DESIGN FOR A FOREST STUDY

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Introduction

In 1946 this Journal published a paper by Thomson, "Design for a Forest Survey". In the intervening twelve years, National Forest Survey, working on Thomson's pattern in its systematic coverage of the indigenous forests, has amassed volumetric and ecological plot data. An accurate and comprehensive estimate of the national indigenous timber resources has been obtained from the volumetric data and the type maps, while the ecological data have laid the synecological foundations for a further more intensive study of the forests.

The synecology of South Island forest areas has been described by Holloway in his "Forests and Climates of the South Island of New Zealand" (Holloway, 1954), and all future work there must be based upon this primary account, or at least take cognisance of it. For the forests of the North Island there has been devised a provisional type classification; and regional descriptive accounts containing a treatment of forest development, with accompanying type maps, are in preparation. In the problem protection forests of the South Island, transect work is proceeding under arduous and difficult conditions, while in the North Island supplementary ecological plot work continues. This present paper describes studies to be carried out, not in the erosion-liable high country of the South Island where the peculiar conditions require especial techniques, but in other forests, particularly those of the North Island.

In summary the situation in the North Island is this: The main forest types are known and are being described; their distribution has been determined and ecological maps are being produced to show it; from a study of field tally sheets and with the aid of pedologists and geologists a beginning has been made in understanding post-Pleistocene forest development; there is an overall appreciation of regeneration trends and the effects upon these of animal populations of various kinds and different intensities; and there is also a rough appreciation of the condition of the protection forests and of animal impact in these. In other words, for the bulk of North Island forests the end of the exploratory phase, the survey, is in sight. Now comes the post-exploratory phase, the study. The forests must be examined intently to prove or disprove theories of forest development, to understand thoroughly forest-type transition, internal mechanisms, and rates of growth and change.

Mapping

A note of explanation is needed about mapping. National Forest

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Survey has produced type maps of the commercial forest areas. Of necessity, these maps are detailed; and the main types have been broken down into volume classes. Again, of necessity, the maps were produced piece-meal, the first being compiled long before the last field work was completed. This precluded an overall appreciation of the forest pattern and the maps do not conform to any one comprehensive type classification. Ecological type maps must now be produced. This will necessitate the grouping of types of broad ecological comparability, irrespective of the type separation which was made for assessment purposes.

What the forester wants to know

It would be easy to lose sight of ultimate objectives in recording masses of detail. We must therefore decide what the forester wants to find out and adhere to these aims. The forester is managing forests mainly for production or protection, or both. In production forest he wants to know the rates of growth of timber species; in protection forests he is interested in both tree and shrub species and needs to understand the structural characteristics and inter-relationships of these, the extent and type of floor cover, and the changes occurring; in both production and protection forests he must understand the pathogenic behaviour of the plant community, and he must have knowledge of regeneration trends, including such things as abundance and periodicity of seed production, factors governing seed dispersal, and factors determining seedling establishment and survival. In most forests there is consistent site variation; therefore the forester must understand the influence of site upon forest mechanisms. Different animal populations have different impacts upon the same forest type, again reflected by different forest mechanisms. In brief, for each site class in each type, and for different animal populations, the forester must know and be able to predict the forest mechanisms significant to productive and protective forestry, and the rates at which they occur.

There is another important concept. Holloway has stressed the necessity for a multilateral attack on protection forest problems and a similar approach would be of immense value in the present project. Indeed, if the forest is to be understood, it is essential that forester, animal ecologist, pathologist, pedologist and, in protection forest, hydrologist should together act as a team. A forester may detect a significant change in regeneration mechanisms – a valuable finding; but if this change can be correlated with trends in either animal or insect populations, or in soil changes, then a much greater understanding will have been reached. This concept is, of course, that of the ecosystem where a change in one component affects the rest, and has been described and elaborated by Riney (1956).

Methods

Experience in permanent studies in indigenous forest has shown that for ease of establishment, facility of recording, and adequacy of sampling, a band transect at right angles to the "grain" of the terrain is most suitable. In this project transects 10 chains 50 links long and 1 chain wide are used. The size of the transect is a compromise. The first one established was 20 chains 50 links long by a chain wide. However, it was found that a transect this size took eight working days for a four man party, allowing a day to walk in and a day to walk out. Again such intensive recording for six days tended to make the observers less acute with reduction in efficiency. Consequently the size of the transect was reduced by half. Transects are now placed in pairs; this gives an establishment time of two party-weeks and a re-examination time of one party-week for each pair. Each transect is divided longitudinally into three zones: a tree zone, a sapling and pole zone, and a seedling and ground-cover zone. Frequent remeasurement and inspection will be necessary and a two year interval has been adopted. The disposition of the zones is shown in Fig. 1.

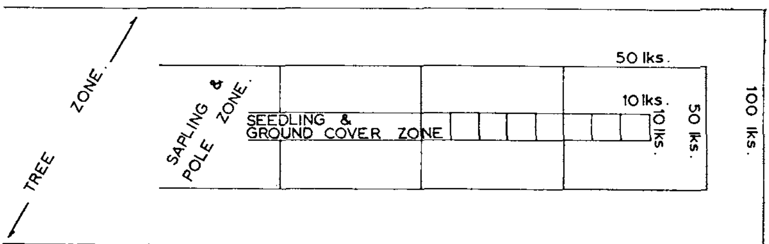


Figure 1

Proposed methods

The seedling and ground cover zone falls within the sapling and pole zone and this, in turn, falls within the tree zone. In this way regeneration and other trends can be correlated with overhead cover. The technique of recording is:

Tree Zone: 10 chains 50 links × 1 chain and taking in all trees over 12 inches D.B.H. All trees have their positions plotted, diameters and total heights measured (the latter in 10 feet height classes), and are banded and tagged.

Sapling and Pole Zone: 10 chains × 50 links and taking in all erect plants over 1 inch D.B.H. and under 12 inches D.B.H. This zone is shorter than the tree zone because it is surrounded entirely by it, and in turn surrounds entirely the seedling and ground cover zone. To plot the position of, tag, and relocate each individual at periodic remeasuring would be laborious and impracticable. Yet we want to know growth rates *and* the effect of overhead cover; for this latter purpose there must be positional control. As a compromise the zone is divided along its length into 50 link squares and in each square the individuals are tallied in one inch diameter classes. Periodic re-measuring will reveal the shift from one diameter class to the next and thus give diameter growth rates. For each diameter class an average height is also obtained. The position of each square is fixed and thus lower tier mechanisms induced by canopy conditions can be recognised in plan. In this way net growth rates will be obtained. However, if there is considerable mortality accompanied by vigorous recruitment, or if these balance, a false idea will be obtained of the actual growth behaviour. In considering the management potential of any forest type being studied it will be important to know both the gross and net growth rates. The gross rates can be obtained only from tagged individuals that can be relocated at each remeasuring. But, as discussed above, it is impracticable to tag and plot the thousands of individuals that will usually fall within this zone. Once again we have to compromise. A number (5 to 10) 50 x 50 link squares, each representative of a site, are selected and on these all individuals are measured, tagged, and plotted.

Seeding and Ground Cover Zone: 9 chains 10 links × 10 links and taking in all plants that had hitherto not been recorded. As in the pole and sapling zone, it is divided into squares, 10 × 10 links in this case, and net growth rates obtained per square. Here, the individual plants are tallied in one foot height classes; diameter measuring in this zone would be impracticable and, for many species, ridiculous. Ephemeral seedlings will be discounted, all plants below 6 inches in height being ignored. Of course, discretion must be exercised and, where warranted, field notes made on such phenomena as mats of cotyledonary beech seedlings. Again in this zone, for reasons already given, it will be necessary to trace the development of certain individuals. This can be done by selecting 10 × 10 link squares, one in each of the 50 × 50 link squares previously selected for study of growth behaviour and gross rate of growth of saplings and poles.

Particular attention is paid to the ground cover and for each 10 × 10 links square a photograph from a fixed camera point is taken. A visual percentage estimate of the area of exposed mineral soil is also made for each square.

Other Techniques

In addition to the photographs of the forest floor fixed camera points are being established to record changes in forest structure and changes in the densities of the different tiers. It is intended to experiment with double photographs from slightly varying position to give a stereoscopic effect. Where necessary field notes will be made for each 50 x 50 link square and each 10 x 10 link square. It will be necessary to have a flexible approach; probably the methods for different transects will never be exactly similar. For instance in production forests there will not be the need to study the forest floor as intensely as in protection forests.

Allied workers will adopt their own techniques. The animal ecologist will use pellet counts and browsing intensity as yardsticks; the pathologist will use beating methods for insect collection. But it is presumptuous in this short paper to guess at the methods which workers in other fields will use. All we can hope to do is to interest them in the project.

Scope

It is hoped that eventually there will be hundreds of transects established, and that parties will go from one to the next, remeasuring and re-photographing, metaphorically keeping a finger on the pulse of the forest. The knowledge obtained will form an ecological background for all kinds of forest management and for land-use decisions. To illustrate graphically just what we are aiming at, imagine a conference between a forester and a forest ecologist in ten years time. The forester would state that he wanted to manage a certain area of Type M2 (Provisional Classification of N.I. Forests) for tawa. The ecologist would advise a slight reduction in deer population to induce a better stocking of seedling and sapling tawa on ridges and valley sides; however this animal reduction would tend to promote inhibiting scrub hardwood growth in gulleys and some form of releasing would be required for these sites. All highly imaginary and drastically oversimplified but if we can get to a stage approaching this in ten years we will have made real progress. The important thing is to get the transects established now.

A note on the method of analysis

It may be wondered how the growth rates will be measured in the two smaller zones; there is no problem in the tree zone where each tree will be followed individually, but for example, in the sapling and pole zone, the frequencies within each diameter class are the only figures available. How may these be treated so as to be incorporated with the data obtained from the tree zone?

Consider a hypothetical example.

Diameter class, in.	6	7	8	9	10	11	12	12+
No. of trees 1957	50	46	38	32	29	26	19	
No. of trees 1962	60	56	49	38	32	28	22	5

It is assumed that a tree will gain no more than 1 in. in diameter between measurements.

It will be seen that 5 trees have gone out of the 12 in. class; the remaining 14 of the 1957 count must still be in the 12 in. class and therefore recruitment to the 12 in. class from the 11 in. class must be 22 — 14 = 8. Therefore 26 — 8 = 18 trees must remain in the 11 in. class and recruitment to the 11 in. class from the 10 in. class must be 28 — 18 = 10. Proceeding in this manner the following table is derived.

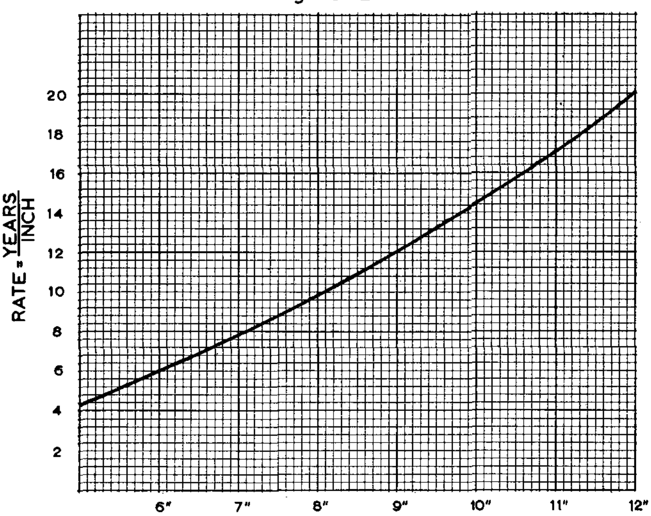
Diameter class, in.	Under 6	7	8	9	10	11	12	12+
Recruitment	50	40	30	19	13	10	8	5

The average gain in diameter over the five year interval for the 6 in. class is therefore estimated as $\frac{40}{50} \times 1$ in. = 0.80 in. or 0.16 in. per year, and for the 7 in. class as $\frac{30}{46} \times 1$ in. = 0.65 in. or 0.13 in. per year, etc., as in the following table:

Diameter class, in.	Under 6	7	8	9	10	11	12
5 years' increment	0.80	0.65	0.50	0.41	0.34	0.31	0.26
Increment per year	0.160	0.130	0.100	0.082	0.068	0.062	0.052

The increment per year may be plotted against diameter but it will be more convenient to plot the inverses against diameter (Fig. 2).

Figure 2.



This is in effect a graph of $\frac{dt}{d\,(\text{diam.})}$ against diameter and therefore the integral $\int \frac{dt}{d\,(\text{diam.})} \cdot d\,(\text{diam.})$ which is equivalent to the area under the curve up to diameter d, will give, on the average the time required for a tree to reach diameter d. The average time required for trees to reach any given diameter (greater than 12 in.) above that required to reach 12 in. is of course readily obtained from the tree zone data.

It should be noted that the example is only illustrative of the method and the figures used are not necessarily typical of what will be found in practice. For convenience, they present a somewhat idealised condition.

References

HOLLOWAY, J. T., 1954. Forest and Climate in the South Island of New Zealand. Trans. Roy. Soc. N.Z. 82: pp. 329–410.

HOLLOWAY, J. T., 1956. The National Forest Survey and the Watershed Protection Forests. N.Z. Jour. For. Vol. VII, No. 3.

HOLLOWAY, J. T., and WENDELKEN, W. J., 1957. Some Unusual Problems in Sample Plot Design. N.Z. Jour. For. Vol. VII, No. 4.

McKELVEY, P. J., and NICHOLLS, J. L., 1957. A Provisional Classification of North Island Forests. N.Z. Jour For. Vol. VII, No. 4.

RINEY, THANE, 1956. A Zooecological Approach to the Study of Ecosystems that include Tussock Grassland and Browsing and Grazing Animals. N.Z. Jour. Sci. & Tech. Vol. 37, No. 4.

THOMSON, A. P., 1946. Design for a Forest Survey. N.Z. Jour. For. Vol. V, No. 3: pp. 191–199.