

PERMANENT SAMPLE PLOTS IN NEW ZEALAND EXOTIC FORESTS

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Historical Outline

It is proposed to discuss volume growth or yield plots as distinct from plots laid down for any other purpose.

The first effective establishment of exotic forests in New Zealand commenced soon after the announcement of a State Afforestation Policy in 1896. Under an afforestation branch of the Lands and Survey Department over 37,000 acres had been planted by 1919 in what Foster (1) has described as the first period of *intensive* State forestry. During this period a few permanent plots were established, such as those in Dusky Forest in Otago. They were small single plots of a quarter of an acre or less laid down in 1915 in larch, Douglas fir, insignis and Austrian pines and *Populus serotina* aged 9 to 15 years. They were remeasured in 1923 and 1931 but were not thinned until the latter date. Small sub-plots were then added to some to act as controls.

The second period, that of *extensive* State forestry, began four years after the formation of a separate Forest Department in 1919. The new Department (designated State Forest Service after 1920) gave some attention to permanent plots, and a number were laid down in the more important species in stands 14 to 21 years old established in the earlier period of intensive forestry. Most of these plots were established in 1922 and 1923, at Waiotapu and Kaingaroa Forests in the Rotorua district, at Hanmer in Canterbury, and at Conical Hills in Otago. The Rotorua plots were single acre areas which were measured at inception but not thinned. A few years later each was divided into four sub-plots of which three were given different grades of thinning, the fourth serving as a control. The Canterbury plots were differentiated and thinned at the beginning, but the sub-plots immediately adjoined each other. The absence of surrounds in both cases was a major defect. Most of the plots were remeasured twice at three-year intervals, but few were given a second thinning.

Previously the work had been done mainly by local officers in each Conservancy, but in 1930 a Sample Plots Officer was appointed to do the work for the whole country.

In 1932 a number of single quarter-acre plots were established in Pukerau and Conical Hills Forests, Otago, chiefly in insignis pine planted between 1914 and 1918. The plots in the latter forest were measured and thinned once, but in the former were measured three times at three-year intervals, though thinned only once. They pro-

vide some useful information on the growth of what can be considered unthinned insignis. It is proposed to remeasure them in 1950 and at three-year intervals to the end of the rotation. A few plots were established in other parts of the country at about the same time.

After 1932 difficult economic conditions restricted the research activities of the State Forest Service and the post of Sample Plots Officer was abolished. In consequence the continuity of the work was broken ; the sample plots were virtually forgotten. This was a serious loss for had the work continued, a useful series of plots accorded reasonable thinning treatment might now be in existence in the older, well established stands. Nevertheless, the number of plots laid down up to 1933 was quite inadequate, and in few instances was the site range covered in any Conservancy. A few plots were remeasured after this date ; for instance six in Waiotapu and Kaingaroa Forests, because a technical officer happened to be available. Thinnings were not repeated, nor was a definite policy laid down, until the establishment of the Forest Research Institute in 1947.

The old plots have now been examined : the best have been retained and will be treated and all of value will be remeasured at three-yearly intervals. These old plots cannot provide data on normal treatment, but a number do give information of value on the growth of the older unthinned stands, and on stands which will have had two thinnings.

It would not be fitting to omit a short account of the work done by bodies other than the State Forest Service.

In 1925 the Canterbury College School of Forestry commenced the establishment of a series of permanent sample plots in exotic forests throughout the province. Eight were laid down in insignis and ponderosa pines and Douglas fir in the Selwyn Plantation Board forests on the Canterbury Plains, and four in larch and pine in the Mackenzie County Council forest at Burke's Pass. In 1927 four were added in the Selwyn forests and one in a private plantation at Otaio. In 1928 a further two were added to the Selwyn forests and three to the Mackenzie areas (3).

All were established in young stands soon after planting, with the objective of tracing the complete life cycle. From 1925 to 1928 height measurements were recorded every year and mortality counts made (4). In 1929 the measurement of diameter was commenced. In that year two new plots were established, and measured before and after thinning. Four were added in 1930, two in the Selwyn forests and two in a private forest. Volume measurements were commenced. In view of this fact it was decided to measure at five-year intervals in the future.

The Canterbury College plots were to suffer the same fate as those of the State Forest Service. In 1934 the School was closed and

has not been reopened. The remeasurement scheduled for 1935 could not be carried out and, so far as is known, the plots have not received any subsequent attention.

The largest private forestry company, New Zealand Forest Products Ltd. (formerly N.Z. Perpetual Forests Ltd.), has a comprehensive series of permanent plots, 150 in all, chiefly in insignis pine. These are on the volcanic country of the central plateau of the North Island. Establishment was chiefly in the period 1932 to 1935 and commenced soon after the holding of a conference arranged by the N.Z. Institute of Foresters to standardise sample plot procedure.

The plots cover a wide range of site and age. They are measured periodically, some yearly, most at longer intervals. Measurement will probably be continued until the end of the rotation. From the data obtained a yield table for unthinned insignis pine has already been compiled.

The New Programme

An adequate series of permanent plots in the more important exotic species throughout New Zealand is essential to the development of good silviculture. The objects of the plots are :

- (1) To obtain information on the development of stands subjected to two or more grades of thinning.
- (2) Eventually to obtain data for the compilation of normal yield tables.

Since its inception the Forest Research Institute has taken over the control and co-ordination of the work in State Forests and a Sample Plots Officer has been appointed. One of the first steps has been to plan an adequate programme of plot establishment. This entails locating plots to cover the range of species and sites in each forest region, usually a Conservancy.

The aim is to establish plots in unthinned, fully stocked stands which are at or near the best age for first thinning. One difficulty is the bad distribution of age classes which necessitates many plots being laid down in stands appreciably beyond first thinning age. Another difficulty is the preponderance of stands established during the *extensive* period of afforestation. These had a low initial stand density of 680 trees per acre or less, and in consequence the trees are often of poor quality. All that can be done is to search for fully stocked stands of the required site quality and near the required age. Areas of sufficient extent can usually be found. On the other hand, many plots can be located in the better stocked young stands established during the later period of more intensive forestry which began in 1937.

The fact that many sites are unclassified presents a further difficulty. Yield tables compiled for unthinned *P. radiata*, *P. laricio*,

P. ponderosa and Douglas fir in the Rotorua Conservancy are a guide. In other Conservancies the Sample Plots Officer must classify the sites approximately in locating his plots.

The work is being carried out by Conservancy technical officers under the direction of the Forest Research Institute. Uniformity is secured by the issue of a manual of procedure for the guidance of officers and by periodical inspections by the Sample Plots Officer. Thinning is controlled by classifying the trees and marking according to a specification which is essentially similar to that used by the British Forestry Commission (2). The specification allows some latitude to individual officers, but ensures uniformity within limits. Computations are carried out and records prepared by the Forest Research Institute.

Treatment

It is intended to subject the plots to a definite and continuous system of management. This will consist of thinning and pruning at intervals throughout the rotation according to the needs of the crop. The plots will be measured every three years and thinned at three or six year intervals as necessary. Pruning will be carried out in two or three stages to a final height of 20 feet, starting soon after canopy is formed.

Procedure

The following is an outline of procedure in plot establishment.

A site is selected in an area of full stocking of sufficient extent to fit in three sub-plots. The sub-plots are made half an acre wherever possible. This size is sometimes difficult to obtain in the desired species and site, and smaller sub-plots down to a quarter acre must be accepted. Each is made rectangular with a surround half a chain wide. The sub-plots may be in a row or a group, but should be close together.

It is essential that the stocking be full and that the site be uniform over the three sub-plots. Both are judged initially by careful inspection. The second is then tested :

- (a) By measuring the heights and diameters of 15 to 20 well distributed trees per plot, chiefly in the dominant class; and constructing a height/diameter graph. The graphs are compared and a maximum difference of 5 per cent in dominant height is permitted.
- (b) By comparing the stocking. The breast height diameters of all trees on each sub-plot are measured to the nearest inch using a Biltmore stick, and the total basal areas computed. A maximum difference of 10 per cent is permitted though a limit of 5 per cent is the aim.

When any sub-plot exceeds the limit difference it must be discarded and another sought. When comparability has been established the measuring proceeds. The breast height diameter of every tree is recorded to the nearest tenth of an inch, the point of measurement being marked with crayon. Thin horizontal bands are later painted immediately below the marks and numbers painted on the main crop trees. Trees to be removed in thinning are left unmarked. To save time, classification of the trees is carried out when diameters are measured.

The two sub-plots for different degrees of thinning are selected and each, with its surround, marked for thinning.

To determine volume, sample trees are usually measured. Formerly one set was taken for each sub-plot, at least six to represent the main crop and five to represent the thinnings, covering the range of diameters but with emphasis on the larger sizes. It is now considered satisfactory to take one set of sample trees for the three sub-plots since their comparability has been established. This effects an appreciable reduction in the work. The trees are measured by climbing where possible.

The characteristics of sample trees are assessed by eye, care being taken to choose those which are average for their class in height, crown size and form. Height can be measured and compared with the height/diameter graph. A method of testing form is under trial. Where suitable volume tables are available they can be used in place of sample trees.

Three average dominants are selected from the sample trees and the stems analysed. When the trees are measured standing, the number of rings at various heights on those to be analysed can be obtained by counting the whorls from the ground up, provided that the species is uninodal and that the age is known.

Stocking diagrams are constructed showing the position of every tree in each plot. Circles round the thinning trees distinguish them from the main crop.

The corners of the plots are marked with durable posts painted white and by digging trenches. The boundary rows of the surrounds are marked with bands of white paint at breast height.

A general description of each plot series is recorded, together with a particular description for each sub-plot and a description of the soil profile from a pit dug near the centre of each. A pictorial record is obtained by photographing before and after thinning from marked points.

Computations

The sample tree volumes computed are :

- (a) The total over-bark and under-bark volumes.
- (b) The utilisation volumes to 4 inches and 6 inches under bark.

For some Conservancies volume tables are available giving the above volumes for the chief species. When volumes are determined from sample trees they are plotted against the corresponding basal areas at breast height over bark and a curve drawn which is slightly S-shaped but often approximates to a straight line. Curves are drawn for each of the three types of volume.

For each tree class (dominant, co-dominant, etc.) for (a) main crop and (b) thinnings, the trees are arranged into groups of twenty starting with the largest, the volumes corresponding to the mean basal area of each group read off the appropriate curve, and multiplied by 20. The volumes are then totalled for the tree classes, and the main crop and thinnings.

From the stem analysis data height/age curves are constructed. Form factors and bark percentages are calculated.

Summary

The history of the establishment and treatment of permanent yield plots in the exotic forests is outlined. In the State Forests a few plots were laid down in 1915, a larger number in 1922 and a few in 1932, after which they were largely neglected until 1947. The Forest Research Institute was then established and a programme of plot establishment instituted to cover the whole country.

A series of 27 plots was established by the School of Forestry in young local body forests in Canterbury between 1925 and 1930, but the closing of the School in 1934 prevented further work being done. New Zealand Forest Products Ltd. established a comprehensive series of 150 plots in their forests chiefly between 1932 and 1935. These have been measured periodically throughout.

An account is given of present treatment and procedure in plot establishment in the State Forests.

References

- (1) Foster, F. W. (1947). Exotic Forests of New Zealand. Paper prepared for Fifth Empire Forestry Conference, United Kingdom, 1947.
- (2) British Forestry Commission (1928). Bulletin No. 10: Growth and Yield of Conifers in Great Britain.
- (3) Kennedy, D. (1928). Some Growth Measurements in Canterbury Exotics. *Te Kura Ngahere*, Vol. II, No. 3 (Journal of the Canterbury College School of Forestry).
- (4) Hutchinson, F. E. (1934). The Growth and Yield of Exotic Conifers in Canterbury. *N.Z. Journal of Forestry*. Vol. III, No. 4.