "isn't it, Sir!"

The sun broke through the trees when they reached the top of the wood, and when Ianto had switched off the engine the visitors stepped out and strolled off down a path.

Ianto weighed up the situation. He felt that the worst was over. The run downhill would be no problem. If the unexpected happened and the engine broke down, they couldn't fail to arrive at the bottom of the incline. He took a bag of oats to his horses and when he returned the men had already taken their seats for the return trip.

They started off gently downhill and from that moment Ianto reckoned that it would all be plain sailing. As the trolley ran quietly along he leaned out of the cab and looked forward, like a driver on the main line locomotives, and then took a quick glance at his passengers who seemed to be enjoying the ride . . . must be the fresh air, Ianto thought to himself, but here was the first bend. Seizing the flat, shiny steel lever of the brake he pulled it hard back as far as it would go.

Ianto had never applied the brake before and was not quite certain what to expect. He was a little disconcerted though to find that it made no apparent difference to his speed. Nothing seemed to be happening at all except the sound of a high-pitched metallic squeak as the brake tightened on the wheel.

Somewhat surprised he moved the lever forward again and repeated the action. Still nothing happened. Ianto was very puzzled. He pulled harder on the lever . . . harder. The engine gained speed and ran faster than ever downhill.

Ianto was now very worried and looked at the accelerator lever. Perhaps he thought, that he had not shut it down. Perhaps that was why they were running faster. Putting his hand to it he found that it was in the OFF position, and at this point a nasty taste came into Ianto's mouth and his stomach turned over.

He could now picture everything, and he was very frightened. At the rate that they were travelling they would soon be at the bottom of the hill and crash . . . straight into the buffers. And then what? Buffers would not stop them. They would be off the lines and straight over the bank into the main road. Good grief . . .! On Bank Holiday . . . a heap of oily metal and five broken necks. Well . . . perhaps only four . . . Dear me, if Archie the regular driver and his mates knew what was going on wouldn't they laugh! . . . but *Diawl* . . . this was no laughing matter. He had heard of brakes failing on lorries, and someone usually saved the situation by doing something heroic. But Ianto's mind was a blank and he never felt less heroic in his life. Sweat broke out on his forehead. How did you stop a runaway train? . . . Had he better jump? . . . No, that was useless . . . not down that bank on to all those stones . . . you'd be a gonner anyway . . . crack your head open. He looked sideways at his passengers and was amazed to see that they had no clue as to what was happening. The fools . . . there they were sitting enjoying the scenery . . . Whew! if they only knew!

Perspiration ran down Ianto's face like tiny grapes and once more he pulled hard on the brake handle.

Ianto now began to curse himself under his breath for being such an idiot as to embark on this trip. He ought to know that something like this might have happened, it wouldn't have been like this though with a team of horses. You only had to shout and they stopped dead. They were only too pleased to. What was it he used to say . . .? I'll stick to horses. If he ever got out of this mess he'd stick to horses . . . but what ever was wrong? What had he not done? . . . once more he tried the brake and looked at the lever as it moved on a bolt on the floor of the cab.

Ianto, now desperate, was about to appeal to his passengers when he saw a small metal box on the footplate at his feet above the wheel. Looking hard at it again he saw that it contained sand . . . SAND . . . that reminded him of something.

He had heard Archie talk about filling the sand box. Come to think about it he had seen him rattle this box with a stick and kick it when he applied the brake.

Suddenly Ianto realised what he was looking at. SAND . . . that was it . . . you ran it on to the lines to grip the steel when you braked . . . the wheels were slipping on the lines . . . that was the trouble. Ianto kicked the box viciously again and again and applied the brake hard as he wondered how far they were from the buffers. He saw sand begin to fall on to the lines . . . another kick and a small heap fell. Ianto pulled the brake lever back until it clicked into the last notch tight against the trolley wheels. He felt the engine slowly reduce speed. A long-drawn-out squeal, and slowly, slowly, the diesel drew up and halted a few feet from the buffers. There was no contact or bump. The driver of the Royal train could not have pulled up with greater skill.

Ianto took a deep breath and wiped the sweat from his face. "A near 'un that was," he said to himself, recovering his confidence and composure.

Stepping out of the truck the passengers alighted. One of them came round to Ianto.

"An enjoyable ride, driver" he said in a cultured accent, slipping a half-crown into Ianto's rough palm.

"You'd pay a lot of money for that trip in Switzerland . . . beats British Rail every time."

Ianto grinned and said nothing.

I met the official party later that day and learned that one of the hauliers, a short, square man in leggings had driven them up in the wood behind a diesel trolley.

There was no mistaking who that referred to, and the following day, under pressure, I wormed the full story out of Ianto.

"Well, Ianto," I said, "if you can drive a diesel you're a useful chap to have about the place . . . engine drivers are hard to come by . . . we must look after you . . . how would you like the job permanently? I daresay we could get you a rise in your wages!"

But Ianto only gave me a suspicious look, then turning to lead his mare back into the wood said: "Me drive engines . . . no fear mun' . . . never did like machines . . . stinky old things, these diesels . . . rather keep the job I 'ave got . . . It's a horseman I am!"

THE LOCH NESS MONSTER

By **D. G. GOWLER**

Executive Officer, Headquarters

Loch Ness is 24 miles long, up to 1½ miles wide, over 700 feet deep for most of its length, and almost completely surrounded by forests. It is longer than the width of the English Channel at Dover and is four times as deep as the Channel at its deepest, and has never been known to freeze. It is situated in the Great Glen of Scotland, an enormous "rift valley" formed when the entire northern part of Scotland was wrenched sixty miles to the west following a gigantic upheaval in bygone ages. The loch was undoubtedly connected at one time to the sea, probably at both extremities, and although it is now considered a freshwater lake, there is every possibility that at some distance below the surface there is still salt-water, a reminder of its ancient connection with the sea. (A 1,100 feet deep Canadian lake has recently been found to have a mixture of sea-water—probably thousands of years old—below 400 feet. Unfortunately, no such investigation has yet been carried out at Loch Ness.) Visibility in the loch is practically nil, due to the amount of peat content washed into it by the many streams and rivers entering from the surrounding countryside. The sides of the loch are extremely steep; at Cormorant Rock it plunges sharply to a depth of 236 feet just fifty feet from the bank!

The loch is not, therefore, a very prepossessing sight and is a natural focus of local superstition. One can imagine local mothers chastising their children with the threat of "bogey-men" and "monsters" rising out of this sombre expanse of water and carrying off all those children who were naughty. The phenomenon of Loch Ness might well have remained as mere local superstition if it had not been for the overwhelming number of actual sightings of the so-called "monster" by reputable witnesses.

The Loch Ness phenomenon is by no means a recent acquisition to the fauna of Scotland. According to legend it has always harboured a "beastie" or "water kelpie"; and the first written account of the creature dates way back to the middle of the sixth century A.D. when St. Columba was visiting Brude, King of the Northern Picts, at Inverness. According to Adamnan, St. Columba's biographer, writing a century after the event, the holy man reached the banks of the loch as the local inhabitants were burying one of their number who had been bitten to death by the "monster". Despite this, he instructed one of his followers to swim to the other side of the loch and return with a boat that had been moored there. The man had not been in the water long before the "monster" arrived on the scene, making a bee-line for the now panic-stricken swimmer. But St. Columba muttered a few prayers and ordered the "monster" to leave the man alone. Needless to say, the "monster", on hearing the voice of the blessed man, turned tail and fled. Regular sightings of the creature have been made from that day to this.

The frequency of the sightings of the animal increased tremendously in 1933, and this was solely due to the widening of a road (the A.82) along the northern side of the loch. The blasting necessary for the road's construction sent shock-waves the length and breadth of the loch and agitated the animal into an unusual outburst of activity. A Ness Fisheries Board representative estimates that every year since 1933 there have been 20 to 30 sightings reported that he would regard as genuine. The number of reports accepted as genuine and inexplicable by the Loch Ness Phenomena Investigation Bureau since 1963 has been: 1963—40, 1964—18, 1965—9, 1966—29. The modernization of the A.82 mainroad has enabled more people to have long uninterrupted looks at the loch than at any other time in history, and consequently the number of sightings has increased considerably. Witnesses to the existence of the animal come from all walks of life: churchmen, policemen, gamekeepers, mayors, labourers, monks, Members of Parliament, and even Forestry Commission workers!

In the issue of *The Slasher* for February, 1959, there is the following account: "It seems that the monster made its most recent appearance just before Christmas. It should be stated that a forestry interest emerges because the men who saw it were at the time returning to Inverness with a 35-ft Christmas tree cut from Farigaig Forest. It is reported that after seeing a considerable disturbance of the surface of the loch beyond Urquhart Castle, they then saw three distinct humps which seemed unmistakedly those of a species of giant sea-serpent." The same journal in its issue of April, 1964, says: ". . . three of our workers claim to have seen it at one and the same time. It is reported that, for several minutes after there had been a rock-blasting explosion in the locality, 'Nessie' was spotted and kept under observation. First of all 'a large black object' was seen to break surface and cruise towards the opposite shore. It turned suddenly and, moving at about 25 m.p.h., went parallel to the shore, causing a great wash. Then it lay still on the surface for some seconds before sinking slowly out of sight. It is said that a Stornaway fishing boat in the vicinity at the time recorded a strange object showing on the chart of the echo-sounder; this object was estimated to be at 40 fathoms and 30 feet long!"

I have quoted these two reports at some length because they are identical to the majority of the sightings made, and space precludes me from describing many actual sightings. Suffice it to say, most reports are surprisingly similar, and it is a simple matter to build up a composite picture of what the animal must look like. Most reports say that the L.N.M. (Loch Ness Monster) is dark in colour, often brown but elephant-grey is sometimes mentioned. The variation in colour described by the witnesses is probably due to the differing intensity of light and whether the object was seen in silhouette or not. The number of humps seen ranges from eight down to one, but by far the greatest number of reports speak of one hump or two. The length of its body is usually estimated at between 20 and 40 feet. The head and neck (described in just under half of the recorded sightings) is always five or six feet above the water-line, snake-like, with the head no thicker than the diameter of the neck. The majority of descriptions refer to a definitely reptilian type of head with a pair of "horns" similar to those of a giraffe or snail. As mentioned before, two humps are most frequently seen, but the humps vary in number, shape and size, and on occasions these changes have actually been watched taking place. Rounded humps, triangular humps, and a line of small humps in a row have been observed; and the animal has been seen to swim off with three humps showing and then return a few minutes later with no humps showing at all! Unbelievable as it may seem, there can be little doubt that the visible parts of the back of the animal are capable of changing shape. Flippers or paddles have been sighted occasionally. More frequent has been the mention of splashes on both sides of the animal, and it is probable that it uses its flippers as an additional means of propulsion through the water. The tail has not been seen very frequently, but the few sightings describe it as being thick, powerful and over six feet long. All reports agree that the skin of the animal is *skin* and not hair or fur. The L.N.M. is not a purely aquatic animal as it has been seen a number of times on dry land, and on one occasion it was seen to cross the B.852 in broad daylight. A drawing of the animal based on the above information is given in Figure 6.

Now that we know what the animal looks like, we come to the more difficult task of trying to decide what it can possibly be. The theories put forward to solve the mystery can be divided into four major groups, that the L.N.M. is: (i) an inanimate object; (ii) an ordinary member of a known species of animal; (iii) a giant form of a known species; and (iv) an, as yet, unknown animal.

The "inanimate object" explanations are much-favoured at the present time by the scientific element of our society. By this method they seek to explain away the sightings of objects in Loch Ness as dead trees and vegetable mats brought to the surface of the loch by the formation of natural gas within them caused by the decomposition of the vegetable matter. This gas makes the tree, of whatever, rise to the surface where the gas is dissipated and the object then sinks below the water until enough gas has been generated to force it to surface once again. This may be an explanation of a few of the sightings of the L.N.M., but it is hopelessly inadequate when, as in most of the sightings, the animal has been seen to move at quite rapid speeds across the surface of the loch.

Turning to the "animal" explanations, we find very little in the second category and these can be dismissed fairly easily. The most popular culprits here are the long-necked seal, the otter, and the red deer. They can all be discounted as being the cause of the Loch Ness phenomenon purely on the question of size. But it is worth mentioning them as they can undoubtedly provide the answer to three or four of the reported sightings. The seal, like some other animals, is able to stretch its neck to quite a considerable degree, and it is a popular theory that this could account for the reports of "long necks" seen above the surface of the loch. No importance seems to be attached to the fact that the presence of seal is unknown in Loch Ness. The popularity of the otter theory has increased quite considerably over the past couple of years because of the support given it by a prominent naturalist. Otters can account for the one or two reports of five to eight humped sightings, but, although otters can reach a length of over 5½ feet, they can in no way account for the bulk of the sightings which refer to large, powerful, solid humps up to thirty feet long. A red deer stag when swimming across the loch can fit extremely well some of the descriptions of the head and neck of the L.N.M., particularly when mention is made of two horn-like protuberances. This may account for four or five sightings.

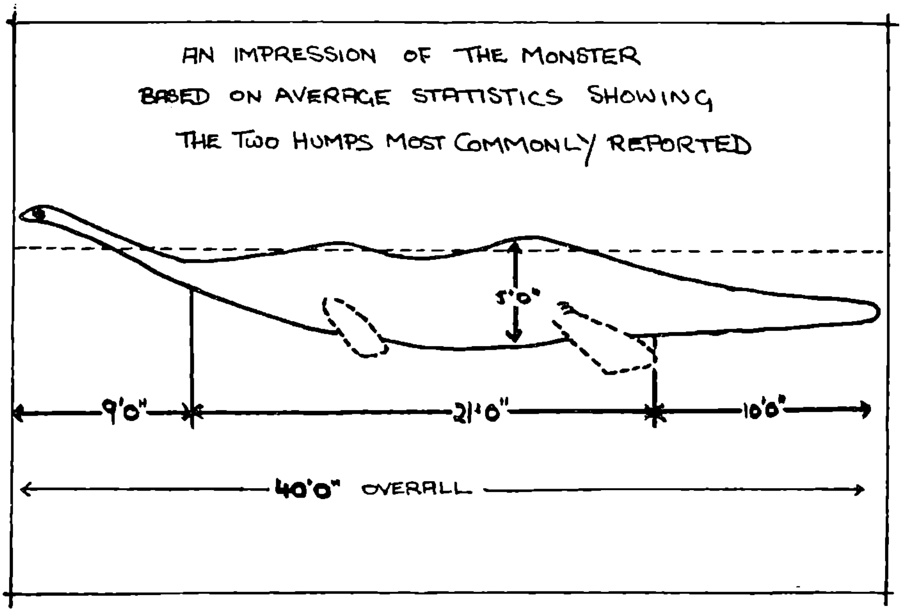
The third category is much more feasible than the second. Giant fish of all types have often been put forward as the "monster". A giant sturgeon is by far the favourite of armchair amateur detectives because a diagrammatic representation of a sturgeon lying just below the water surface with its snout and bony back ridges protruding above the surface looks very much like some of the reports of many-humped "monsters". But practically all fish can be dismissed from our quest for the answer because the animal in Loch Ness must be able to survive for some time out of water to account for the sightings of it on land. Even the fish-theorists cannot explain how a 30-ft "monster" was seen to cross a main road before disappearing into the loch! Giant molluscs offer more reasonable explanations, and would account for the lack of fossil remains and the variable back postures. The Loch Ness Phenomena Investigation Bureau considers a giant marine slug as presenting fewer difficulties than any other present-day theory. Perhaps the most acceptable of the theories in this category is that of the giant eel. The larvae of eels, called leptocephali, are normally about three inches long and develop into six foot eels when adult. In 1930, a Danish student caught a giant sea eel larva in the South Atlantic that was six feet long. Considering that the giant larva was at the same stage of development as an ordinary eel larva and that its growth must follow the same proportions, the adult sea eel emerging from this larva must reach a length of well over 60 feet. This could be the answer to the mystery of the often seen "giant sea serpent" as well as to our local Loch Ness problem. It is known that many ordinary eels live in Loch Ness and there seems to be no reason why their giant relations could not also be accommodated. The one stumbling block to this explanation is the sightings of the L.N.M. on land. Eels can exist out of water for a short period, but whether it can stay on land as long as the L.N.M. has been reported to do is a matter for conjecture.

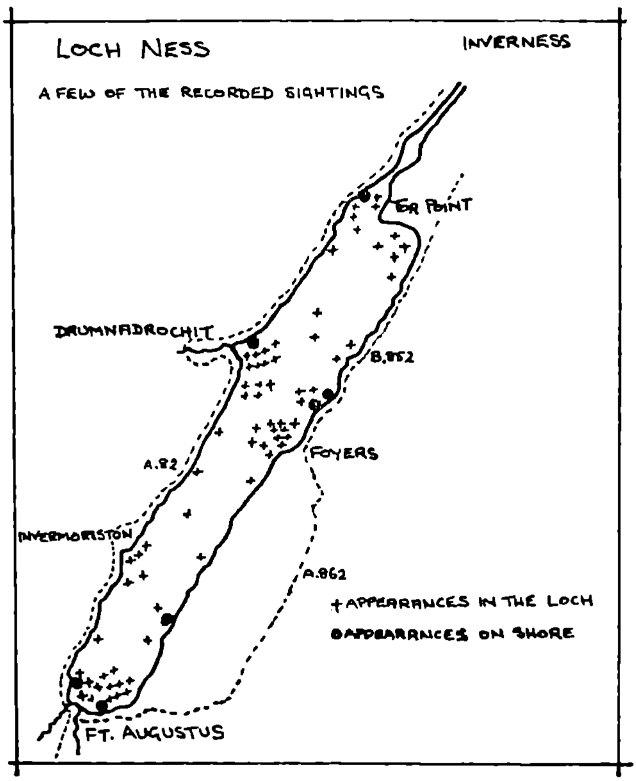
It seems, then, that we are left with our last category to provide us with the answer we are looking for. It is very difficult to analyze a completely unknown animal and we must approach this problem in a different way. From the evidence produced by the numerous recorded sightings, we have been able to build up a picture of what the animal in Loch Ness must look like (Fig. 6). But what can it be? The most striking aspect is the amazing similarity it has with the pre-historic plesiosaur family. Is it a plesiosaur? It certainly has the required shape and, just as important, the right size. But scientists tell us that the plesiosaur became extinct over a hundred million years ago. This is true. But it is also true that these same scientists insisted that the coelacanth, a pre-historic fish, had died out seventy million years ago but a specimen of this was dredged up off the coast of South Africa in 1958! It therefore becomes impossible to argue that because plesiosaurs are thought to be extinct there is no chance of finding one alive today. A plesiosaur, or more probably a close relative that has adapted to its present conditions, is the only answer we have that fits all the facts in our possession. All fictional detectives have said at one time or another that the theory must be chosen to cover all the facts and not the facts to fit the theory. Sherlock Holmes often said to the ever-faithful Watson that when the impossible had been eliminated, that which was left, however improbable, must be the truth!

LINES WRITTEN AFTER DRIVING BEHIND A COUNCIL WEED-KILLING SPRAYER IN THE FOREST OF DEAN

No primrose, orchid or anemone is seen
Beneath the trees near public roads in Dean.
No flash of yellow catches artist's eye,
Or dainty petal tempts the butterfly.
Scorched is the fern and brown the bracken fronds
Beneath the oak and birch near Cannop ponds.
The parent chaffinch looks in vain for seeds,
Wild strawberries have succumbed with noxious weeds.
The moth imbibing dew on tufted vetch
Is sprayed with T.V.O., unlucky wretch!
A toxic mist asphyxiates the bee
With smell like disinfected mortuary.
Fine nozzles squirt a liquid on the verge,
While diesel engine hums a funeral dirge.
Labour is dear . . . Weedkiller fairly cheap
So poison kills what flowers escape the sheep.

R. J. JENNINGS


AN IMPRESSION OF THE MONSTER
BASED ON AVERAGE STATISTICS SHOWING
THE TWO HUMPS MOST COMMONLY REPORTED
5'0"
9'0"
21'0"
10'0"
40'0" OVERALL


LOCH NESS
INVERNESS
A FEW OF THE RECORDED SIGHTINGS
DRUMNADROCHIT
B.852
FOYERS
A.82
INVERMORISTON
A.862
+ APPEARANCES IN THE LOCH
● APPEARANCES ON SHORE
FT. AUGUSTUS

BOOK REVIEWS

BREEDING PEST-RESISTANT TREES

Proceedings of a N.A.T.O. and N.S.F. Advanced Study Institute on Genetic Improvement for Disease and Insect Resistance of Forest Trees—held at the Pennsylvania State University, 30th August to 11th September 1964. Edited by: H. D. Gerhold, E. J. Schreiner, R. E. McDermott and J. A. Winieski. Pergamon Press, Oxford 1966. Price £8.

Presented in this volume are the Proceedings of a N.A.T.O. and N.S.F. Advanced Study Institute on Genetic Improvement for Disease and Insect Resistance of Forest Trees held at the Pennsylvania State University. Some eighty scientists participated in the two-week institute, devoted to reviews of work carried out in various parts of the world with regard to breeding forest trees for insect and disease resistance. The discussions which followed the lectures are also incorporated in this volume.

It was realized when selecting the subject matter that only a few intensive programmes for breeding trees that will be resistant to disease and insect attacks have existed for any appreciable length of time. Nevertheless, a large number of scientists in several countries have been conducting related research that has provided an accumulation of basic information needed for commencing new breeding projects.

Many of these scientists have had only limited opportunities to converse with colleagues whose interests in pest-resistance are similar but whose affiliations are oriented along different lines. This symposium therefore provided a valuable opportunity for the dissemination of information and the interchange of knowledge and opinions useful to geneticists, pathologists, entomologists and foresters.

A wide range of subjects was covered in some forty Papers and these are presented under Section and Topic headings. Copies of this invaluable book are held in both the Alice Holt Library and the Genetics section at Edinburgh.

AGRICULTURE AND ECONOMIC GROWTH IN ENGLAND 1650–1815

edited with an introduction by E. L. Jones. Methuen & Co., Ltd, London 1967. Price 25s.

Surprisingly little systematic attention has been paid to the economic consequences of agricultural change, whether during the first industrial revolution, or in the case of the less developed countries today. Even though most books on English economic history give some account of agrarian development and its effects, this is the first to discuss why agricultural supply became more "responsive", and to provide broadly based evidence of the ways in which that "responsiveness" may have influenced the growth of the economy.

Seven essays, reprinted here in their entirety, have been chosen to illustrate altered perspectives of agricultural change. They range from Lord Ernle on "Obstacles to Progress" to Peter Mathias on "Industrial Agriculture". Other articles discuss the enclosure movement (Professor J. D. Chambers and Dr. J. M. Martin), progress within open-field farming (Michael Havinden) and achievements before 1750 (the editor and Professor A. H. John). Dr. Jones's introduction places the beginnings of a significant rise in farm output as far back as the mid-seventeenth century. He also examines the later, more arduous stages of advance and evaluates the contributions of better husbandry techniques and improved agrarian organization. This survey is followed by sections on the supply of food and industrial raw materials, the release of labour, capital and entrepreneurs from farming to industry and transport, and the emergence of a large rural market for industrial goods. He concludes that agriculture played a vital but complicated role in the economy of eighteenth-century England.

TIMBER

Its Mechanical Properties and Factors Affecting its Structural Use, by Frederick D. Silvester, G.G.I.A., F.B.I.C.C., A.I.W.Sc. Pergamon Press, Oxford 1967. Price 35s.

The growth and structure of wood, so far as it affects the structural use of the material when converted from the round to squared timber, is covered and the information is presented in a manner which can be easily understood by anyone employing wood for structural purposes, whether he be designer, technician, or operative. Simple terminology is used throughout and liberal use is made of sketches and photographs to illustrate and supplement the text. Commencing with the growth of the tree and cellular structure of wood, the fundamental properties and factors affecting strength are discussed, and then basic information on the structural grading of timber is dealt with in considerable detail.

The influence of seasoning on strength of timber, and degrading which can occur through lack of knowledge of the material or lack of care in seasoning are described, the general strength properties of the material are discussed, and a description of the method by which these are assessed is given. The book concludes with a chapter on "testing for strength" which sets out general principles and provides practical guidance on this type of work. In addition to a fund of knowledge the author has considerable practical experience. His book will be valuable to all whose work concerns, or is associated with, wood as a structural material, and should be particularly useful to students of timber technology, building and structural engineering.

THE ECONOMICS OF IRRIGATION

by Colin Clark, Director, University of Oxford Agricultural Economics Research Institute. Pergamon Press, Oxford 1967. Price 35s.

All those who may have any responsibility for spending money on irrigation, whether for small schemes or large, whether private or public, whether in arid or in humid climates, will find this volume extremely valuable. This applies whether their responsibility is direct, or whether it is the kind of indirect responsibility incurred by those who help to form political and business opinion.

The book is intended as a piece of applied economics, collecting the critically important facts over as wide a range as the author has found possible. Knowledge is pre-supposed of only the simplest principles of economics, of the distinction between money and real costs, of the distinction between marginal and average costs and products, and of the applicability of the principle of opportunity costs when comparing hydro-electric and thermal electrical generation in developing countries.

The provision of food and raw materials for both the present and the swiftly expanding population of the world is a matter of the utmost concern. In this book the author makes an important contribution to knowledge, in a form which may well influence the judgements of those whose duty it is to make, or advise upon, significant decisions.

WEATHER AND AGRICULTURE

Edited by James A. Taylor, Senior Lecturer in Geography, University College of Wales, Aberystwyth. Pergamon Press, Oxford 1967. Price 80s.

The contents comprise eighteen papers selected from a series of symposia held at the Geography Department, University College of Wales. The papers have been grouped under headings as follows:—Part I. The Environment. Part II. Hazards. Part III. Productivity. Part I includes four pages on climatic factors with particular reference to the growing season, soil, climate and wind factors. Part II includes seven papers dealing with weather hazards in relation to farm productivities and agricultural development. Problems examined include relationship of the weather to farm management decisions, to variations in milk production, and to the incidents of virus diseases and the liver fluke disease. Part III includes seven papers related to productivity with reference to both historical and contemporary examples. A special study is made of the varying effects of climate on the changing agricultural systems of Wales, of adding marl to peatland in Lancashire, on climatic factors and the development of local grass drying in Wales, and on the related significance of economic and ecological productivity under British conditions.

The basic purpose of the symposia and also of the book is to relate weather factors to agriculture. The papers are written for the University level, but are so broad in implication that the material is not excessively over-specialized and should be accessible to meteorologists, climatologists and biologists on the one hand, and agriculturists, geographers and economists on the other. The papers are generously illustrated and preceded by an explanatory introduction by the Editor and a note in which he dedicates the volume to the memory of the late Sir L. Dudley Stamp. There is a preface by the eminent climatologist, Professor F. K. Hare, Master of Birkbeck College, London.

The Pennine Way

By Christopher John Wright. Constable, London 1967. Price 25s.

The Pennine Way runs northwards from the Peak District of Derbyshire along the moorland spine of northern England, through Redesdale Forest, as far as the Cheviots on the Scottish Border—a total distance of 250 miles, and the longest footpath in Britain. The features of natural beauty and the places of historic interest which lie along its course are a powerful attraction to hikers, walkers, ramblers and climbers of all ages.

The Pennine Way provides some of the roughest walking to be found in Britain, but in good weather it is within the capacity of anyone able to undertake 12 or 15 miles of hill-walking daily, sometimes across boggy ground or through expanses of heather and moorgrass, and sometimes through pleasant riverside pastures.

The idea of a continuous footpath—which should be nothing more than a way trodden by walkers—was first suggested as long ago as 1935. But it was not until 1951 that approval was granted to the National Parks Commission to open negotiations for the 90 miles of new footpaths which were needed to complete the route. On 24th April 1965 the Pennine Way was officially opened by the Minister of Land and Natural Resources.

This guide book is a practical celebration of that event. It is the first fully-illustrated, completely detailed pocket guide to the route. It also contains information on accommodation, route finding, safety precautions, equipment, availability of supplies, weather conditions, etc. The numerous photographs and maps which complement the text are a striking feature of an invaluable guide book.

Comprehensive Russian-English Agricultural Dictionary

Compiled by: B. N. Ussovsky, Sc.Ag., E. F. Linnik, Agr., Yu. M. Podkamennykh and E. I. Shkonde, M.Sc.(Agr.). Second edition revised and enlarged by B. N.

Ussovsky, Sc.Ag. and W. Linnard, M.A.(Oxon.). Pergamon Press, Oxford 1967. Price £8.

Agriculture is the basis of human existence and it is an industry practised on a vast and intensive scale throughout the world. The agricultural literature of the Soviet Union is of considerable interest and importance. Many advances have been made in the science and technology of agriculture in the U.S.S.R. and a means of removing the language barrier, so that access to this knowledge is possible, is of paramount importance.

This is the only comprehensive bi-lingual Russian-English Agricultural Dictionary in existence, and is available now in the form of a revised and enlarged second edition. It forms a universal reference book for all Russian agricultural literature. It contains some 40,000 terms, and covers agriculture in the broadest sense, including all the ancillary topics such as farm machinery, land-survey, horticulture, botany, veterinary science, forestry, fish breeding, soil science, hunting and fur farming etc.

The Dictionary will prove extremely valuable to all engaged in both research and practical work in agriculture and land use and to tutors and students in University departments concerned with study of these and associated subjects. A copy is held in the Alice Holt Library.

AGRICULTURAL INSURANCE

Principles and Organization and Application to Developing Countries.
By P. K. Ray, Food and Agriculture Organization of the United Nations, Rome. Pergamon Press, Oxford 1967. Price £5.

This is an exhaustive treatise on various types of agricultural insurance practised in the United Kingdom and United States of America and also, to some extent, in West European and in certain Asian countries. It also deals with the adaptation and application of certain major types of such insurance to the most urgent needs of, and the situations in, the newly developing countries. Starting with an analytical study of Agricultural Risks and their Insurability (Part I), it describes the main systems of Crop and Livestock Insurance, Farm Property and Farm Engineering Insurance, Personal Accident and Liability Insurance for Farmers (Parts II-V); then examines the nature and problems of different organisations—public and private—in insuring agricultural risks (Part VI), and, finally, discusses such basic considerations as the Actuarial Consideration of Agricultural Risks, Reinsurance, including Problems and Possibilities of International Reinsurance of National Crop Insurance Systems, and the application of Agricultural Insurance in newly developing countries. The book is a suitable textbook for any advanced courses or lectures, and also forms a practical handbook and reference for those who are, or may be, concerned with the establishment and/or operation of insurance applying to agriculture. The developing countries will find it specially useful as it examines their specific problems and indicates the way toward solutions. The book is based on a close and prolonged study of the subject by the author, on his personal contacts with public (government) and commercial insurance organisations in the United Kingdom, United States of America and other countries, and on his work and experience while working as an adviser, for the Food and Agriculture Organization of the United Nations, to a number of countries, including Ceylon, Cyprus, Greece and Yugoslavia. A copy is held in our Alice Holt Library.

FOREST HYDROLOGY

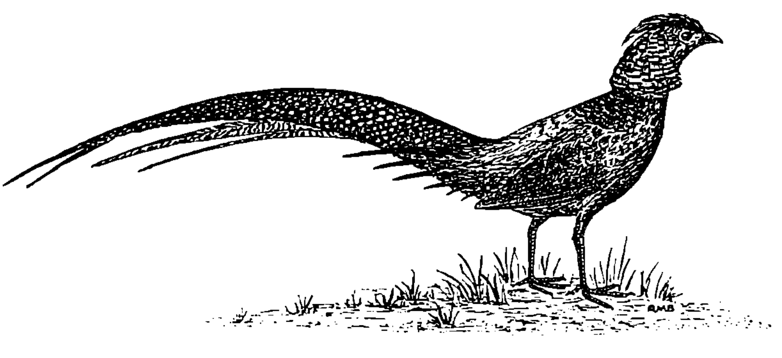
Proceedings of a National Science Foundation Advanced Science Seminar held at The Pennsylvania State University, 29th August to 10th September, 1965. Edited by William E. Sopper and Howard W. Lull. Pergamon Press, Oxford 1967. Price £15. 15s.

"From the time man first stood under a tree to get out of the rain, or set up his tent in the forest to get out of the heat, or began to speculate on the eruption of erosion and floods from hillsides that once possessed forest cover, there has been increased recognition that in some way and to some degree forests and water were related."

In these words, quoted from the opening to their Preface, the editors provide a vivid word-picture of, and a thought-provoking introduction to, the important subject of the book. It is the fact that population increases and technological advances have increased the value of forest and water resources and that the ever-increasing importance of these concurrently gives considerable importance to the relationship between forest and water. Research concerned with forest watersheds has shown that forest cutting methods influence both the yield and quality of water and has been proven on a world-wide scale.

The beginning of the International Hydrological Decade on 1st January 1965 stimulated activity in hydrologic research and provided an appropriate occasion for the subsequent holding of a Symposium on the subject. This was sponsored by the School of Forest Resources of the Pennsylvania State University, the Northeastern Forest Experiment Station of the U.S. Forest Service, the International Association of Scientific Hydrology, and Section 11: Forest Influences and Watershed Management of the International Union of Forestry Research Organizations.

Nearly ninety scientists from twenty-two countries took part and the fund of expert knowledge provided, in the more than eighty papers presented, is recorded in this most informative book. In addition to its value to research and practising workers in the field it will also prove extremely useful as a text, or reference book, for college courses in forest hydrology, forest influences, and watershed management. It will also be of value as a supplementary text for courses in hydrology, hydrometeorology, hydrogeology, and soils.



Tailpiece

FORESTRY COMMISSION STAFF

At 1st December, 1967

Note: It has not been possible to show the stations of individual officers in Conservancies. The list should not be read as a Seniority list; it has been compiled from returns submitted by various offices to Establishment Branch.

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Fife, R. G. (Ind. Estabs.—SW/E)
Jones, D. J. (Ind. Estabs.—N/W)
Lancaster, R. A. (Ind. Estabs.—E/E)
Middleton, J. W. (Education—Northerwood)
Murphy, B. (Forest Management—Bristol)
Powell, A. (Education—Gwydyr)
Turnbull, M. T. (Ind. Estabs.—NE/E)
Twallin, R. W. (Education—Dean)
Wheeler, R. T. (Education—Gwydyr)

FORESTER

Amer, D. J. (Forest Management Radio Unit)
Clark, J. (Ind. Estabs.—N/S)
Cooper, P. L. (Ind. Estabs.—SE/E)
Delap, P. (Forest Management—New)
Fruen, C. R. (Ind. Estabs.—SW/E)
Fryer, T. G. (Ind. Estabs.—S/W)
Gardner, E. C. C. (Ind. Estabs.—N/W)
Hobbs, A. B. (Ind. Estabs.—NW/E)
Hodgson, M. (Ind. Estabs.—NE/E)
Holmes, M. J. (Ind. Estabs.—New)
Howard, R. L. (Ind. Estabs.—N/S)
McBurnie, A. N. (Ind. Estabs.—S/S)
MacLeod, N. (Ind. Estabs.—W/S)
Masson, V. (Ind. Estabs.—E/S)
Mowat, P. (Ind. Estabs.—S/S)
Murray, R. A. (Education—Faskally)
Nichols, A. A. E. (Ind. Estabs.—NE/E)
Niles, J. R. A. (Education—Dean)
Parker, J. A. (Ind. Estabs.—NW/E)
Payne, W. C. (Ind. Estabs.—E/E)
Pike, D. C. (Ind. Estabs.—S/W)
Robertson, J. H. (Education—Gwydyr)
Sharp, H. O. (Ind. Estabs.—Dean)
Solway, D. F. (Education—Dean)
Stoddart, W. F. (Education—Faskally)
Thom, H. (Ind. Estabs.—N/S)
Thompson, B. S. (Education—Gwydyr)
Tilley, J. W. (Ind. Estabs.—SW/E)
Turner, A. S. (Ind. Estabs.—W/S)
Woods, A. J. (Ind. Estabs.—E/E)

PLANT AND VEHICLE MANAGER

Muddle, W. J. (T.W.G.I) (Mile End)
Low, W. L. (T.W.G.I) (Chapelhall)

MECHANICAL ENGINEER

Kernahan, K. A. (T.W.G.II) (Alice Holt)

WORKSHOP MANAGER

Gawn, S. (T.W.G.III) (Mile End)

HOSTEL MANAGERESS

Thatcher, Mrs. E. (Northerwood House)

HEADQUARTERS: Churchill House, Churchill Way, Cardiff

Telephone: Cardiff 40661

SENIOR OFFICER FOR WALES:	J. W. L. Zehetmayr, V.R.D.
HIGHER EXECUTIVE OFFICER:	E. G. Owen.

NORTH-WEST ENGLAND CONSERVANCY

Dee Hills Park, Chester (24006)

CONSERVATOR:	Chard, J. S. R.
ASSISTANT CONSERVATOR:	Grant, D.; Legard, P. H.; Raven, W. J.
DISTRICT OFFICER I:	Fletcher, J. R.; Mitchell, T. C.; Osmaston, J. F., Purser, F. B. K.; Voysey, J. C.; Wilson, J. F.; Winchester, P. L.
DISTRICT OFFICER II:	Hurst, R. T.; Simpson, L. M.
SENIOR EXECUTIVE OFFICER:	Elliott, J. W.

CHIEF FORESTER

Cameron, A. H.
Guthrie, F. H.
Morgan, L. G.

HEAD FORESTER

Allcock, M. S.
Anderson, R. D.
Atkinson, I. D.
Bennett, H.
Brandon, J. W.
Brooke, B. L.
Brown, D.
Daglish, T. E.
Francis, E. R.
Garner, W.
Grant, W.
Hall, D.
Hall, W.
Hardy, R. B.
Jones, E.
Keens, D. W.
McKay, H.
Mackenzie, J. H.
MacMillan, J. R.
Morley, D. S.
Morris, J.
Murray, M.
Nelson, D.
Pemberton, F.
Rowlands, I. G.
Shelley, W. R.
Stokoe, J.
Thomas, D. R.
Waddelove, E.
Wilson, W. J.

FORESTER

Ainsworth, P. H.
Aspinall, E.
Attenborough, T. J.
Axtell, D. W.
Bignell, R. A.
Birch, F. C.
Birch, T.
Blackwood, C. H.
Bollard, W. A.
Bruce, G.
Collings, J. B.
Collings, P. J.
Day, J.
Dean, B. G.
Edwards, K. T.
Evans, W. C.
Hall, J. R.
Harpin, J. W.
Hawkes, D. M.
Hill, J. T.
Hobson, K. A.
Hutchinson, P.
Long, T. W.
MacDonald, R.
McGowan, G. H.
Morrill, W. H.
Patten, B. D.
Sarsby, O. R.
Sivill, J.
Thick, F. W.
Tyler, W. H. S.
Ward, A. A.
Watts, D. W.
Wood, C. W.
Wood, D.
Yates, H.

TRAINEE FORESTER

Dale, I. A. G.
Jackson, M. C.
Petty, S. J.
Charlton, J. M.

CONSERVANCY CIVIL ENGINEER: Allan, C. S. (T.W.G.A.)

AREA CIVIL ENGINEER: Hoyle, H. N. (T.W.G.I)

CONSERVANCY MECHANICAL ENGINEER: Haynes, W. S. (T.W.G.I)

SUPERINTENDENT OF WORKS: Clark, J. (T.W.G.III); Cottrell, C. J. (T.W.G.III); Winter, J. R. (T.W.G.III).

SENIOR CLERK OF WORKS: Goodwin, W. A. (T.W.G.II); White, R. H. (T.W.G.II).

CIVIL ENGINEERING ASSISTANT: Brightmore, R.

DRAUGHTSMAN (CART.): Williams, Mrs. E. K. C.

HIGHER EXECUTIVE OFFICER: De Groote, A. M.; Walker, J. A.

EXECUTIVE OFFICER

Ainsworth, S.
Davies, Miss C. M.
Holland, B.
Pritchard, J. G.
Stewart, Miss B.
Watts, J. E.

CLERICAL OFFICER

Atkin, Mrs. V.
Bass, Mrs. M. A.
Chilton, L. M.
Dickey, Miss J. M.
Ellis, Miss M. P.
Evans, A.
Evans, Miss J. L.
Griffiths, Mrs. A. A.
Haines, Miss D.
Hayes, E. J.
Hughes, T. B.
Hughes, Mrs. U.
Lanceley, Miss V.
Langford, R. M.
Newell, F. E.
Patterson, G.
Simpson, W. V.
Smith, E. H.
Stafford-Smith, Mrs. S. J.
Whitehead, Mrs. D. M.
Wilson, F. J.

NORTH-EAST ENGLAND CONSERVANCY

Briar House, Fulford Road, York (24684)

CONSERVATOR: Godwin, G. E.

ASSISTANT CONSERVATOR: Conder, E. M.; Dent, T. V., M.B.E.; Portlock, W. J. J.

CHIEF EXECUTIVE OFFICER (ACTING): Chaplin, L. A.

DISTRICT OFFICER I: Kellie, J.; Leslie, J. E.; Marshall, I. R. B.; Perry, D. J.; Rix, A.; Weston, F.; Raban-Williams, R.; Wilson, K. W.

DISTRICT OFFICER II: Alexander, A. C.; Chadwick, D. J.; MacDonald, I. A. D.; Peregrine, J. P.

CHIEF FORESTER: Simpson, C. N.

HEAD FORESTER

Baird, R. L.
Barraclough, J. W.
Bolam, T. W. B.
Bowns, A.
Brown, W. C.
Charlton, E.
Chisholm, J. D.
Cumming, J.
Davison, A.
Dawson, K. J.
Fawcett, E.
France, J.
Featherstone, C.
Gledson, J. G.
Harbin, W. B.
Hartley, A.
Heaven, S. F.
Hislop, J. J.
Jane, T. A.
Johnstone, T.
Langford, D. M. E.
McCavish, W. L.
Marsh, E. W.
Marshall, J. A.
Parker, G. W.
Parlett, H. F.
Scott, G. H. J.
Scott, J. J. O.
Sharp, G. A.
Stanley, W. E.
Stephenson, F.
Stickland, H. F.
Straughan, J. G.
Tait, J.
Tarran, J.
Taylor, S. E.
Telford, J. W.
Terry, T. N.
Thomas, T. J. H.
Woodcock, F. A.

FORESTER

Adams, G.
Barry, G. N.
Bartholomew, W.
Clark, P. F.
Collier, T. E.
Edes, D. S.
Embleton, H. N.
Fowler, N. L.
Furness, D. J.
Giggall, D. F.
Green, P.
Griffin, C. R.
Hammond, D.
Hanafin, M.
Haw, G.
Holden, R. L.
Howes, R. E. J.
Marchant, R. E.
Maughan, B.
Metcalfe, J. E.
Moore, W.
Moules, T. R.
Pannett, H.
Robinson, P. D.
Scott, T. I.
Simpson, G.
Smart, J. S.
Spencer, J. B.
Stockdale, B. R.
Stokoe, G.
Straughan, W.
Stubbs, R. W.
Wade, J.
Wilbert, G. N.
Williams, K. D.
Woodward, F. G.
Young, J. P.

TRAINEE FORESTER: Hornby, D. R.; Ledgard, I. D.; Little, G. B.; White, D. G.

FOREMAN: England, T.

CONSERVANCY CIVIL ENGINEER: Murdock, T. A. (W.G. Senior G.)

AREA CIVIL ENGINEER: Halliday, J. (W.G.M.G.); Bassey, T. (T.W.G.I); Jones, A. (T.W.G.I)

CONSERVANCY MECHANICAL ENGINEER: Petty, D. (T.W.G.I)

SUPERINTENDENT OF WORKS: Halkyard, S. (T.W.G.III); Hornsby, J. B. (T.W.G.II); Morgan, J. F. (T.W.G.II); Symons, A. J. (T.W.G.II).

CHIEF CLERK OF WORKS: Lees, W. R. (T.W.G.I)

CLERK OF WORKS: Collin, H. J. (T.W.G.III); Kirby, C. (T.W.G.III).

LEADING CIVIL ENGINEERING ASSISTANT: Blankenburgs, V.; Grant, V.

CIVIL ENGINEERING ASSISTANT: Holmes, D.; Thompson, B. H.

DRAUGHTSMAN (CART.): Crofts, E. A.

HIGHER EXECUTIVE OFFICER: Blott, J. C.; Wood, J. H.

EXECUTIVE OFFICER: Chapman, J.; Iredale, N.; Mitchell, M.; Nurse, Mrs. M. A.; Price, J. R.; Simpson, R. W.

CLERICAL OFFICER

Arundale, Miss M. E.
Barker, Mrs. E. McK.
Blake, Miss P. A.
Broadley, Miss J.
Buckley, Miss C. P.
Davies, Mrs. J. M.
Herbert, R. C.
Justice, Miss C.
Kilcran, Mrs. P.
Lancaster, Mrs. A. S.
Little, R.
Pattinson, A. C.
Pearce, E. C. M.
Perry, R. J.
Pitt, W. H.
Porter, A.
Rogan, Miss S. D.
Stabler, N. E.
Tattersfield, Miss H.
Taylor, G. A.
Townend, A.

EAST ENGLAND CONSERVANCY

Brooklands Avenue, Cambridge (54495)

CONSERVATOR: Backhouse, G. W.

ASSISTANT CONSERVATOR: Johnston, D. R.; Mithen, D. A.; Snook, K. R.

CHIEF EXECUTIVE OFFICER: Searle, A. J.

DISTRICT OFFICER I: Bassett, H. A. E. Tilney-; Halton, K.; Hughes, B. D.; Mackay, D.; Munro, N. S.; Overall, P. A. W.; Searle, H.; Small, D.

DISTRICT OFFICER II: Barrett, F. D.; Horne, A. I. D.; Lofthouse, M.; Verey, J. G. E.; Waters, W. T.

CHIEF FORESTER: Chapman, S.; Lawson, G. E.; Poll, E. A.; Redford, C. W., B.E.M.

HEAD FORESTER

Acott, E. J.
Adams, H.
Axten, G. B.
Beard, B. W., M.B.E.
Bloor, C. A.
Burnie, H. W.
Campbell, I. R.
Claydon, G. W.
Faddy, A. G.
Field, H. C.
Gracie, A.
Hall, V. B.
Harker, A.
Hinton, F. I.
House, D. H.
Hutchins, D. R.
Ingram, L. D.
Irons, E. R.
Jones, F. B.
Keeler, B.
King, S. G.
Kirby, P. D.
Law, S. J.
Leutscher, E. H.
Ling, J.
McLeod, E. C.
Marshall, D. F.
Marston, W. H.
Mitchell, A. L.
Moulden, D. J.
Muggleton, H. G.
Parker, J. W.
Power, R. J.
Roberts, G.
Rogers, E. V.
Steel, W. H.
Webster, J. T.
White, J. B.
Williams, J. H.
Wilson, A. L. D.
Woodrow, R. B.

FORESTER

Banks, P. A.
Belton, G. C.
Boughton, M. J.
Breed, T. G.
Brunton, J.
Butcher, A. J.
Cavell, E. W.
Chandler, R. H.
Cheesewright, M.
Clark, J. F.
Devine, T. D.
Dickinson, H.
Ellis, D. E.
Gladman, R. J.
Gordon, B. S.
Grayson, J. O.
Hamstead, E. W.
Hellard, P.
Hendrie, D. T. A.
Hobbs, G. A.
Hoddle, C. R.
Horn, A. P.
Howarth, J.
Hunt, L. H.
Kew, F. M. B.
Lane, P. B.
Mackie, D. B.
Marshall, G. H. W.
Martindale, J. M.
Mitchell, W. P.
Nicholson, J. H.
Proctor, W. A.
Rayner, D. A. R.
Reynolds, P. M.
Roebuck, B. A.
Rouse, R. S.
Sayer, M. J.
Schofield, R.
Shaw, J. K.
Shinn, F. S.
Smith, W. P.
Snowden, J. D.
Southgate, G. J.
Sturges, W. B.
Trussell, J.
Walker, C.
Wainwright, J. D. E.
Wiseman, J.
Wood, P.

TRAINEE FORESTER

Case, D.
Cox, I. C.
Ham, M. O.
Ingoldby, M. J. R.
Pruden, J. J.
Saunders, J. A.
Tinsley, M.
Webb, R. O. J.

FOREMAN: Marsh, L. E.; Pickwell, H.; Rutterford, D.

CONSERVANCY CIVIL ENGINEER: Phillips, W. M. (T.W.G. 'B').

CONSERVANCY MECHANICAL ENGINEER: Cook, G. O. (T.W.G.I)

SENIOR CLERK OF WORKS: Holmes, W. (T.W.G.II)

CLERK OF WORKS:	Bugg, P. E. (T.W.G.III); Foote, J. (T.W.G.III)
DRAUGHTSMAN (CART.):	Chubb, Miss W. E.; Elliott, H.
HIGHER EXECUTIVE OFFICER:	Lloyd, H.; Parker, E. G.
EXECUTIVE OFFICER:	Allen, J.; Hills, P. A.; Kitteridge, K. E.; McIntyre, H. V.; Sell, J. B.; Threadgill, J. S.

CLERICAL OFFICER

A'Court, L. L.
Arnold, W. J.
Atkins, Mrs. J. M.
Collinson T. H.
Dobbie, Mrs. D. M.
Fitzpatrick, B. J.
Frost, Miss C. M.
Gilbert, F.
Hargrave, Mrs. M. I.
Harte, W. K.
James D. M.
McTaggart Miss A. L.
Millar, V. P.
Netherwood, K. A.
Reynolds, W. A.
Sizer, J. W. C.
Sharland, C. P. A.
Smith, Mrs. D. E. S.
Wallis, Miss W. S.
Warren, Mrs. M.
Williams, R. W. H.
Woodman, E. M. D.

SOUTH-EAST ENGLAND CONSERVANCY

"Danesfield", Grange Road, Woking (61071)

CONSERVATOR:	Barrington, C. J.
ASSISTANT CONSERVATOR:	Stocks, J. B.
DISTRICT OFFICER I:	Burton, E. S. V.; Dickenson, M. E. S.; Savage, G. F. d'A.; Simmonds, S. A.; Thallon, K. P.
DISTRICT OFFICER II:	Dinning, M.; Harrison, J. C.; Kipling, T. H.; Massey, J. E.
SENIOR EXECUTIVE OFFICER:	Gulliver, H. W.

HEAD FORESTER

Arnott, W.
Awbery, P. P.
Barden, J. T.
Barling, F. C.
Bashall, J. R. C.
Brinsley, D. A.
Brook, J. W.
Catchpole, R. A.
Cooper, J. H.
Davies, D. J.
Davies, W. J.
Davy, J. H.
Devine, R.
Francis, R. E.
Harvey, D. R.
Henderson, J. R.
Hyslop, R. M.
King, B. H.
Salmond, M. P.
Smith, H. J.
Trodd, K. H. C.
Vickery, F. J.
Watkinson, R. F. V.
Watts, F. C.

FORESTER

Ballard, B. H.
Batt, C. J.
Bayston, P. W. R.
Budgen, E.
Cale, G. F.
Choules, C.
Cooper, J.
Davis, D. E.
Davys, J. P.
Dineen, P. J.
England, W. J. H.
Freeth, A. J.
Fulcher, D. E.
Green, G. G.
Griggs, B.
Hammond, B. R. G.
Hinds, C. H.
Hoblyn, R. A.
Howell, W. R.
Hunt, P. B.
Laker, T. J.
Leemans, B. R.
McNamara, N. A. G.
Marples, D.
Meek, W. T.
Monk, R. F.
Moseley, J.
Newland, R. L.
Parnall, D. L.
Pearce, P. H.
Perkins, R. M.
Ralph, P. W.
Richards, S. M.
Rickards, S. W.
Seddon, T. R. T.
Sutton, B. E.
Tyers, J. D. A.
Usher, F.
Vines, R. C. B.
Wainwright, K.
Walker, I.
Wood, I. E.
Woollard, R. P. C.

TRAINEE FORESTER

Malone, S. E.
Newborough, R.
Sherrington, P. R.

CONSERVANCY CIVIL ENGINEER:	Hughes, R. E. (T.W.G.'B') (covers New Forest also)
CONSERVANCY MECHANICAL ENGINEER:	West, R. W. (T.W.G.I)
SENIOR CLERK OF WORKS:	Bush, E. J. (T.W.G.II)
CIVIL ENGINEERING ASSISTANT:	White-Cooper, R. R. T.
DRAUGHTSMAN (CART.):	Hart, A. J.
HIGHER EXECUTIVE OFFICER:	Carter, L. W.; Davies, R. R.
EXECUTIVE OFFICER:	Godfrey, Mrs. D. M.; Pearson, W. E.; Powell, E. S.; Rance, K. A. E.; Shea, E. G.; Smith, Miss H. J.

CLERICAL OFFICER

Barr, W. S.
Cobbett, F. J.
Coward, F.
Dawson, R. O.
Draper, F. A.
Gardner, Miss C. M.
Gibbs, Miss H. R. M.
Gill, Mrs. O.
Harris, Miss P.
Jennings, Miss J. F.
Jones, Mrs. M. J.
Norton, Miss G. R.
Osman, F. F. J.
O'Sullivan, Mrs. G. J.
Root, M. J.
Screen, Mrs. B. M.
Shaw, Mrs. L. M.
Styles, Mrs. H.
Ward, Mrs. M.

SOUTH-WEST ENGLAND CONSERVANCY

Flowers Hill, Brislington, Bristol 4 (78311)

CONSERVATOR:	Connell, C. A.
ASSISTANT CONSERVATOR:	Dixon, E. E.; Penistan, M. J.
DISTRICT OFFICER I:	Banister, N.; Carnell, R.; Harker, M. G.; Keen, J. E. A.; MacIver, I. F.; Moir, D. D.; Rogers, S. W.; Shirley, M. C.; White, A. H. H.; White, J.
DISTRICT OFFICER II:	Campbell, D.; Rumbold, A. L.
SENIOR EXECUTIVE OFFICER:	Bowers, G. H.
CHIEF FORESTER:	Beasley, G. F.; Parsons, F. F. G.

HEAD FORESTER

Barber, E. G.
Bowman, P.
Braine, R. G.
Bultitude, R.
Clarke, H. F.
Cox, D. J.
Deal, W.
Gould, J.
Green, W. J.
Gunter, A. T. G.
Hendrie, J. A.
Humphries, W. J.
Lewis, W. P.
Lewis, C. J.
McIntyre, N. E.
Parker, J.
Parsons, P. H.
Sherrell, D. A.
Skinner, F. C.
Stott, W. S.
Strawbridge, F.
Tackney, A. J.
Thompson, L. T. J.
Walsh, J. E.
Whale, R. S.
Wills, K. G.
Wilson, M. J.
Young, R. E.

FORESTER

Anderson, J. E.
Ayers, D.
Bibby, W. B.
Budden, R. C.
Carter, D. E.
Chalmers, J. G.
Cliffe, P. E.
Coles, L. H.
Cordrey, E. B.
Edwards, B. F.
Everitt, E. C. W.
Fox, F. G.
Grenfell, R. G. P.
Hall, M. P.
Hambly, J. R.
Hibberd, E. C.
Hodge, R. J.
Houghton, M. A.
Humphrey, A. W.
James, M. E. H.
Jenkinson, G. A.
Judge, J. N.
King, R. J.
Millman, M. R.
Mills, E. W.
Mitchell, G. G.
Morrish, F. G.
Peach, J.
Pearson, A. A.
Pedler, D. C.
Powell, D. E.
Powell, R. B.
Rayner, G. L.
Scott, M. J.
Snellgrove, D. S.
Stark, M. H.
Stone, P. L.
Sturgess, W. F.
Thurlow, F. G.
Tisdall, J. C.
Waller, A. J.
Walton, R.
Yeardsley, D. E.

TRAINEE FORESTER

Gatiss, R. Smith d'Arch, J. F.

HEAD STALKER:	Prior, A. R.
CONSERVANCY CIVIL ENGINEER:	Perkins, J. S. (T.W.G.'A')
CONSERVANCY MECHANICAL ENGINEER:	Inglis, E. J. (T.W.G.I)
AREA CIVIL ENGINEER:	Allright, J. C. (T.W.G.I); Williams, E. L. (W.G.B.G.)
SUPERINTENDENT OF WORKS:	Lang, A. S. (T.W.G.III)
CLERK OF WORKS:	Court, T. J.
CIVIL ENGINEERING ASSISTANT:	Gize, E.; Payne, K. W.
DRAUGHTSMAN (CART.);	Moore, R.; Powell, R. W.
HIGHER EXECUTIVE OFFICER:	Rendle, R.; Thomas, J. L.
EXECUTIVE OFFICER:	Butt, A. A.; Child, Miss A. V.; Cutcliffe, B. W. J.; Maher, Mrs. B. M. T.; Phillips, P. R. R.; Roper, R. G.

CLERICAL OFFICER

Adams, Miss L. A. R.
Brace, Mrs. M. M.
Chainey, D. V.
Collett, J. A.
Edmondson, Miss D. M.
Foote, C. E.
Gibbs, Miss S. M. E.
Hale, E. W.
Hoyles, W. R.
Hudson, D. S.
Jenkins, Mrs. W. B.
Kimber, Miss L. P.
Lane, E. C.
Lawrence, Miss K. M.
Lewis, Miss M. A.
Lloyd, L. H.
Parry, Mrs. J. L.
Richings, Miss M.
Roberts, Miss C. A.
Roberts, S. A.
Spooner, Miss P.
Stone, G.
Watts, L. G.
Young, G. B.

NEW FOREST

The Queen's House,
Lyndhurst, Hants.
Telephone: Lyndhurst 2801

DEPUTY SURVEYOR:	Cadman, W. A.
DISTRICT OFFICER I:	Winterflood, E. G.
DISTRICT OFFICER II:	Gradwell, J. W.; Wildash, J. T.; Yorke, D. M. B.
SENIOR EXECUTIVE OFFICER:	Watson, W. G.
CHIEF FORESTER:	Cross, L. G. F.
HEAD FORESTER:	Cuff, E. W.; Fox, K. W.; Green, F. J.; Hodgson, R. S.; James, A. L.; James, H. B. S.; McNulty, M. E.; Meech, R.; Wood, J. F. B.

FORESTER

Barfield, G. F.
Barton, E. N.
Scott, M. H. Bell-
Budd, J. L.
Christmas, S. E. V.
Colley, M. A.
Conduit, J. S.
Evans, R.
Fletcher, R.
Goodson, P. B.
Hall, I. G.
Howard, D. J.
Pulford, B.
Robinson, D. A.
Roe, W. T.
Sainsbury, B. H.
Pitkin, W. P.
Willingham, M. W. K.

TRAINEE FORESTER:	Mihalop, R.; Gordon, D.
HEAD KEEPER:	Breakspear, A. F.; Humby, J.; Smith, B. B.
CONSERVANCY CIVIL ENGINEER:	Hughes, R. E. (T.W.G.'B') covers SE/E
SUPERINTENDENT OF WORKS:	Bradbeer, E. G. (T.W.G.II)
SENIOR CLERK OF WORKS:	Gilbert, R. L. (T.W.G.II)
LEADING CIVIL ENGINEERING ASSISTANT:	Fulcher, R.

DRAUGHTSMAN (CART.): Kennedy, W. J.; Ironside, F. J.

EXECUTIVE OFFICER: Foard, W. H.; Giddens, H. J.; Loader, M. E.; Pettitt, A. G.; Tester, R. W.; Wilkinson, M. J.

CLERICAL OFFICER

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Clark, B. H.
Durrant, S. G.
Gray, D. F.
Judd, Miss M. E.
Lawrence, Miss J.
Marshall, A. D.
Slayton, Miss S. E.
Stilwell, Miss N.
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Witt, V. A.

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DEPUTY SURVEYOR: Baker, R. G. Sanzen-

DISTRICT OFFICER I: Crowther, R. E.

DISTRICT OFFICER II: Sidaway, R. M.

HIGHER EXECUTIVE OFFICER: Whiting, E. F.

CHIEF FORESTER: Lingwood, N. J.

HEAD FORESTER

Brain, J. S.
Dunn, M. J.
Falconer, I. A.
Freeman, J. E. D.
Jones, H.
Lee, J. J.
North, S. J.
Russell, C. F.
Waygood, G. E.
Westacott, W. D.

FORESTER

Davis, S.
Fraser, A.
McCreath, N. F.
Parry, H. M.
Pugh, T. C.
Richards, J. B.
Ricketts, G. A.
Roberts, G. E. J.
Venner, B. G.
Wallis, K. E.
Wearing, M. F.

TRAINEE FORESTER: Heming, A. M.; McKinley, J. R.; Starling, L. G.

DEPUTY GAVELLER, DEAN MINES: Tallis, J. R.

SUPERINTENDENT OF WORKS: Labram, W. J. (T.W.G.II)

SENIOR CLERK OF WORKS: Yemm, C. F. (T.W.G.II)

DRAUGHTSMAN (CART.) Elley, B. G.

EXECUTIVE OFFICER: Hale, E. F.; Rose, A. C.

CLERICAL OFFICER: Bevan, Miss J. M.; Carpenter, Miss B. J.; Cox, D. J.; Howell, A. E.; Hyett, Mrs. M. W.; Iles, W. A.; Kingston, Mrs. E. F.

NORTH SCOTLAND CONSERVANCY

60 Church Street,
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Telephone: Inverness 32811

CONSERVATOR: Maxwell, H. A.

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CHIEF EXECUTIVE OFFICER: Macbeath, T. S. B.

DISTRICT OFFICER I: MacKay, A. F.; MacLeod, D.; MacRae, F. M.; Morrison, A.; Paterson, D. B.; Woodburn, D. A.

DISTRICT OFFICER II:	Cowie, G. M.; Finn, P. M.; Hamilton, G. J.; Jardine, J.; Marnie, R. J. R.; Ray, A.; Biggin, P.
CHIEF FORESTER:	McLeman, A.; MacLeod, D. M.; Nicholson, W. J.; Ross, D. M.; Thom, A. B.

HEAD FORESTER

Calder, A. M.	McAllen, F. M.	Officer, A. W.
Cameron, W. J.	Mackay, A.	Oglivie, J. A.
Carmichael, D.	MacKay, H.	Riddell, J. M.
Crawford, A.	MacKay, J.	Robertson, D. D. C.
Fell, J. B.	Mackay, J. A.	Scott, J.
Fraser, L. A.	MacLean, A. R.	Scott, M. P.
Fulford, A. G.	Maclean, K. A.	Small, G.
Galt, T. J.	MacLeod, J.	Smith, D. R.
Grant, D.	Macpherson, W. D.	Stobie, F. D.
Harvey, K. B.	MacRae, H.	Sutherland, F. W. S.
Hunter, W.	Morris, A. M.	Taylor, J. W.
Laird, D. M.	Morris, H. D.	Tear, D.
Lockhart, W. A.	Newsom, G. B.	Watson, J. C.

FORESTER

Auld, J. B.	Gibson, A.	Morison, A. W.
Baird, T. L.	Gordon, J.	Morrison, I. C.
Beaton, D. A.	Gordon, J. M.	Munro, A.
Beattie, W. R. C.	Grant, W. M.	Murdoch, R. K.
Boustead, J. C.	Herd, A.	Nichol, A.
Brown, A. R.	McCreadie, F.	Ogilvy, R. S.
Brown, R. S.	MacDonald, J.	Patience, J. J.
Cameron, F.	MacDonald, P. A. R.	Patience, W. M.
Campbell, J.	MacDougall, D. A.	Phipps, N.
Campbell, J.	MacInnes, D. F.	Reid, G. W. M.
Chree, J. W.	McIntosh, D. C.	Reid, H. R.
Denholm, J.	McIntyre, J. A.	Rothe, I. P. Toulmin-
Dunbar, G. R.	MacKay, J. W.	Sandilands, A.
Dyce, W. J. P.	Mackinnon, J.	Saunders, E.
Evans, R.	Macintosh, L. W.	Smith, M. J. A.
Fisher, J. H.	MacLennan, D.	Taylor, C. A.
Fleming, C. E. S.	MacLeod, D. J.	Thomson, R.
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Fraser, T.		

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Baird, W.	Millwood, F. H.	Stanger, B.
Bowers, H. W.	Milner, H.	Whitaker, D. S.
Davidson, N. H.		

FOREMAN:	Elder, J. C.; Macbeth, H.
HEAD STALKER:	Ferguson, A. W.
CONSERVANCY CIVIL ENGINEER:	Malcolmson, P. (W.G. Senior Grade)
AREA CIVIL ENGINEER:	McKillop, E. R. (T.W.G.I); McKenzie, N. A. (T.W.G. Main Grade); Hay, R. M. (T.W.G. Main Grade)
CONSERVANCY MECHANICAL ENGINEER:	Fox, E. P. M. (T.W.G.I)
SUPERINTENDENT OF WORKS:	Carmichael, J. H. (T.W.G.II); Dargie, J. H. (T.W.G.III); McConnachie, J. (T.W.G.III); Murray, D. F. M. (T.W.G.III); Noble, A. (T.W.G.III); Stewart, A. R. (T.W.G.III)
SENIOR CLERK OF WORKS:	Stables, J. M. (T.W.G.II)
CLERK OF WORKS:	Kerr, W. G. (T.W.G.III)
LEADING CIVIL ENGINEERING ASSISTANT:	Cartlidge, R. G.; Johnson, M. R.

CIVIL ENGINEERING ASSISTANT: Allingham, J.; Macintosh, D. J.; Newton, B. E.; Robertson, G. D.; Vickers, A. W.

DRAUGHTSMAN (CART.): Atherton, A. P.; Riddell, Miss I. H.

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MacKenzie, Miss M. A.
Macintosh, S.
MacLeod, A.
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Miller, J. E.
Miller, J. W. B.
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Sinclair, Miss C. M.
Smith, Miss W. L.
Wylie, Miss H. W.

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DISTRICT OFFICER II: Everard, J. E.; French, W. F.; MacKenzie, J. M.; Roberts, F.

SENIOR EXECUTIVE OFFICER: Steele, J.

CHIEF FORESTER: Allison, R. A.; Anderson, D.; Frater, J. R. A.; Urquhart, D. J.

HEAD FORESTER

Aitken, R. G.
Allan, J. S.
Anderson, M.
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Christie, J. H.
Davidson, A. L.
Main-Ellen, R.
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Harwood, A. E.
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Murray, G. M. W.
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Seaton, J. A.
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Stewart, S. W. R.
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Stuart, P.
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Thow, G. B.
Thow, J. B.
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Webster, J. O.
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FORESTER

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Fraser, J. R.
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Priestley, P.
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Salmean, C.
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Stewart, W. B.
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Thirdle, G. S.
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FOREMAN:	Anderson, S. C.; Grant, A. M.; McCann, W. G.
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CONSERVANCY MECHANICAL ENGINEER:	Swinyard, H. W. J. (T.W.G.I)
AREA CIVIL ENGINEER:	Auld, J. M. (T.W.G.I); Clarkson, W. H. (T.W.G.I)
SUPERINTENDENT OF WORKS:	Clark, J. D. (T.W.G.III); Logan, G. M. (T.W.G.III); Rae, M. F. (T.W.G.III); Ross, P. F. (T.W.G.III)
SENIOR CLERK OF WORKS:	McClory, J. (T.W.G.III)
CLERK OF WORKS:	McIntosh, A. F. (T.W.G.III)
CIVIL ENGINEERING ASSISTANT:	Cunningham, J. F.
DRAUGHTSMAN (CART.):	Williamson, G.
HIGHER EXECUTIVE OFFICER:	Edward, C.; Furneaux, D.
EXECUTIVE OFFICER:	Aitken, D. A.; Angus, J.; Benoy, D. W.; Brittain, D. W.; Cheyne, J.; Stephen, J. S. J.

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SOUTH SCOTLAND CONSERVANCY

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Telephone: Dumfries 2425

CONSERVATOR:	James, J. E.
ASSISTANT CONSERVATOR:	Chard, R.; Dier, H. V. S.
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DISTRICT OFFICER II:	Cram, A. R.; Fergusson, W. S.; Portlock, E. S.; Steel, R. P.; Thompson, P. A.; Walker, A. D.; Whitaker, J. D.
CHIEF FORESTER:	Fox, T. F.; Irving, R. H.; Jamieson, R. A.; Mackay, W. H.; McNicol, F.; MacRae, A. D.; Parley, C. W.; Watson, J.

HEAD FORESTER

Armstrong, H. O.
Broll, J. L.
Cameron, D. M.
Campbell, D.
Carruthers, J.
Carruthers, M. F.
Chisholm, M. R.
Cochrane, A. S.
Cooper, B.
Davidson, J. R.
Drysdale, N.
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Liddell, A. T.
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Murray, W.
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Thomson, J., D.C.M.
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Marshall, A. H.
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Priestley, P. E. B.
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Rainey, T. L.
Reid, J. M.
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Watson, A. W.
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Waugh, G.
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Wood, R. A. L.

TRAINEE FORESTER: Bunyan, N. C.; Jefferson, P. F.; Leech, K.; Mutch, W. C.; Price, R. C.; Shuttleworth, L. M.

HEAD STALKER: Clark, K. W.

CONSERVANCY CIVIL ENGINEER: Walker, P. H. F. (W.G. Sen.G.)

AREA CIVIL ENGINEER: Bennett, D. (T.W.G.B.); Brown, R. R. (W.G.M.G.); Green, A. M. (T.W.G.I)

CONSERVANCY MECHANICAL ENGINEER: Hart, A. E. (T.W.G.I)

SUPERINTENDENT OF WORKS: Campbell, J. J. (T.W.G.III); Cowperthwaite, F. T. (T.W.G.II); Crossan, G. W. (T.W.G.III); Currie, J. J. (T.W.G.III); Smith, W. B. (T.W.G.II)

SENIOR CLERK OF WORKS: Johnston, F. J. (T.W.G.II)

CLERK OF WORKS: Hay, W. (T.W.G.III)

LEADING CIVIL ENGINEERING ASSISTANT: Irvine, J.: Thomson, A.

CIVIL ENGINEERING ASSISTANT: McMillan, J. G.; Ritchie, J. W.

DRAUGHTSMAN (CART.): Sutherland, J. W.

HIGHER EXECUTIVE OFFICER: Burnett, A. G.; Hendry, D. L.

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CLERICAL OFFICER

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Belshaw, F. J.
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Carrick, R. R.
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Cunningham, K.
Grieve, P.
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Struthers, B. H.
Thomson, S. B.

WEST SCOTLAND CONSERVANCY

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Telephone: Douglas 7261

CONSERVATOR: Stewart, G. G., M.C.

ASSISTANT CONSERVATOR: Davies, E. J. M.; Johnson, W. A. J.; Robbie, T. A.

CHIEF EXECUTIVE OFFICER: Wharam, J. B.

DISTRICT OFFICER I:	Cassels, K. A. H.; Davis, F. G.; Forrester, S.; Gillespie, J.; Haldane, W. D.; Illingworth, R. P.; Larsen, R. T. F.; Macnair, A. S.; Thomson, W. P.
DISTRICT OFFICER II:	Bramwell, A. G.; Huntley, J. H.; Norrie, W.
CHIEF FORESTER:	Fairbairn, W.; Law, H. G.; Mackinnon, H.; MacRae, D. J.

HEAD FORESTER

Angus, R. S.	MacCaskill, D. A.	Mitchell, R. F.
Beaton, K. A.	McDonald, M. K.	Morrison, N.
Black, D. F. D.	McGavin, J. M.	Munro, D.
Campbell, J. A.	McGeachey, R. H.	Murray, R. G.
Cunningham, A. J.	MacGregor, D. R.	Polwart, A.
Francey, G. S.	Mackay, A.	Reece, A. V.
Fraser, T. S.	McKenzie, I. H. M.	Robertson, D. A.
Garrioch, I. M.	McLarty, M. C.	Rodger, J. H.
Gillies, A.	MacLean, A.	Ross, D. H.
Jackson, J.	McMillan, J.	Ross, I.
Johnston, C. R.	MacNicol, I.	Sinclair, L.
Keiller, W. C.	MacPhee, C. J.	Stout, H. C.
Lawson, D. W.	McRorie, J. P.	Young, A.
McCallum, D.	Martin, W. C.	

FORESTER

Armstrong, P.	Hart, C. W.	Maule, S. G.
Barker, G. J.	Harvey, R.	Morrison, A.
Beaton, J. M. C.	Heddon, G. S.	Morrison, I.
Blake, G. W.	Henderson, A. A.	Muhl, R. G.
Boyd, R. D.	Littlewood, A. T.	Murray, J. T. H.
Caird, D. G.	Livingston, J.	Oliphant, R.
Campbell, D.	Lyon, J. H. M.	Proudfoot, L. O.
Campbell, D. McL.	Lyons, D. J.	Ratcliffe, P. R.
Campbell, M. M.	McCallum, D. F.	Rae, G. W.
Campbell, W. W.	McDonald, W.	Reid, I. L.
Cowie, F. R.	MacDuff, R. J. A.	Robertson, J. B.
Craig, J. M.	MacFadyen, D.	Robertson, K.
Crawford, W.	Macintosh, A.	Sallie, J. L. T.
Cruickshank, A.	McKeand, J. W.	Shaw, M.
Dye, W. E.	Mackenzie, J. S.	Simpson, A. A. C.
Fergusson, P. D.	McLaughlin, R. S.	Sinclair, D.
Fraser, J. M.	MacLean, R.	Smellie, A.
Graham, A.	Main, D.	Smith, A. K.
Hamilton, J.	Mason, W. A.	

TRAINEE FORESTER:	Arnold, I. B.; Fox, A. B.; Grieve, J. C.; Henderson, W. D. C.; Kinsey, W. R.; Martin, B.; Neil, J. D.; Rees, S. W.; Reynard, B.; Wood, D. L.
FOREMAN:	McEachern, J.; Rose, W.
CONSERVANCY CIVIL ENGINEER:	Dishington, J. V. (W.G. Sen. Grade)
CONSERVANCY MECHANICAL ENGINEER:	Atkins, F. C. (T.W.G.I)
AREA CIVIL ENGINEER:	McEwan, D. M. (W.G. Main Grade); Ruthven, G. (T.W.G.I); Stark, W. (T.W.G.I); Thomas, P. A. (W.G. Main Grade)
SUPERINTENDENT OF WORKS:	Chisholm, J. (T.W.G.III); Dalgleish, T. (T.W.G.II); Howden, A. (T.W.G.III); McKenna, J. (T.W.G.III); Pritchard, R. W. (T.W.G.III); Ross, J. G. M. (T.W.G.III)
CHIEF CLERK OF WORKS:	MacKellar, D. L. (T.W.G.I)
SENIOR CLERK OF WORKS:	McLay, J. D. (T.W.G.II)
CLERK OF WORKS:	MacDougall, H. (T.W.G.III); Raisborough, R. (T.W.G.III)
LEADING CIVIL ENGINEERING ASSISTANT:	Watson, R.

CIVIL ENGINEERING ASSISTANT: Banks, A.; Hawes, G. V.; Murdoch, M. M.; Turnbull, I. McL. W.

DRAUGHTSMAN (CART.): Watson, J. A.

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Allan, C. M.
Cameron, A.
Campbell, Miss M. B.
Campbell, Miss P.
Connor, M.
Cullum, Mrs. M. C.
Hughes, J. T.
Irving, L. T.
Laidlaw, I.
Mackie, A.
McLellan, L.
McMillan, Miss E. W.
McNaughton, Miss M.
Morrow, Miss E. H. G.
Power, Miss T.
Reidford, Miss M. A.
Sloper, R.
Weir, Miss C. K.
Wilson, Miss C. M.

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Telephone: Aberystwyth 2367

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Jones, L.
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B: DEPARTMENTAL FORESTRY COMMISSION PUBLICATIONS ISSUED BETWEEN 1st APRIL AND 31st DECEMBER 1967

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