CONTINUOUS FOREST INVENTORY IN WESTERN AUSTRALIA

H. Campbell and A. Lush[1/]

1. By far the most intensively managed forest type in Western Australia is our pine forest and our inventory system for this type is consequently more highly developed. Inventories of our native hardwood forests have been carried out several times in the past to provide broadscale information on our hardwood resource. These inventories were carried out as the need arose and not in a planned sequence of operations as implied by the term Continuous Forest Inventory. Since 1974, we have used management level inventories in our hardwood forests. They are carried out within defined cutting coupes one or two years before harvesting. We cannot plan to follow up these inventories due to uncertainties introduced by the very high incidence of dieback disease.

The type of inventories that we class as continuous are those which provide for the re-measurement of the resource at regular and planned intervals. The following notes deal exclusively with systems of this kind.

2. Native Hardwood Forests (Growth and Increment Plots)

2.1 Types and Areas of Forest Assessed

Hardwood forests in Western Australia comprise approximately 1.7 million hectares made up of Jarrah forests (1.5 million hectares), Karri forests (140 000 hectares), Wandoo forests (106 000 hectares). Marri and a variety of minor species occur in varying proportions in all of these types.

2.2 Type and Intensity of Sampling

Sample plots are randomly located within all strata of the major forest types. The primary purpose is to monitor growth and increment but they are also used to supplement temporary sample plot data for resource estimation. The required precision has never been defined in either context. The intensity of sampling varies with forest type and stratum in the range .015 to .02%.

2.3 Type of Plot

The plots are strip-line, 20 metres wide and varying in length up to a maximum of 400 metres for the most productive strata. The start point at one end of the plot centre-line is relocated

1/ Respectively - Officer-in-Charge, A.D.P. Section, Inventory and Planning Branch, Forests Department, Como, Western Australia, and Officer-in-Charge, Inventory and Planning Branch, Forests Department, Manjimup, Western Australia.

by distance and bearing, from a recorded landmark at roadside. Sample trees within the plot are identified by numbered tag and marked with a painted strip at breast height. Trees greater than 30 centimetres diameter are measured over the whole plot. Trees in the range 10 centimetres to 30 centimetres diameter are measured within a sub-plot extending 5 metres on either side of the plot centreline. Trees less than 10 centimetres diameter are neither measured nor recorded in any way.

2.4 Parameters Measured

For the purposes of growth estimates, the plots are measured on a ten-year cycle. Plot parameters recorded are: Co-dominant height, forest type, stratum, the year last cut-over and the presence or absence of disease (dieback and leaf-miner).

Tree parameters measured or recorded are: species, marketability class, diameter (b.h.u.b.), and utilizable pole height. Bole height estimation is mainly visual but frequent clinometer checks are made. Underbark diameters are measured by diameter tape and bark gauge.

As previously mentioned, these plots are also used to supplement temporary sample plot data for resource estimates. For this purpose they are re-measured at irregular intervals as required. The measurements recorded on these occasions include the length and utilization class of each log likely to be produced by every sample tree. The log measurement data are used to calibrate the temporary sample plot data which do not include log measurements.

2.5 Outputs

The growth data are processed by a computer system which stores the data derived from every measurement. Selected pairs of measurements may be retrieved to produce statements of current plot stocking, basal area and volume, and estimates of the periodic mean annual increment in diameter, basal area and volume. All of these parameters are tabulated by species, tree marketability class and tree diameter. Estimates of mortality and ingrowth are also presented.

2.6 Applications

The volume increment rate is used in the calculation of long term yield estimates. It has been proposed to develop growth models from these data.

2.7 Advantages

This is a low cost method of obtaining broad-scale growth data on selectively cut stands. The rate of growth on these

forest types is relatively slow and has minor impact on medium term yield estimates.

Disadvantages

There are not sufficient plots to provide sound statistical data for the many different strata in the major forest types.

2.8 System Development

The system was developed locally.

3. Pine Forests

3.1 Types and Area of Forest Assessed

Pine forests in Western Australia comprise approximately 40 000 hectares with roughly equal proportions of *Pinus radiata* and various strains of *Pinus pinaster*. Individual stands are almost exclusively uniform in both species and age. Pine stands are measured for the first time when they reach 8-10 years; about 15 000 hectares have been sampled to date.

3.2 Type and Intensity of Sampling

The inventory system provides the basic data for more than one planning phase. The most demanding phase in terms of precision of the yield and resource estimates is the short term, operational phase (logging plan). The level of precision required for this purpose is 5%. To achieve that level we have established permanent plots on a 200 metre grid which represents one plot per 4 hectares of forest. The plots are of the variable radius type, measured with a 2 square metres per hectare factor prism. These plots contain relatively few trees so that, in spite of the high density of the plots, the average number of trees measured rarely exceeds 5 per hectare.

3.3 Parameters Measured

The plot parameters measured or recorded are: age, top height, fertilizer treatment and slope. The age and top height measurement permit the calculation of the local site index. The breast height diameter over bark and the height to tip are recorded for each sample tree. The heights of several trees in a plot are measured by instrument to provide "bench marks", the heights of the remaining trees are estimated visually.

3.4 Outputs

The plot data are processed by two distinct computer systems, one of which deals with increment calculations and the second with yield and resource estimation. The growth system maintains

a plot data base which records every measurement on a sub-set of our permanent plots. The outputs tabulate the current resource and the periodic annual increments in height, basal area, diameter and volume by plot and by stand. The yield and resource system maintains a plot data base which records the latest measurement on all our sample plots. The outputs provide annual estimates of yields from a plantation for any nominated period usually less than 20 years. The yield estimates are presented by individual stands and by product class, where a product class is defined in terms of a log crown diameter class and a log length.

3.5 Applications

The yield prediction system has for several years provided the basis for the development of cutting plans at several levels:

Long term management plans (10-20 years)
Medium term logging plans (5 years)
Annual logging plans

The system has also been used for casual enquiries to solve day-to-day procurement problems.

3.6 Feedback

Complexities introduced by use of growth models and thinning simulators make it impossible to calculate the precision of yield estimates from sample statistics. In these circumstances, precision can only be monitored by direct comparison of the estimates with actual out-turn. This is by no means a simple task as it requires strict controls on the implementation and documentation of thinning operations. We have recently put into service a computer system which handles the commercial aspects of our pine marketing operations. One of its functions is to maintain a complete record of all out-turn by cutting coupe. These cutting records will in future permit a very thorough monitoring system to be undertaken.

3.7 Advantages - Disadvantages

It is often necessary to sub-divide uniform stands into smaller units such as buffer zones, amenity strips or steep slopes, with different management treatments prescribed for different units. The systematic distribution of a large number of small plots which is a feature of our inventory system has advantages in this situation as it ensures adequate plot representation and valid yield estimated for any arrangement of treatment units. On the other hand, there is a financial penalty involved in the relatively high cost of plot re-location.

The computer systems which process the inventory data together with the growth models and thinning simulators incorporated in them were all developed by the Western Australian Forests Department. The system is very flexible in that there are virtually no restrictions on the kinds of cutting strategies that can be investigated nor on the type or intensity of the thinning prescriptions that can be simulated. However, the system is purely mensurational. The strategies it develops are not necessarily optimal as the economic or financial consequences of the strategies are not examined.

RESEARCH OFFICER
DR I.J. ABBOTT
FORESTS DEPARTMENT
COMO RESEARCH

FOREST RESOURCE INVENTORY

The article attached is a brief statement of inventory methods used in W.A. for permanent plots (those that are remeasured at regular intervals) in both hardwoods and pines.

Although written several years ago for presentation at a workshop in Colorado, U.S.A. on Forest Resource Inventories, it is still relevant and will be of interest to many officers.

The full reference is :

Campbell, H. and Lush, A. "Continuous Forest Inventory in Western Australia". pp 1202-1024 of "Forest Resource Inventories Vol II" edited by W.E. Frayer 1979. F.D. library reference 524.6(02).

PJ McNamara

ACTING CONSERVATOR OF FORESTS

16 December 1983

DISTRIBUTION:

ALL PROFESSIONAL STAFF