INVENTORY OF THE JARRAH FOREST USING LARGE SCALE AERIAL PHOTOGRAPHY AND GROUND MEASUREMENTS

by PAUL BIGGS

Introduction

During 1987, the Department of Conservation and Land Management in Western Australia commenced a complete re-inventory of the state's jarrah forest. Although designed as a resource-level inventory, a relatively intense sample was required to match the complex management in the forest which involves production for a diverse range of log products, minerals, water, recreation and conservation. Despite this, 1.25 million hectares of forest are to be covered by the year 1990.

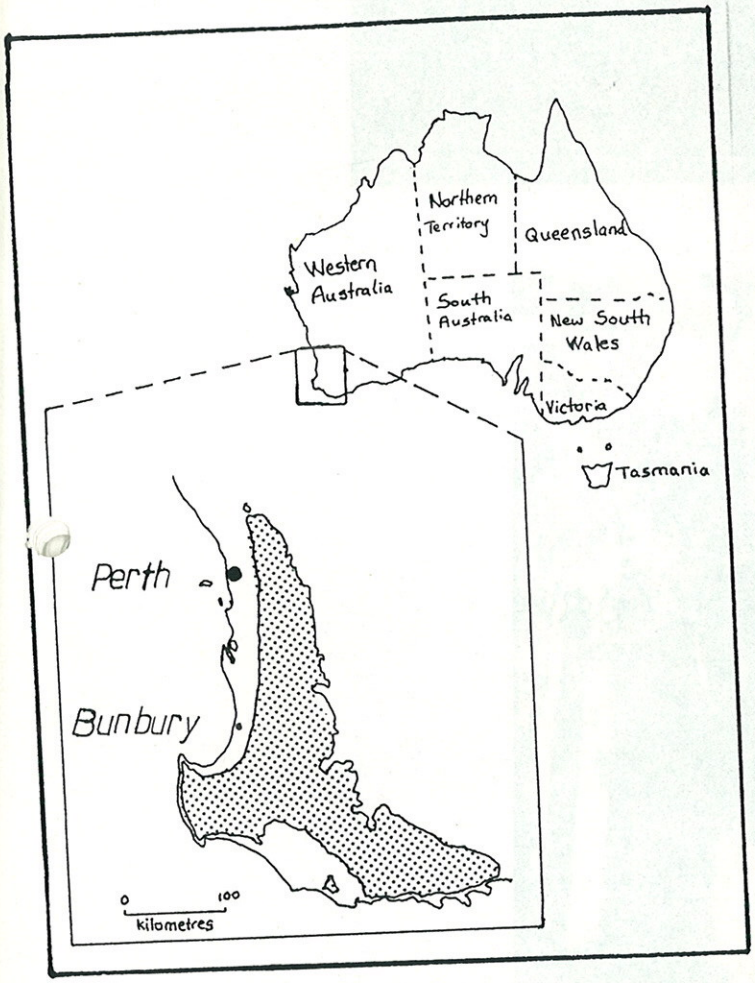
To achieve the dual aims of a quick and intense sample, a two stage inventory has been designed, using large-scale air photo samples in the first stage and ground measurements in the second.

This paper contains a brief description of the equipment and techniques assembled to complete the first two years of the project.

Contents

The Jarrah Forest

The jarrah forest covers an area of approximately two million hectares in the south west of Western Australia. Dominant species are jarrah (*Eucalyptus marginata*) and marri (*Eucalyptus calophylla*) along with other eucalypt species. Stands typically reach a maximum height of 35 to 40 metres in the higher quality areas. The inventory will have to cover the 1.25 million hectares of the forest which is zoned for timber production.



To the east, the jarrah forest gives way to open eucalypt woodlands of wandoo (*Eucalyptus wandoo*) and other species. Much of this has been cleared for wheat and sheep farming. In the high rainfall, fertile area to the south is the karri (*Eucalyptus diversicolour*) forest, reaching heights of 85 metres.

Much of the jarrah forest today consists of regrowth following selective cutting over the past 100 years. Increasing quantites of log products are being cut from the smaller regrowth trees. It is an aim of the inventory to improve the accuracy of information about this regrowth resource.

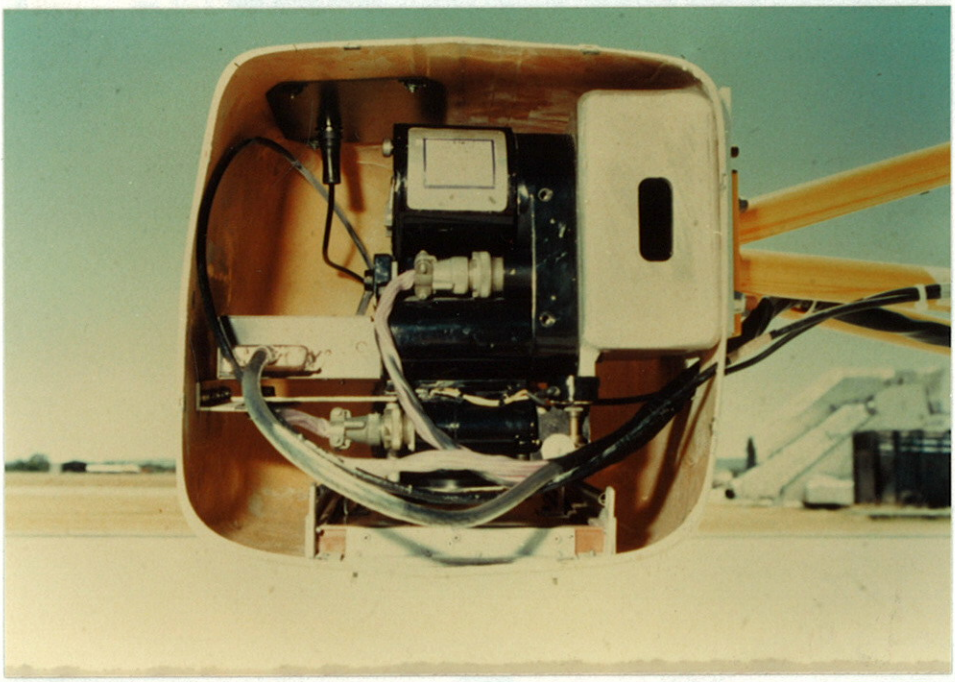
From the air, the forest is open and the ground easily visible. Species identification is made using crown characteristics such as leaf colour and density, branching pattern and, at certain times during the year, flowering.

Aerial Photography

A twin camera, fixed air-base arrangement was selected for the aerial photography. It was mounted transversely (on a Bell 206B Jetranger) to reduce the impact of mis-synchronisation of the cameras. Mylar-glass pods were placed around the cameras to protect them and to reduce drag. There were insufficient expertise or equipment available to test the single camera option with tip and tilt recording and foliage penetrating altimeter in the time given.

Vinten 492 cameras were used for the first year of photography (1987/88), selected for their robustness, film capacity, remote aperture control and frame numbering. The Vintens had been used by the Department for several years to obtain the photography used to map dieback disease. The intervalometers, frame counters and exposure controls were all available for them.

Cameras	Vinten 492
Lenses	Wild Falconar f1.4, 98 mm
Film	Kodak Aerochrome 2448



Hasselblad 500 EL/M cameras were introduced for the 1988/89 photography to overcome the measurement problems caused by the Vintens' focal plane shutters. Three Hasselblad 500 magazines were obtained, giving the cameras a reasonable film capacity and a new camera control system was built. A reseau plate was installed in each camera to facilitate measurements by analytical plotter.

Cameras	Hasselblad 500 EL/M
Lenses	Zeiss Planar CF f3.5, 100 mm
Film	Kodak Aerochrome 2448

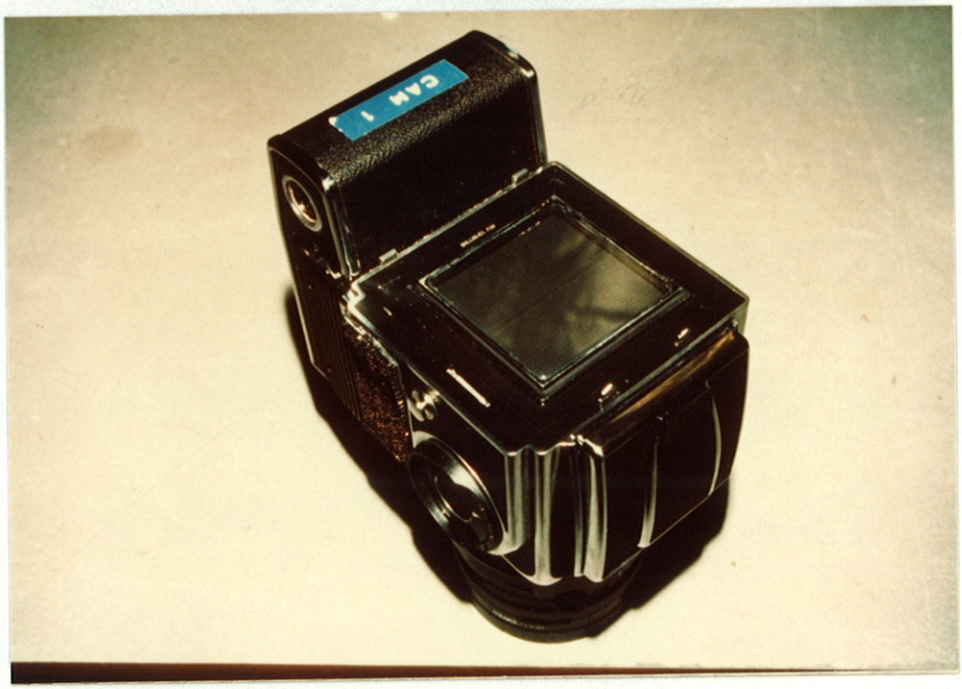


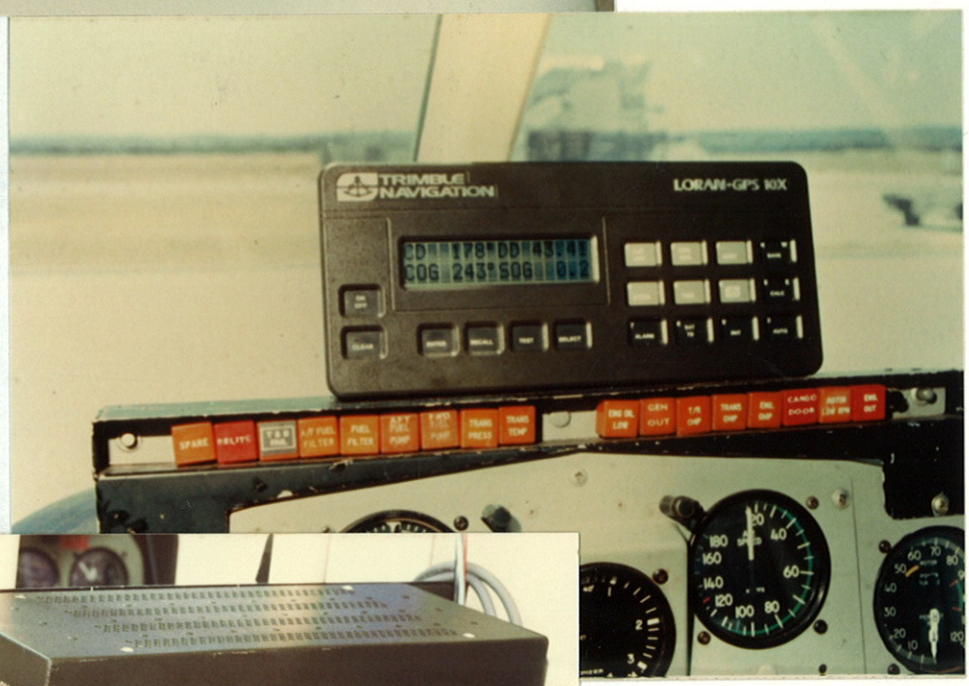
Photo Measurement

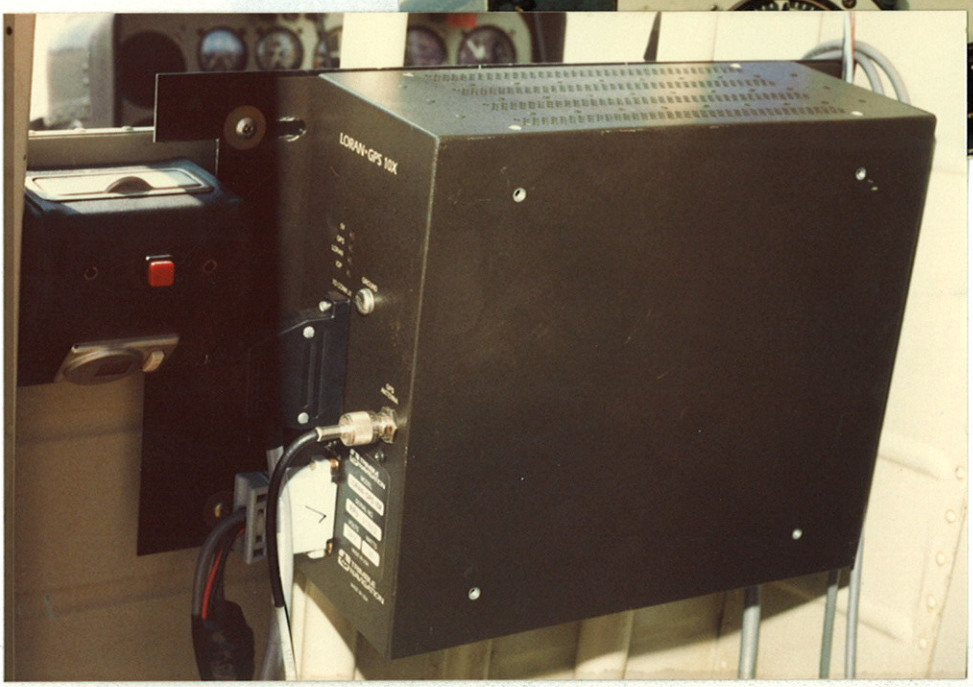
A Zeiss Interpretoscope and two Stereotopes are being used to measure tree heights on the Vinten photographs. Adam MPS-2 small format analytical plotters will be used to measure the Hasselblad photographs.

Navigation

A satellite based "Global Positioning System", the Trimble 10X is used to determine the accurate position of each photo-pair. This allows the volume estimates derived from the photos to be linked with precise area information and also helps the quick relocation of some samples for ground measurement.

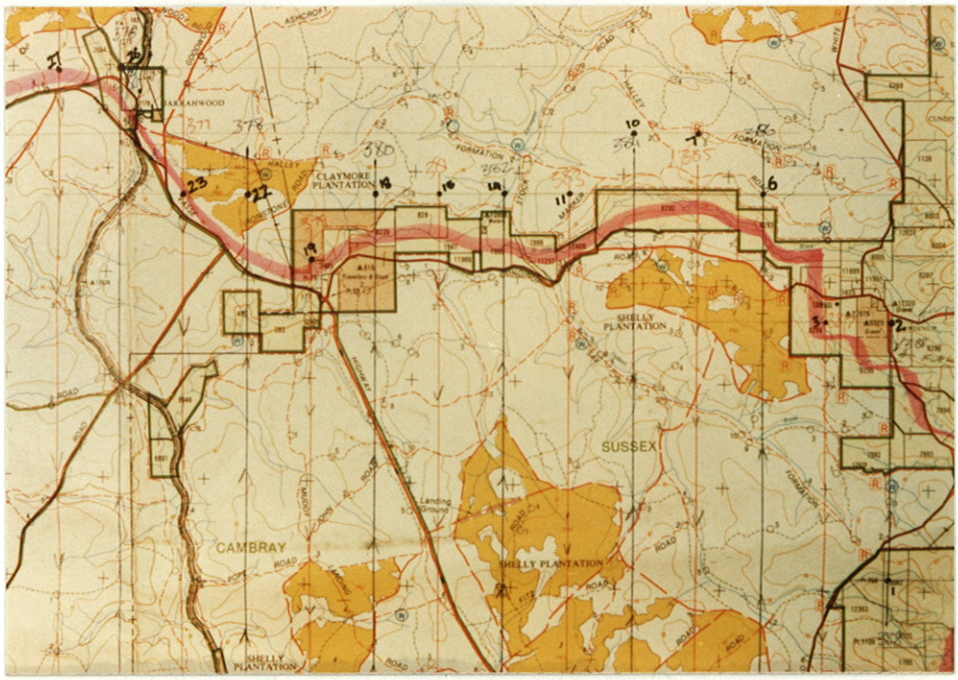
The Trimble 10X antenna is mounted on the port camera pod to avoid interference from the rotor blades, the receiver/processor is mounted behind the front passenger seat and the control/display unit on the pilot's instrument panel.

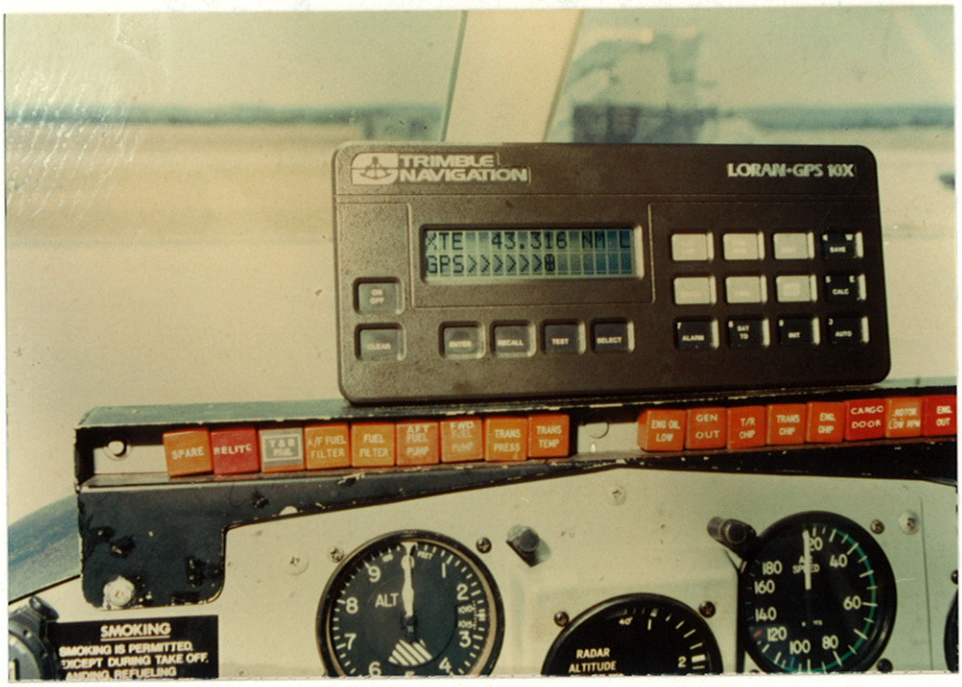




A laptop computer is connected to the Trimble 10X via an interface unit. The computer receives position information from the Trimble every second, calculates the distance flown and then fires the cameras on a pre-programmed distance interval. This ensures a constant sample intensity regardless of the ground speed of the aircraft. For each photograph taken, the computer records the position along with the time, satellite status and the frame number. It also records the altitude from a standard radar altimeter which is used for verification and checking of the altitude calculated from the fixed air-base.

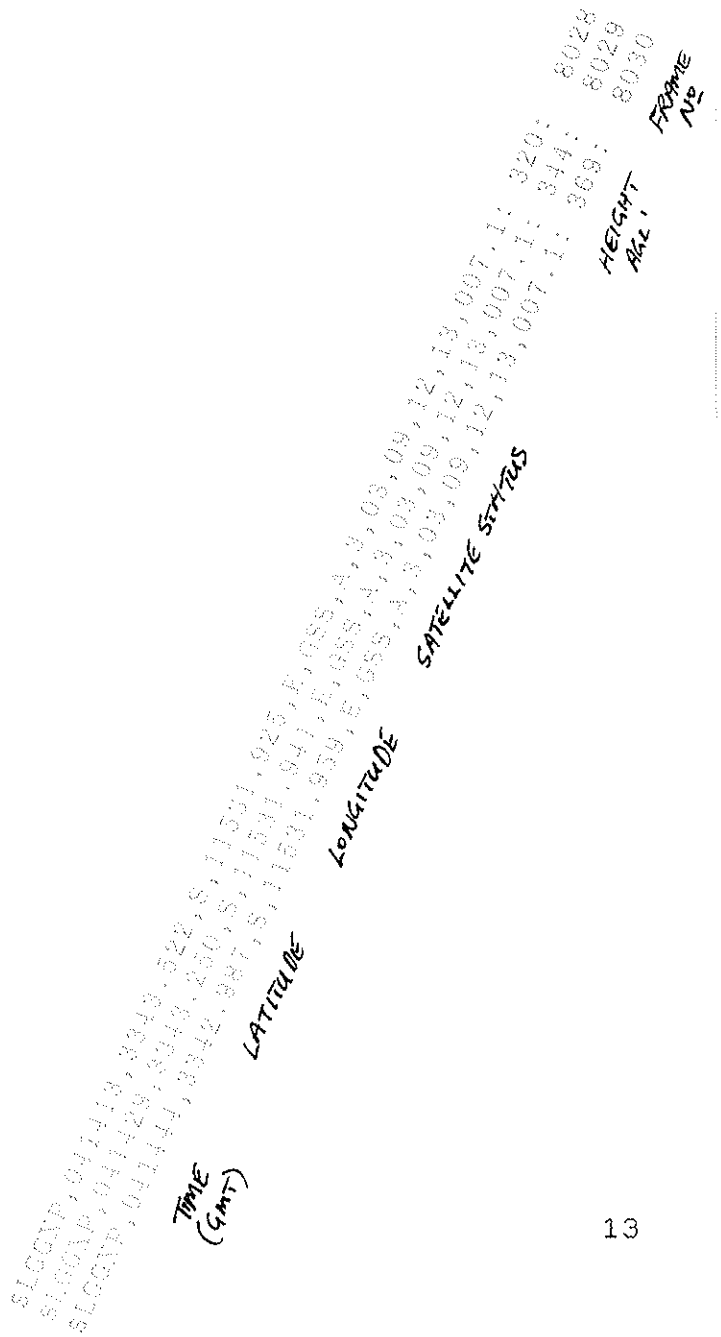
The Trimble 10X is also used to navigate along the planned flight lines. The coordinates of the end points of each line are entered, up to 98 at a time from the laptop computer before each mission. In flight, the navigator selects a route between two end points and the Trimble provides steering indicators to direct the pilot along that route.

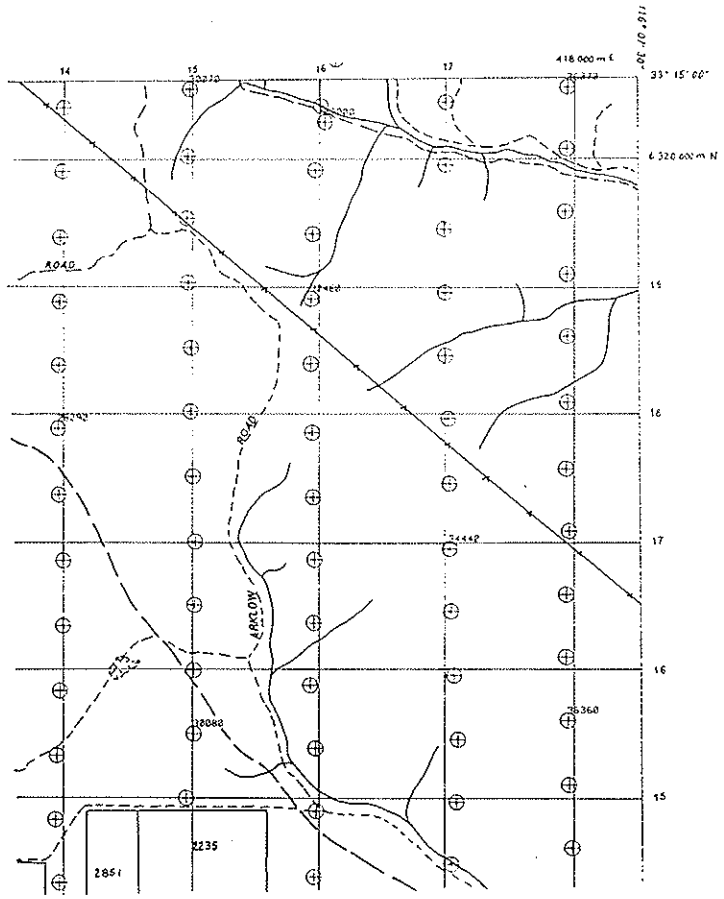




At the end of the photography mission, the photo location data are transferred from the laptop computer to the Department's Intergraph computer mapping facility and maps are produced showing the location of every photo-pair. 1:250 000 scale maps are used for administration and 1:25 000 scale maps are used for field relocation.

Future volume statements for any part of the forest will be generated by recalling the data from photo-samples and ground samples contained within that zone or window. The window will be defined using a combination of Intergraph, Esri Arc/Info and a grid cell GIS called FMIS.





Ground Plots

Ground measurement crews relocate the centre of every tenth photo plot by chain and compass survey off the 1:25 000 scale maps and by reference to the photos themselves. The photos are clipped onto perspex boards and viewed with a pocket stereoscope. Eighty-five percent of the photos are found within 100 m of the surveyed point. Accumulated errors from the GPS, the map and the survey all contribute to this.

Ground plots are assessed using a new technique to estimate the allocation of logs to the many product classes. It is designed for flexibility as diminishing old-growth resources are forcing rapid changes to utilisation patterns.

The technique involves assessment of the location, extent and severity of every defect or "quality" in the bole which may effect utilisation. A computer modelling process sorts the tree into product classes according to the utilisation standards defined at the time. Estimates can be revised by changing the standards and re-running the model.

Summary

The new resource level inventory of the jarrah forest uses fixed air-base, large-scale aerial photography techniques similar to those developed in Canada over the past twenty years. Differences include the use of 500 EL/M cameras and a transverse boom.

A satellite-based navigation system is used to control flight paths and to aid relocation of sample plots. By combination with a lap-top computer, the navigation system allows the accurate spacing of photographs, independant of ground speed.

GIS window generation is used to extract sample data for estimating volumes for small parts of the forest. A modelling process is used to estimate volumes of different log products based on variable utilisation standards.