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Guidelines for Regional Private Native Forest Inventory

**A report for the RIRDC/L&WA/FWPRDC
Joint Venture Agroforestry Program**

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Foreword

In 2005 -2006, the Joint Venture Agroforestry Program, with Natural Heritage Trust funding, managed several projects on private native forestry which reviewed spatial data collection methods and data availability, and tested forest sustainability assessment indices. As part of this, the Bureau of Rural Sciences (BRS) undertook a project that aimed to encourage future adoption of proven, consistent and reliable survey and inventory methods for private native forest resources.

A key activity of the BRS project was a workshop with the people involved in each of the above private native forestry projects. Its purpose was to discuss the development of agreed guidelines for regional private native forest resources inventories and to report on the status of existing regional private native forest inventory. The workshop was conducted on 10 and 11 March 2005 in Canberra.

The output from this inventory project is a set of draft guidelines for regional private native forest inventory. The draft guidelines include:

- principles, general procedures and minimum standards
- the outputs required, for example, maps and reports showing forest location, age classes or stand structure, harvestable and restricted sites, timber and non-timber values, roads and other infrastructure.

It is anticipated that adoption of these guidelines will lead to consistent data assessments of private native forest, regional wood supply, conservation issues, and reporting on sustainability criteria and other benefits. In the longer term, adoption of these methods will improve data available for national level reporting, as is required for the Montreal Process and State of the Forests Reporting.

This project was funded by the Natural Heritage Trust through the Joint Venture Agroforestry Program (JVAP), which is supported by three R&D Corporations—Rural Industries Research and Development Corporation (RIRDC), Land & Water Australia, and Forest and Wood Products Research and Development Corporation (FWPRDC), together with the Murray-Darling Basin Commission (MDBC). The R&D Corporations are funded principally by the Australian Government. State and Australian Governments contribute funds to the MDBC.

This report, a new addition to RIRDC's diverse range of over 1600 research publications, forms part of our Agroforestry and Farm Forestry R&D program, which aims to integrate sustainable and productive agroforestry within Australian farming systems. The JVAP, under this program, is managed by RIRDC.

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Peter O'Brien

Managing Director

Rural Industries Research and Development Corporation

Abbreviations and Glossary

Australian Geographic Datum (AGD) and Geocentric Datum of Australia (GDA)

AGD and GDA are the two alternative map referencing systems used in Australia. AGD (AGD66 or AGD84) was used as the basis for the production of most maps until around 1994 when the Geodetic Datum of Australia (GDA) was adopted as the standard for Australia. It is a requirement that all maps generated by Australian Government Agencies adopt GDA.

Within either AGD or GDA there are two acceptable alternatives for the projection of maps. Latitude/longitude (lat/long) provides equidistant lines representing latitude and longitude. As the distance between lines of longitude decrease away from the equator, such maps will have a variable scale. Lat/long projections allow maps to be prepared covering large areas but distortion occurs; examples are maps produced at 1:1 000 000 scale. The Map Grid of Australia (MGA) is a grid that has been overlaid to allow maps to be projected with a uniform scale. Because Australia is large, a single grid cannot be used and a series of seven grids (known as Zones) are used. Maps based on MGA typically cover a relatively small area (for example 1:25 000 and 1:50 000 scale).

Basal area

The cross section area of a tree measured at ‘breast height’, that is, at 1.3 metres above the ground. The cross section areas of individual trees on a sample plot are summed and extrapolated to estimate the basal area per hectare.

Basal area wedge

A basal area wedge is a device for estimating basal area by taking a sample at a point in the forest. Basal area wedges are calibrated so that the basal area estimate at a particular point is the number of trees counted in the sample multiplied by the gauge factor.

For further information, refer to the *Tree measurement manual for farm foresters* (second edition, 2003). T. Abed and N. Stephens, Bureau of Rural Sciences, Canberra (www.brs.gov.au/nfi).

Geographical Information System (GIS)

A GIS is a computer system capable of managing spatial data and associated attributes by integrating, storing, editing, analysing, and displaying geographically-referenced information. GIS is a ‘smart map’ tool that allows users to create interactive queries (user created searches), analyse the spatial information, and edit data.

More information can be found at http://en.wikipedia.org/wiki/Geographical_information_system

Global Positioning System (GPS)

A GPS is an electronic device that displays the user’s precise location on the ground. It receives signals from a constellation of earth orbiting satellites which it uses to compute the users position on the globe. These devices can record single points or sequences of positions which can be transferred to a GIS and displayed as positions, tracks or polygons. Their accuracy varies with the sophistication of the unit but is generally to within less than 10 metres.

More information can be found at http://en.wikipedia.org/wiki/Global_Positioning_System

GEODATA TOPO 250K

A vector representation of the major topographic features appearing on the 1:250 000 scale NATMAP topographic maps. It is primarily designed to provide high quality data for mapping and GIS professionals. It is available to download for free as individual tiles, or can be purchased as state and territory based packages on CD-ROM.

The product incorporates five main data themes—Hydrography, Infrastructure, Relief, Reserved Areas and Vegetation. These themes contain up to 138 feature classes, covering essentially all the features depicted on the paper map series.

This data has been designed for use in specialist GIS software, and is available in three popular GIS formats. Users without access to GIS software can access free GIS viewing software that will allow them to display and print the data.

More information can be found at <http://www.ga.gov.au/nmd/products/digidat/250k.htm>

Map grid of Australia (MGA)

Refer above to Australian Geographic Datum.

MARVL

MARVL is short for *method for assessment of recoverable volume of logs*. MARVL is a proprietary computer software package developed by Forest Research New Zealand. It uses visual assessment of individual tree stems on sample plots to estimate the volume of particular types of log (for example, fence posts, each specified size of sawlog, veneer logs, pulp logs) from the forest.

Model Sampling

A sampling method based on a statistically sound relationship between a variable relatively easily measured and a variable of interest that is more difficult to measure. A small number of samples is used to determine the relationship between the two variables. For any given number of samples, model sampling will provide a more precise estimate of the average than can be achieved by simple random sampling.

Contents

Foreword	iii
Abbreviations and Glossary	iv
Executive Summary.....	viii
1 Introduction	1
2 Regional inventory—principles, procedures and minimum standards.....	2
2.1 Principles.....	2
2.2 Mapping and inventory procedures	2
2.2.1 Approach.....	2
2.2.2 Forest types	3
2.2.3 Management.....	4
2.2.4 Mapping	4
2.2.5 Cadastre.....	8
2.2.6 Remote sensing	8
2.2.7 Timber resource inventory	9
2.3 Standards	12
2.3.1 MARVL inventory	12
2.3.2 Log specifications	12
3 Outputs.....	14
3.1 Maps	14
3.1.1 Polygon	14
3.1.2 Line	14
3.1.3 Point	15
3.1.4 Display	15
3.2 Raw data	15
3.3 Processed data—reports	16
4 Next steps.....	17
Appendix 1 Current information on private native forests.....	20

Tables

Table 1	Example of standardised descriptions for management level.....	4
Table 2	Road classification system used in GEODATA topographic 250 000 maps	7
Table 3	Tenure status of forested land in Victoria	22
Table 4	Private and public native forest within RFA regions ('000 ha).....	23
Table 5	Private and leasehold forest ² within and outside RFA regions ('000 ha).....	24
Table 6	Private native forests, Western Hardwoods Region, Queensland	27

Figures

Figure 1	GEODATA topographic 250 000 scale index map	6
Figure 2	Private and leasehold native forests and regional forest agreement regions	28

Executive Summary

What the report is about

This project developed guidelines for survey and inventory of private native forest resources, to encourage adoption of proven, consistent and reliable methods. The project also summarised features of some recent private native forestry inventory projects. This report aims to increase understanding of the need for more consistent data collection methodologies.

Who is the report targeted at?

The guidelines are for use by organisations that undertake regional inventories or assessments of private native forests. Regional inventories or assessments of private native forests may potentially be undertaken by, or for organisations such as: Private Forestry Development Committees, Catchment Management Authorities, State Government departments and agencies, and Australian Government departments and agencies.

This report may also assist people who are involved in mapping and inventory of native forests and woodlands, in particular private native forests –foresters, regional natural resource management groups and staff of government departments. In the long term, more consistent data collection will allow greater data sharing and more powerful planning and resource management across jurisdictions.

Background

Privately owned native forests represent the largest category of native forests in Australia. Information on the extent, composition, management and condition of these forests is important to assist planning and management at local, regional and national levels. Adoption of more consistent methods between organisations that undertake regional mapping and inventory of private native forests will lead to better data for assessment of area of private native forest, regional wood supply, conservation issues, and reporting on sustainability criteria and other benefits.

Aims/Objectives

The purpose of the project was to develop guidelines for survey and inventory methods for private native forest resources – to encourage and enable adoption of proven, consistent and reliable methods within and between organisations.

Methods used

A workshop to develop guidelines for regional private native forest resources inventories was held on 10 and 11 March 2005. These guidelines were prepared as a result of the workshop. The guidelines include:

- principles, general procedures and minimum standards
- the outputs required, for example, maps and reports showing forest location, age classes or stand structure, harvestable and restricted sites, timber and non-timber values, roads and other infrastructure.

Results/Key findings

The guidelines clearly differentiate two approaches to the collection of such data. The top-down approach aims to collect generalised information over large areas. An alternative is a bottom-up approach where data are collected at the individual landholder level and amalgamated to a regional and national level. Regardless of the method used, there is a need for standardisation of a wide range of aspects of data collection for inventory and stand condition assessment.

The workshop provided the opportunity to share information on approaches but detailed coverage of the requirements was not possible.

Implications for relevant stakeholders

Organisations that play a role in coordinating regional inventory projects will improve data compatibility in the future if they encourage use of these guidelines by others during design and collection of inventory data.

Recommendations

The following 15 recommendations aim to progress development of a standard approach.

1. Review existing vegetation grouping approaches and develop and/or adopt a set of vegetation groups that can be used at a range of levels (regional, State, national).
2. Where forest type descriptions (such as the Broad Vegetation Groups used in Queensland) are used, that these be allotted appropriate categories within the standardised set of vegetation groups defined in Recommendation 1 above.
3. Develop a set of standardised terms to describe forest management practices currently applied such that data can be amalgamated from a local to a regional to a national level.
4. Where terms have previously been used to describe management practices, that these be interpreted and fitted to the terms adopted in Recommendation 3 as appropriate.
5. A standard set of classifications be developed and adopted for all elements of mapping themes across GIS systems. The GEODATA Topographic 250 000 series provides a strong base and could be used as a model.
6. Where data are obtained from organisations that have different approaches to classification that a set of 'conversion equivalents' be developed to allow these data to be used but to also allow the data to be amalgamated at the regional or national level.
7. Where GPS units are used to collect data, a standard approach to collection of raw data needs to be prepared as this will greatly assist in providing a uniform approach that will allow subsequent data aggregation.
8. Locational software packages provide a simple and low-cost tool for navigation by combining the information available on a topographical map and the locational detail from a GPS. It is recommended that a simple document (compact disc based) be prepared demonstrating the availability and use of locational software and the use in private forest inventory.
9. Develop a set of standardised descriptions to allow freehold land to be grouped into units where legal status or management intent is likely to be similar.

10. Given the wide range of uses for aerial photography, it is recommended that the preferred scale for large-scale photography for forest inventory be agreed.
11. Prepare a technical guide outlining the range of satellite imagery available, access, cost and derived products that could be of assistance (such as SLATS, NPP); specifying standards seems inappropriate given the rapidly changing nature of the tools being developed in this field.
12. All reports generated as a result of an integrated approach to private native forest assessment should specify the log specifications applied in that region, including species, size (length and diameter), straightness and internal defect.
13. Develop a set of standards for GIS systems that will ultimately be used to generate maps; these standards extend from standard data file names, standard mandatory field names and formats through to standardised templates for map production.
14. Develop a set of protocols such that data to be submitted to a national database on private native forests conform to a set of agreed standards. These data should be available to the general public for interrogation. The platform used by the Australian Greenhouse Office National Carbon Accounting Toolbox may be suitable for this purpose.
15. Develop a standard report 'template', together with appropriate notes, to provide some level of consistency in reporting.

1 Introduction

Of the 164 million hectares of native forest across Australia, 24 million hectares are in private ownership and a further 46 million hectares are privately managed in lease arrangements. The privately owned and leased forests are managed by a multitude of owners for grazing, timber and other commercial products, biodiversity conservation, aesthetics, catchment protection, and combinations of these and other purposes. Pressure on the private forests to provide timber products has increased in several regions due to a reduction in supply from public native forests due to land use decisions and other factors.

While there is considerable information available about the commercial and non-commercial resources of public native forests, there is generally little known about private native forest resources. With the exception of a few regions, that information is limited to forest cover and type. Information to enable planning for resource conservation and use is generally inadequate. Inventory and/or mapping projects have been undertaken for private native forests in several regions. The methods, coverage and key outcomes of those projects are described in Appendix 1.

The Joint Venture Agroforestry Program, with Natural Heritage Trust funding in 2005 and 2006, managed several projects on private native forestry which reviewed spatial data collection methods and data availability, and tested forest sustainability assessment indices. The guidelines in this report are the result of one of those projects. The purpose of the guidelines is to encourage adoption of proven, consistent and reliable survey and inventory methods for private native forest resources.

The process to develop the guidelines included a workshop conducted on 10 and 11 March 2005 with the people involved in all of the other private native forests projects. The purpose of the workshop was to assess current knowledge of private native forests and to discuss the development of agreed guidelines for regional private native forest resources inventories. While the workshop was not able to facilitate detailed analysis or recommendation of specific strategies, an agreed list of the information required from regional private native forest inventories was formed. That list is incorporated into these guidelines.

These guidelines describe:

- principles, general procedures and minimum standards
- the outputs required, for example, maps and reports showing forest location, age classes or stand structure, harvestable and restricted sites, timber and non-timber values, roads and other infrastructure.

It is anticipated that adoption of such methods by organisations that undertake regional mapping and inventory of private native forests will lead to better data being available to Catchment Management Authorities, other regional authorities, State and Australian Government agencies for assessment of regional wood supply, assessment of conservation issues, reporting on sustainability criteria and other benefits. In the longer term, adoption of these methods will help improve the data available for national level reporting, such as is required for the Montreal Process and State of the Forests Reporting.

2 Regional inventory—principles, procedures and minimum standards

2.1 Principles

Private native forests are, by definition, located on freehold land and are managed by landholders. While governments at local, State or Territory and Federal levels have legislated to control various aspects of the management of native forests on private lands, individual landholders may choose a range of forest management options.

Information on the extent and management of private native forests is of value at the regional and national level for a range of purposes including:

- assessment of regional wood supply
- assessment of stand condition or extent of forest types for conservation purposes
- reporting on sustainability criteria and other benefits.

Assessment of attributes that may assist in providing such information needs to be consistent across jurisdictions if such data are to be aggregated or adjoining jurisdictions compared. Aggregating regional data to State or National level provides more comprehensive information to policy and decision makers. It is recognised that achieving consistency in information collation and reporting between agencies and over a period of time is difficult; these guidelines aim to provide a set of standard of procedures that might be common to all agencies, regardless of the jurisdiction or the date collected.

2.2 Mapping and inventory procedures

2.2.1 Approach

The approach to collecting data can be either:

- top-down where information is collected regionally and applied broadly
- bottom-up where information is collected at the forest level and aggregated to provide a regional/national context.

Both approaches have strength and weaknesses.

Top-down approach

The top-down approach is typified by the recent inventories of private native forest undertaken in Queensland where large areas (South-East Queensland Region and the Western Hardwoods Region) were assessed using a combination of ground sampling and satellite imagery to extend the results across the particular region (MBaC 2003a and MBaC 2003b).

The success of this approach depends upon a range of factors:

- ability to gain access to private land to assess attributes
- funding available as the precision of the outcome is directly related to on-ground assessment
- tools available at a regional level that allow plot data to be extrapolated (vegetation mapping, remote sensing data)
- parameters measured (timber volumes are broadly related to inherent productivity; environmental condition is more related to management practices and is not readily correlated with data obtained from broad-scale remote sensing)
- standards used—timber quality (species, defect, straightness, size), as an example, is typically defined differently in various regions and obtaining a reliable and consistent estimate of standing volume and future yield across a range of regions is difficult
- bias caused by sampling only those properties where landholders provide permission to enter.

Bottom-up approach

The bottom-up approach is perceived to be a more reliable method of assessing private native forests as data on both timber and non-timber values can be assessed at the property level. Aggregation of the data then provides the regional and ultimately the national level.

The success of this approach also depends upon a range of factors:

- funding—the funding required to adequately assess sufficient forests to draw regional conclusions is likely to be high and such funding may be unavailable for many regions
- timing—the collection and aggregation of the data is likely to be slow and time consuming and may not provide the ‘snapshot’ that a top-down approach can achieve
- landholder cooperation—the ability to choose sufficient sites in an unbiased way may be severely hampered by political issues involving governmental controls on private native forest management
- monitoring to ensure the same standards are used across small forest areas.

2.2.2 Forest types

The fundamental unit for mapping the extent and variability within native forest needs to be a system of species associations or groups. In the Queensland private native forest inventory projects (refer to Appendix 1), the Broad Vegetation Groups used were broadly defined by species composition. To allow either a bottom-up or a top-down approach to operate effectively, species or vegetation grouping is required at a national level at sufficient detail. It would be appropriate to have two levels:

- **level 1**—a broad agreed set of vegetation groupings that cross State or other boundaries that would provide sufficient detail for top-down regional inventories, such as projects aimed primarily at assessment of wood production potential
- **level 2**—a subset of level 1 vegetation groupings that also cross State or other boundaries that would provide sufficient detail for more detailed studies that could also form the basis for bottom-up regional inventories.

It is beyond the scope of these guidelines to develop these but, without such agreed definitions across the nation, it is unlikely that useful, common datasets can be developed.

Recommendation 1

Review existing vegetation grouping approaches and develop and/or adopt a set of vegetation groups that can be used at a range of levels (regional, State, national).

Recommendation 2

Where forest type descriptions (such as the Broad Vegetation Groups used in Queensland) are used, that these be allotted appropriate categories within the standardised set of vegetation groups defined in Recommendation 1 above.

2.2.3 Management

The management of forests on private land can have a wide spectrum of intensity and styles across a region. At one end of the spectrum there is intensive management with well planned harvesting and regeneration practices including some areas reserved for conservation. At the other end of the spectrum there is opportunistic harvesting of mature trees while grazing and uncontrolled weeds compete with inadequate regeneration and conservation measures are not undertaken.

As with forest types, it would be appropriate to develop a set of standard descriptions (or terms) that describe management status or management intent. Again these would need to be able to be sufficiently detailed to be able to use at a local level but also to be aggregated to a regional or national level.

An example might be:

Table 1 Example of standardised descriptions for management level

Local	Regional	National
Thinned from below to basal area of 12 m ² /ha in 2002 with 5 habitat trees/ha retained. Expected timber MAI 5 m ³ /ha/year.	Intensively managed selection forest with high potential for timber production and maintenance of biodiversity	Managed forest
Thinned from below to basal area of 15 m ² /ha in 2003 with 4 habitat trees/ha retained. Expected timber MAI 3 m ³ /ha/year.		
Clearfelled in coupes of ~8 ha in 2003 with seed from local provenances aerially sown; compacted areas treated and planted with subset of eucalypts in 2004. Minimum of 1 habitat tree/ha retained in conjunction with permanent buffer strips.	Intensively managed clearfall forest with emphasis on timber production within coupe; maintenance of biodiversity achieved through harvesting pattern.	

Recommendation 3

Develop a set of standardised terms to describe forest management practices currently applied such that data can be amalgamated from a local to a regional to a national level.

Recommendation 4

Where terms have previously been used to describe management practices, that these be interpreted and fitted to the terms adopted in Recommendation 3 as appropriate.

2.2.4 Mapping

Scale

Mapping of the extent of forest types or of management activity can be undertaken at a range of scales. Two levels of mapping (corresponding to the vegetation grouping levels described earlier) are likely:

- Level 1 maps would typically be mapped at a large scale (for example 1:25 000) or medium scale (for example, 1:100 000) and then presented at the medium or small (1:250 000) scale. Some data are, however, only available from a 1:250 000 scale base map.
- Level 2 maps would be typically be based on the most commonly available base maps of 1:25 000 topographic although in some jurisdictions (such as South Australia) a map scale of 1:50 000 is the common scale.

In all cases maps should be prepared using the Geocentric Datum of Australia 1994 (GDA94) projection if practicable. This may be difficult as the base maps are commonly in Australian Geographic Datum (AGD) 66 or AGD84 projections. For level 1 maps, it is common to use geographic coordinates (latitude and longitude) so a single map covering different zones can be prepared. For level 2 maps the Map Grid of Australia 1994 (MGA) grid system is useful within specific zones as the grid allows distances to be readily calculated using the 1 km x 1 km grid. In Eastern Australia there are four Zones that apply and care needs to be taken to identify the relevant Zone. For example MGA Zone 53 applies for Kangaroo Is.; MGA Zone 54 applies for Mt Lofty, Green Triangle and Western Victoria; Zone 55 applies to most of the forested parts of NSW and Eastern Victoria while Zone 56 applies in parts of northern NSW and most of the forested areas in Queensland (see Figure 1).

GIS

Geographic information systems (GIS; for example MapInfo, ArcView, ArcInfo) are commonly used tools to generate maps. The various GIS platforms generally have the capacity to convert files from one file format to another, but knowledge of the projection used to create a specific file is imperative if these files are to be transferred from one system to another. A standard set of database field criteria is invaluable if data from various sources are to be collated and aggregated at the regional or national level. These criteria need to be set for roads, streams, forest types etc. A good example is the 1:250 000 scale electronic map files that are available for all of Australia from Geoscience Australia (Geodata topographic 250 000 series). An index to the location of all the 1:250 000 maps is shown in Figure 1 (the relevant MGA Zones are identified on the X axis).

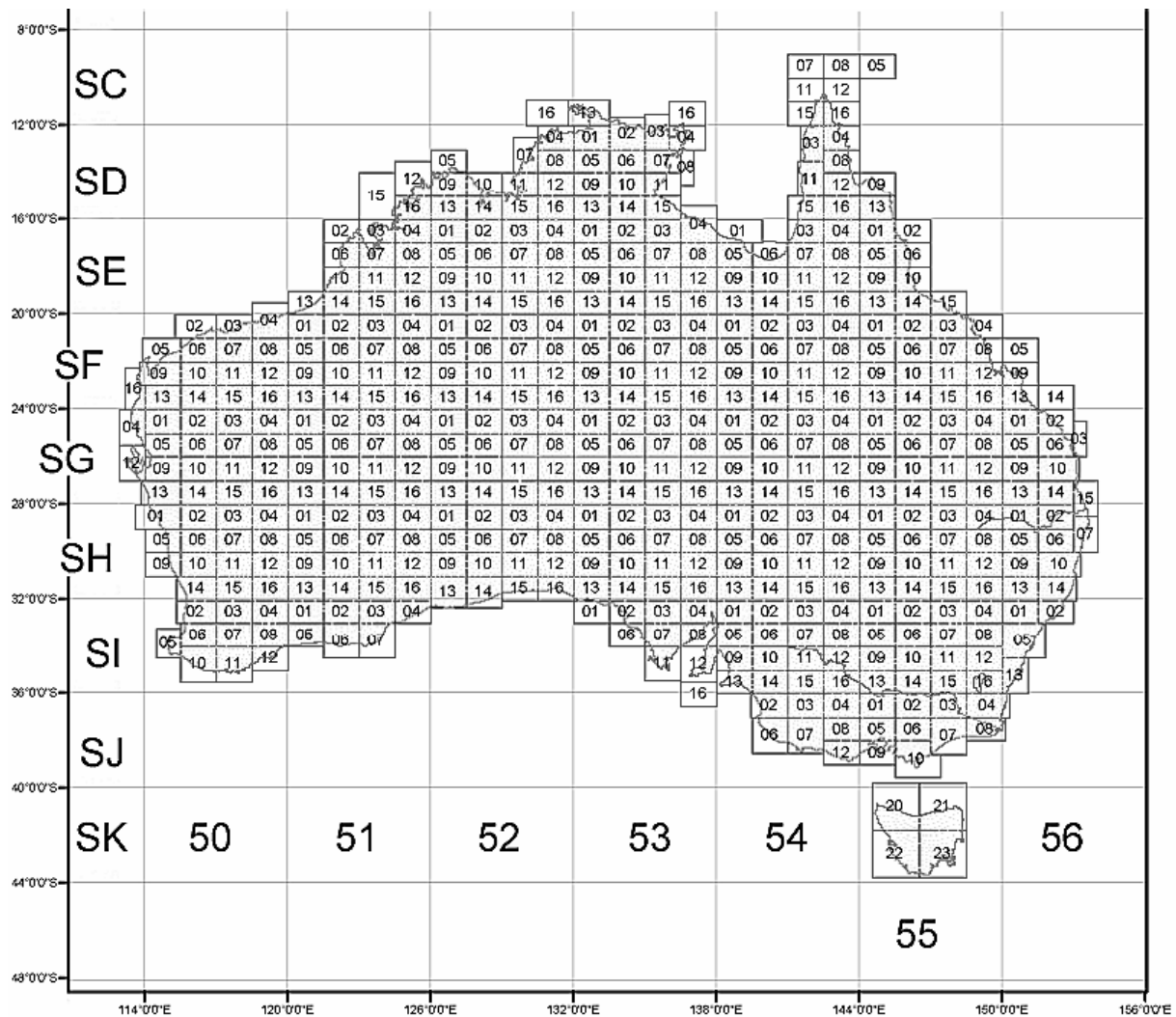


Figure 1 GEODATA topographic 250 000 scale index map

Note: Map sheet locations are identified by cross referencing the code letters on the left hand side and the MGA Region numbers across the bottom.

Mapping standards

The Geodata topographic 250 000 series recognises six themes:

- hydrography (drainage, water bodies, etc)
- infrastructure (road transport, localities, etc)
- vegetation
- reserved areas
- relief (contours, survey marks, etc)
- framework

Roads, for example, are classified under a hierarchy of types as shown below.

Table 2 Road classification system used in GEODATA topographic 250 000 maps

Classification	Formation
1 = dual carriageway	1 = sealed
2 = principal roads, highway	2 = unsealed
3 = secondary road	3 = unknown
4 = minor road	4 = under construction
5 = track	

Similar mapping standards are used in each State and Territory but the standards are not consistent across Australia.

Recommendation 5

A standard set of classification be developed and adopted for all elements of mapping themes across GIS systems. The GEODATA Topographic 250 000 series provides a strong base and could be used as a model.

Recommendation 5

Where data are obtained from organisations that have different approaches to classification that a set of 'conversion equivalents' be developed to allow these data to be used but to also allow the data to be amalgamated at the regional or national level.

GPS

Global positioning systems (GPS) provide the opportunity to navigate in areas where the operator is unfamiliar with the locality and to locate positions pre-determined for inventory. A GPS trace also provides demonstrable evidence of the route taken and that site visits have actually been made and that they are in the correct location. Consistency in GPS data is essential if the data is to be downloaded and overlaid with the GIS. While the Australian standard projection (GDA94) is rarely available in commonly used GPS units, the use of universal transverse mercator (UTM) coordinates and a world geodetic system (WGS) 1984 projection provides a sufficiently close approximation for practical purposes. If UTM is used the appropriate Map Grid Zone needs to be chosen, for example, Zone 55 for the majority of New South Wales.

Locational software

Locational software, such as OzieExplorer, provides a low cost method for navigation using GPS. The software displays position obtained from a GPS onto a scanned and geographically registered image of a topographic map.

Recommendation 6

Where GPS units are used to collect data, a standard approach to collection of raw data needs to be prepared as this will greatly assist in providing a uniform approach that will allow subsequent data aggregation.

Recommendation 7

Locational software packages provide a simple and low-cost tool for navigation by combining the information available on a topographical map and the locational detail from a GPS. It is recommended that a simple document (compact disc based) be prepared demonstrating the availability and use of locational software and the use in private forest inventory.

2.2.5 Cadastre

For private native forests the term ‘private’ needs to be defined. Freehold land may be owned by a wide variety of organisations/agencies. In many cases it may not be practical to manage the forest to achieve timber production or biodiversity goals. For example, freehold land owned by the Commonwealth for defence purposes is unlikely to be controlled by State legislation that would apply to other freehold land. Obtaining field data on such land would require a different approach to that used for farmland. There needs to be a standardised way of grouping freehold title that will provide consistency across regions and between State/Territories.

Cadastral boundaries are generally available in digital form throughout Australia at relatively low cost. Digital cadastre data providing outlines of each land parcel typically contain the title details but do not name the owner. Land title is subject to change as land is sub-divided or amalgamated. Ownership changes are even more common. Obtaining the current title details and ownership frequently requires direct access to the relevant Land Titles Office. Achieving a standard for title description across Australia would be outside the scope of this project but a common format for grouping titles would greatly assist.

Recommendation 8

Develop a set of standardised descriptions to allow freehold land to be grouped into units where legal status or management intent is likely to be similar.

2.2.6 Remote sensing

Remote sensing covers all forms of data collected from aircraft or satellites.

Aerial photos

Aerial photos can be large scale (1:5 000 to 1:10 000) or small scale (1:20 000 or smaller). The requirements for aerial photography depend on the purpose of a particular inventory. For example, under-cloud, large scale aerial photography can be useful for measuring ground conditions and could be an appropriate double sampling technique for assessing biodiversity. Alternatively, broad-scale vegetation typing is likely to be best undertaken on small scale aerial photos taken in cloudless conditions.

Sun angle is important for aerial photographs; in photos taken with a wide angle lens when the sun angles are high (for example summer; closer to the equator; around mid-day) there is a shadow of the aircraft on the photo and interpretation in the ‘shadow point’ is impossible. Shadow point can be avoided by the use of long focal length lenses and choice of the time of day and season for specific latitudes.

Large-scale aerial photos

Large-scale photos are typically collected for a specific purpose. In general long focal length lenses (that is telephoto lenses; 300 mm to 600 mm for survey format cameras) provide the best opportunity to fly at a reasonable altitude and image displacement is minimised. Appropriate lenses will depend on the camera format—for example 70 mm format cameras (often used from helicopters or light aircraft) will require different focal-length lenses to achieve the same effect. The availability of such lenses, particularly for survey format cameras, is commonly a restriction.

Small-scale aerial photos

Small-scale aerial photographs are typically collected as part of State-wide or regional coverage for mapping. Wide angle lenses that accentuate vertical displacement are normally used. Shadow points

are commonly found on such photography but with ample overlap between photos, this restriction can be overcome.

Recommendation 9

Given the wide range of uses for aerial photography, it is recommended that the preferred scale for large-scale photography for forest inventory be agreed.

Satellite imagery

Satellite imagery provides up-to-date data over a large area. As the data collected are digital signals, there is opportunity to characterise the signals (typically from a number of bands) as a 'signature' for a particular forest type. Satellite imagery from Landsat and ERTS is now available Australia-wide through the Australian Greenhouse Office covering scenes from 1972 to 2004.

A number of organisations have utilised Landsat imagery and ground collected data to develop indices of vegetation performance or cover. The SLATS database developed in Queensland, for example, provides a single index that relates to foliage projective cover (refer to Appendix 1). The satellite imagery has been adjusted for each season and provides a strong platform for extrapolating data collected on the ground over large areas. A similar approach has been taken with the AGO where a Net Primary Productivity Index (NPP) has been developed based on climate, topography and soils. Provided the extent of the forest is known, productivity estimates have been found to closely correlate with NPP.

More detailed imagery such as SPOT, IKONOS and Quickbird provides the capacity to much more accurately define forest extent but the cost is high. It seems likely that the cost of such imagery will decrease, particularly for imagery that is not the most recent, and this will open opportunities for use in private forest inventory.

Other imagery

A range of other imagery has been used to varying levels of success. The aerially based Aerial Laser Scanner (ALS) has been clearly demonstrated to provide accurate estimates of canopy and understorey height as well as terrain details but the cost has so far been found to be prohibitive for large-scale regional inventories.

Recommendation 10

Prepare a technical guide outlining the range of satellite imagery available, access, cost and derived products that could be of assistance (such as SLATS, NPP); specifying standards seems inappropriate given the rapidly changing nature of the tools being developed in this field.

2.2.7 Timber resource inventory

Timber resource inventory is the process of collecting data and estimating current or potential future timber volumes. Data and information on environmental and other values can be collected concurrently. The owner of a forest may undertake a timber resource inventory to determine the current volume or value of timber in the forest for marketing or financial planning purposes. Regional inventories can help determine the potential current or sustainable future supply of timber, and therefore assist with planning for timber processing industries.

Sampling design

Because it is not usually practical to measure all the trees in a forest, a timber resource inventory requires measuring samples. The sampling design—that is, the method used to select the samples—must allow for the variability of timber products in the forest and the practicalities and costs of

obtaining sample measurements. Sampling design is particularly complex for a regional native forest inventory because the forests are fragmented and vary widely. Variations in management can be extreme and the appropriate forest type and/or management maps to stratify the forests are unlikely to be complete over a region. The two key factors in sampling design will most likely be:

- funding, and
- access.

Funding to adequately sample each of the strata to a satisfactory level is unlikely over a regional scale. In addition access is also likely to be restricted in some way—either physical access or a lack of permission from the landholder to enter the property.

Experience in Queensland (refer to Appendix 1) found that model sampling was a successful method of correlating a remotely sensed measure (SLATS—Crown Cover Percentage (CCP)) with commercial log volume. In the Queensland case, the use of the net primary production (NPP) layer was also found to be effective, despite the relative coarseness of the underlying data. The key to the success of this method is to equally weight sampling across the range of the remotely sensed variable (in this case CCP). Precision may be improved by stratification by some grouping of localities rather than taking one large area as the population for sampling. Areas of similar climate, soil and other factors might form the basis for such stratification.

Not all private native forests will be suited to the sampling method used in Queensland but the concept of finding some parameters that can be related to remotely sensed data is of particular value. The chosen sampling design will differ depending on whether a top-down or bottom-up inventory approach is adopted.

Plot type

In native forests, equal weight in sampling needs to be given to each size class of tree so that current timber volumes as well as potential future growth can be estimated. Conventional fixed-area sample plots typically include too many young trees and relatively few large trees. There are two options to overcome this:

- fixed area but sampled in concentric rings—concentric plots
- variable radius plots where the probability of a tree being included in the sample is proportional to the tree diameter.

Fixed area plots typically require larger plots and are more expensive to implement than alternative types but may be necessary for statistical analysis of some factors, for example, responses to treatments or economic evaluation of products.

Concentric plots would typically involve three plot radii. The inner plot would encompass all trees, the middle plot would only sample trees with >20 cm dbh and the outside plot would only sample trees >40 cm dbh. The method is useful as no specialist mathematics is required to determine stocking, volume per hectare and other measures. The intrinsic issue of sampling in relation to tree diameter is thus partially overcome and may be acceptable.

Variable radius plots select trees according to their basal area. This can be based on a visual estimate using a tool such as a basal area wedge (refer Glossary) and supplemented by a table that provides a horizontal limiting distance for each size tree; slope can also be incorporated. The only disadvantage is that some more complex mathematics is required to calculate stand statistics.

The type of plot used to obtain data on individual trees is unlikely to be suitable for field measurement of other forest attributes. Disturbance or canopy density measures are examples of parameters where a fixed area approach is appropriate as the parameter to be assessed is related to a unit of land area. Strip lines, a set of observations or other methods may be appropriate. Both techniques were used in the south-east Queensland study to measure such parameters.

Plot size

The selection of an appropriate plot size is important. Large plots (or low basal area factors) mean that many trees must be measured within a plot. Small plots (or high basal area factors) can result in no sample (trees in a particular group) being obtained at that point. As statistics are based on the assumption of a normal distribution of data around a population mean, statistical analysis of a biased data set comprising a large number of zero observations is not an appropriate application of statistics.

In practice, plots with no trees of a particular group will occur as the stratification required is not possible to achieve. Care must therefore be taken in applying statistical techniques to a level of detail where the basic principle of sampling a population is overlooked.

In the south-east Queensland example (refer to Appendix 1) the sample ‘plot’ was the aggregation of data from up to 25 systematically located sample points. This method overcomes many of the problems relating to plot size and allows a value to be calculated for a parameter that can be readily extracted from, for example, satellite imagery where attributes are averaged across some form of unit.

Data recorded

Almost inevitably there will be different requirements for inventories but a common set of minimum standards is needed if the data are to be used at a regional or national level.

Plot level

At the plot level there needs to be a general description of the method:

- plot size (single or aggregation of sub-plots as for the south-east Queensland example)
- plot type (fixed area, variable radius, strip, etc.).

Details required for each plot:

- plot location (XY coordinates, Zone)
- plot size (or sizes)
- basal area factor or gauge used
- date
- organisation and people undertaking the assessment
- forest type
- management type and access to the site
- habitat trees and other environmental variables as appropriate
- data that are best presented at the plot level (for example stand height, crown cover, disturbance by category)—this is likely to be an amalgamated figure rather than a set of individual readings.

Tree level

Where individual trees are measured the following basic data should be recorded:

- species
- diameter at breast height (1.3 m above the ground)
- individual tree height
- individual height to canopy break
- MARVL description of the stem (a standard method is needed)
- hollows and other environmental variables as appropriate.

2.3 Standards

The ideal standard would be a format that could be used by any organisation and that could be modified by the organisation to include data collected for a specific purpose. Such a format would need to be available electronically to load into electronic field data recorders. It is beyond the scope of these guidelines to develop such a format, but clearly there are a number of definitions that need to be developed as ‘standards’ if there is to be national value on the private forest estate as a result of coordinated inventory. Recommendations on many of these standards have been discussed previously.

Other standards are required for:

- MARVL inventory
- log specifications.

2.3.1 MARVL inventory

MARVL (or equivalent software) provides a method to describe a tree stem based on externally observed characteristics such as sweep, straightness, forks, large branches, crown break, potential nesting sites, damage (likely internal defect) and other characteristics.

Provided an acceptable standard set of stem descriptions can be agreed upon, most requirements for the timber industry can be met as the specific standards that apply in a particular region can be applied in the MARVL dictionary, that is, the set of descriptions of log type, species and grade specifications for each log type.

2.3.2 Log specifications

Log specifications vary from region to region, so a standard approach Australia-wide is not practical. In Tasmania, for example, there are markets for sawlogs and pulpwood and these log types are harvested from eucalypts and from specialty species, such as myrtle beech. Different log quality specifications apply to specialty species logs and to eucalypt logs. For example, a myrtle beech log that is acceptable for furniture and craft use may have similar external defects as a eucalypt log that can be marketed only as pulpwood. Similarly, in Queensland, where there is a strong market for cypress pine, logs that would be considered too small for sawmilling in other areas are the main source of sawlogs.

Recommendation 11

All reports generated as a result of an integrated approach to private native forest assessment should specify the log specifications applied in that region, including species, size (length and diameter), straightness and internal defect.

3 Outputs

Numerous outputs are required from inventory projects; for example, maps and reports showing forest location, age classes or stand structure, harvestable and restricted sites, timber and non-timber values, roads and other infrastructure. The outputs need to be in three formats:

- maps
- raw data
- processed data (reports).

In each case, the information should be produced in electronic form. For each type of output a set of standards needs to be applied.

3.1 Maps

Maps will be generated from a GIS. Each shape generated from a GIS will be either:

- polygon (an area; able to be closed and an area calculated)
- line (a linear feature and a length can be calculated)
- point (only X and Y coordinates can be calculated).

The projection and zone (if applicable) should be described and meet the GDA94 standard.

Each type of shape will have an array of attributes that, for ease of handling, should be given standard names, standard formats and standard sizes.

3.1.1 Polygon

For example a shape that defines a forest needs to conform to some standard of naming and the GIS data file needs consistent fields such as:

- unique identification number (integers)
- state (30 characters)
- organisation (30 characters)
- date (day/month/year)
- forest type (10 characters)
- area (ha; decimal; 11 characters).

3.1.2 Line

A line depicting roads might conform to the terminology specified in the GEODATA Topographic 250 000 series. In this case the name of the GIS road map data file needs to be consistent and the data file defining the road also needs to maintain consistency and contain the following fields:

- unique identification number (integers)
- road name (30 characters)
- classification (1 to 5; small integer)
- formation (1 to 4; small integer).

3.1.3 Point

A point may be a feature, such as the location of a sighting of a bird species, or infrastructure, such as a township. Again, a standardised approach to naming such GIS data files and the minimum number of attributes required should be identified.

For example, for a GIS file name ‘Raptor Sightings’, the minimum required data fields might be:

- unique identification number (integers)
- location (X coordinate; decimal)
- location (Y coordinate; decimal)
- date (d/m/year)
- species (30 characters)
- special features text (undefined length).

3.1.4 Display

As the production of maps is rapidly changing from the domain of the specialist map maker to the GIS user, standard output styles for maps would make interpretation and generation of maps simpler. It is now common for organisations to have standard templates that provide such consistency. It is beyond the scope of these guidelines to develop a set of standard templates.

Recommendation 12

Develop a set of standards for GIS systems that will ultimately be used to generate maps; these standards extend from standard data file names, standard mandatory field names and formats through to standardised templates for map production.

3.2 Raw data

Raw data are typically linked to a GIS that automatically stores data along with the geographical reference. Manipulating data in a GIS may not be as convenient as in a spreadsheet or a specialised statistical package, for example. It is generally preferable to keep data within a GIS and export to another format for analysis as required. The integrity of the original dataset is most likely to be maintained if kept within the GIS.

Sharing of data files that contain key data needed to evaluate information at a regional or national level while still protecting the information on individual properties, requires an approach that ensures that only the required information is provided. A useful model for sharing such data has been created through the Australian Greenhouse Office National Carbon Accounting Toolbox (refer Department of Environment and Heritage, Australian Greenhouse Office, Canberra). All data on climate and soils in

that Toolbox are presented at a national level. Data can be readily obtained for each location but details are not available.

Recommendation 13

Develop a set of protocols such that data to be submitted to a national database on private native forests conform to a set of agreed standards. These data should be available to the general public for interrogation. The platform used by the Australian Greenhouse Office National Carbon Accounting Toolbox may be suitable for this purpose.

3.3 Processed data—reports

While web-based systems will increasingly be used, published reports continue to be the most likely repository of the details needed to fully understand and record the specific details. Without the published report, much data can be misinterpreted.

Recommendation 14

Develop a standard report ‘template’, together with appropriate notes, to provide some level of consistency in reporting.

4 Next steps

As described in the introduction, the purpose of these guidelines is to encourage and enable adoption of proven, consistent and reliable survey and inventory methods for private native forest resources within and between organisations. The guidelines are for use by organisations that undertake regional inventories or assessments of private native forests. Regional inventories or assessments of private native forests may potentially be undertaken by or for organisations such as:

- Private Forestry Development Committees
- Catchment Management Authorities
- State Government departments and agencies
- Australian Government departments and agencies.

Some of these organisations may also play a role in coordinating regional inventory projects. A valuable part of that coordinating role would be to develop the recommended systems and protocols for their jurisdictions.

As stated in the introduction, it is anticipated that adoption of these methods by organisations that undertake regional mapping and inventory of private native forests will lead to better data being available to Catchment Management Authorities, other regional authorities, State and Australian Government agencies for assessment of regional wood supply, assessment of conservation issues, reporting on sustainability criteria and other benefits. In the longer term, adoption of these methods will help improve the data available for national level reporting, such as is required for the Montreal Process and State of the Forests Reporting.

Each State and Territory has its own methods and standards of forest inventory developed to suit their needs. There are various committees and groups involved in forest measurement, notable are the National Forest Inventory Steering Committee and Research Working Group 2 (RWG2), which was established under the Forestry and Forest Products Committee (FFPC). Both of these include State and Territory government representatives. RWG2 also includes some representatives from academia and industry as observers. One of RWG2's objectives is to 'continue to collaborate on assessment of technology and development of procedures for forest data collection'. These guidelines are relevant to their work.

Most of the attention and development of forest measurement procedures has been done by governments and directed at public (Crown) lands. However, there is relatively little effort to collect private native forest data in a consistent and coordinated way, and these guidelines form a useful contribution to address that need. Adoption and implementation of these guidelines can be assisted by wide dissemination of this report to organisations and individuals with an interest in collecting forest data.

Implementing these guidelines could also be assisted by further work to facilitate the collection and analysis of forest data. This would be fairly easy to do as a short project to develop a web site that enables reports to be stored, spreadsheets for data collection to be accessed, and perhaps even selected data sets to be requested or even downloaded. An example of this is the Plantation Information Network website (www.brs.gov.au/plantations) developed and hosted by Bureau of Rural Sciences. This web site stores many reports on plantation capability and enables users to access and print maps showing plantation suitability across Australia or specific to their region. One of the reports on that site, 'The Pest and Disease Assessment Manual' is a good example of how a report outlining the method and a spreadsheet for analysis can be easily provided to external users.

At this stage there is no facility for coordinated collection of data suitable for forest inventory, but ready availability of such data would increase the usefulness to a wide range of people. Data collected in this way needs to be handled appropriately, including error checking and validation. There are also some privacy or appropriate use issues which would have to be resolved, perhaps by imposing licence conditions or agreements where there are concerns over the use of the data.

If funds and resources were available, Bureau of Rural Sciences and the National Forest Inventory could develop and host a similar web site to assist State and regional organisations to collect the data following these guidelines. This would require relatively little funding and compared to the large amount of time, dollars and effort to collect field data in the first place would be a very useful additional expense.

Developing and implementing a coordinated program of private forest inventory to improve the resource information base (to meet the increasing information needs and demonstrate good forest management), would be a large expense and require a major commitment of effort and funds over a period of years. As wood production areas on public lands are decreasing there are increasing demands on the private native forests to supply wood products. Closer public scrutiny will require increased knowledge of the quantity and quality of private native forests. These guidelines are just one small step in what will need to be a larger program of support for private forestry that will require the collaboration of a wide range of organisations and likely require public-private partnerships for funding mechanisms and implementation. In the interim, these guidelines will help ensure that any information that is collected from regional private forest inventories will be done in a way that is both technically robust and enable us to build up a more detailed picture of our forest resources over time.

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Appendix 1 Current information on private native forests

Introduction

About 39 million ha (24%) of Australia's 164 million ha of native forest is privately owned. A further 76 million ha (46%) is privately managed in a variety of leasehold tenures (source: National Forest Inventory, Bureau of Rural Sciences). Despite the size and likely social, economic and environmental significance of those areas, no systematic and comprehensive assessment has been undertaken of those forests.

Private native forests have been included in a number of regional assessments undertaken from the mid 1990s to 2001 during development of regional forest agreements. The regions covered by regional forest agreement assessments are shown in Figure 2. Those assessments found that approximately 40% of the forests in those regions are privately owned. There have also been several regional assessments undertaken by regional and/or state government organisations. This section of the report summarises the coverage and type of data that those assessments provide. This summary is taken from Ryan et al. (2002).

Regional Forest Agreement projects—New South Wales

Public and private native forests were assessed in the Eden region (south-east New South Wales), southern and northern regions. The results, including areas of forest types by ownership status for each region are shown in Tables 4 and 5. The method used for each region is described below.

South-east New South Wales

Vegetation types were defined based on floristic, structural, environmental and geographic uniformity. A total of 47 eucalypt-dominated units and 25 non-eucalypt units were recognised as ecosystem units. A map of ecosystem units was derived by overlaying a coverage of native vegetation cover derived from 1994 Landsat imagery.

Northern New South Wales

Forest communities were mapped based on forest types and further subdivided into regrowth, mature and over-mature growth stages. This mapping was based on air photo interpretation predominantly from 1995–96. The upper and lower north-east regions were divided into three biogeographical sub regions: the area south of the Hunter Valley, the area west of the New England Highway, and the area north of the Hunter Valley and east of the New England Highway.

The mapping methods for each sub region depended on the information available. The north-east area mapping was based on existing Forests NSW forest types. The western area mapping was based on floristic data from field survey plots. A classification system using seventy-one forest ecosystems was used for the Hunter sub region.

Southern New South Wales

The southern region of New South Wales was subdivided into three sub regions—South Coast, Western and Northern. Forest ecosystem classification and mapping was based on flora data from over 11 000 survey sites.

Regional Forest Agreement projects—Queensland

Vegetation mapping was undertaken for all land tenures in south-east Queensland at 1:100 000 scale using a minimum polygon size of 20 ha. This mapping was further classified into regional ecosystems, based on biotic and physical landscape components. The distribution of remnant vegetation was based on 1995 Landsat imagery interpreted through the State land cover and tree study. Old growth in eucalypt dominated forests was assessed across approximately 45% of the forested private land in south-east Queensland using API at 1:25 000 scale.

Standing volume and sustainable sawlog yield from private forests was estimated in a simple survey and modelling exercise. The potential annual yield of timber for private forests was estimated to be 215 000 m³. However, if future harvesting was restricted to areas currently containing saleable timber, then future yields might be only 45 000 m³/year.

A total of 170 vegetation types were defined. These were amalgamated and mapped into 142 Regional Ecosystems that were grouped into five categories: eucalypt forests (52), eucalypt woodland (31), non-eucalypt forests and woodland (20), rainforest and vine thicket (26), and non forest (13). Those categories were used as the basis for ecosystems mapping across all tenures.

In general, current native forest management practices on private land were considered to be unsustainable and changes in the allocation of public timber resources were found to be affecting private native forests, causing a substantial transfer of harvesting to the private estate.

Regional Forest Agreement projects—Tasmania

Tasmania has an extensive and varied forest estate. Native forest and plantations cover about 3.7 million ha, 40% of which is owned by farmers or large publicly listed companies. Management of private forests has been a major consideration in Tasmania for over 20 years. For example, the Everett Gentle Inquiry of 1977 resulted in the appointment of a Private Forests Commissioner and the establishment of a Private Forestry Division within the Forestry Commission. This later became Private Forests Tasmania (PFT), a statutory authority under the Private Forests Act, which facilitates management of forests on private land.

PFT provides advice to private forest managers on sustainable management of their forests, marketing and sale of products, and advice and assistance to the Forest Practices Board on matters relating to implementation of the Private Forests Act. Resource inventories of Tasmania's private forests were conducted in the 1980s and 1990s.

These arrangements considerably exceed the support provided for management of private forests in other States. This is due to the higher portion of forests in private ownership than in most other States and the economic significance of timber industries to Tasmania's economy.

Three projects on private forests were initiated as part of the regional forest agreement development process: a survey of private forest owners addressing a range of social and economic issues, a review of inventory information requirements, and a review of modelling techniques to quantify the public and private resource.

The distribution of 50 forest communities has been mapped at 1:100 000 scale with forest communities mapped to a minimum size of 25 ha. Forestry Tasmania and Private Forests Tasmania use the same mapping convention and assessment procedure for forest assessment and modelling of long-term timber production. This is based on forest type mapping using a commercially oriented forest type classification system, a floristic classification for ecological/conservation oriented purposes plus a structural classification based on aerial photography.

Regional Forest Agreement projects—Victoria

Regional forest agreements were developed for five regions in Victoria: East Gippsland, Central Highlands, North East, Gippsland, and West. The proportion of native forest privately owned is considerably lower than for most other States, being only 14% or 768 000 ha of the total forested estate of 5.3 million ha (Table 3). Only 15% of the forest in the Central Highlands is on private land, 6% in East Gippsland, 26% in the Western region, 13% in Gippsland and 14% in the North East. However more than half the area of a number of woodland vegetation classes in North East Victoria, grassy forest classes in western Victoria, and the ‘wet forest’ vegetation class (36 500 ha of 68 500 ha) in Gippsland occur on private land.

In each Victorian regional forest agreement a similar method was used to assess and map ecological vegetation classes across all tenures. Although the original mapping was at a variety of scales, from 1:25 000 to 1:250 000 depending on the purpose, the mapping for regional forest agreements used a consistent presentation scale of 1:100 000 scale. The ecological vegetation classes were derived from floristic forest type mapping.

Since the RFA process was completed, a process of mapping the private native forest resource was commenced. This process was started by the then Department of Natural Resources and Environment. The 1:25 000 mapping commenced in the North East and East Gippsland regions of the State in 2003 and is consistent with Statewide Forest Resource Inventory (SFRI) mapping which covers the public land forest estate. There are obvious benefits for assessing the resource consistently, the most obvious being to provide tenure blind analysis of biodiversity, timber resources and other natural resource criteria.

The stand attributes assessed are similar to the SFRI attributes although the categories of the private native forest mapping are broader. For example, the height classification is in 10 metre intervals not 5 metre intervals as is the case in SFRI. Attributes assessed include the species, height, crown cover and crown form categories. In addition the mapping is applied to forest over seven hectares in size and to forest with a crown cover over 50%.

The process involves using adjacent SFRI mapping for developing the forest type for the private native forest stand, satellite imagery and the aerial photography over the resource.

Table 3 Tenure status of forested land in Victoria

	Public ('000 ha)	%	Private ('000 ha)	%	Totals
Total Victorian land area					22 727
Total forested land	7 523	100%	1 298	100%	8 821
Reserved	6 847	91%	1 168	90%	8 015
Available for timber harvesting	676	9%	130	10%	806

Source: Cameron et al. (2004).

Regional Forest Agreement projects—Western Australia

The regional forest agreement development process in Western Australia included a project aimed at mapping remnant native forest and woodland vegetation on private and public land using remote sensing and modelling. Plantations and public land were deleted to derive a total of 350 649 ha of remnant native forest and non-forest vegetation on private land. These remnants were classified into forest types using a statistical relationship between forest ecosystems and vegetation complexes. The final maps show ecological vegetation classes at 1:100 000 scale, with detailed mapping of vegetation complexes at 1:50 000 scale.

The south-west Western Australian forest ecosystem mapping was developed by Mattiske Consulting and divided the forests into 21 forest ecosystems. Twelve of these are jarrah-based, five karri-based, two of wandoo, two of other forest ecosystems and six are non-forest ecosystems. The final maps show ecological vegetation classes at 1:100 000 scale, with detailed mapping of vegetation complexes at 1:50 000 scale.

Approximately 1.8 million ha (44%) of the West Australian regional forest agreement region is private land, of which 303 000 ha is forest (refer table below). Most of that is in small remnants, with 91% less than 15 ha. This compares with a public forest estate of more than 2 million ha.

Landowner intent

Landowners' intent was assessed in the Tasmanian and northern New South Wales regional forest agreement regions. The Tasmanian model is used as part of the regular forest inventory and updated every five years whereas the northern New South Wales assessment was specific to the regional forest agreement. Assessment of management intent becomes an important part of the planning program for long-term understanding of timber supply levels and should be an integral component of any private native forest inventory.

Table 4 Private and public native forest within RFA regions ('000 ha)

CRA region	Total area	Public native forest ecosystems	Private native forest ecosystems	Private proportion of total forest estate
New South Wales				
South-east	809	408	125	23%
Upper north-east	3 391	972	1 193	55%
Lower north-east	5 288	1 739	1 435	45%
Southern	4 491	1 620	819	34%
South-east Queensland	6 086	1 507	1 191	44%
Tasmania	6 625	2 262	943	29%
Victoria				
Central Highlands	1 130	585	107	15%
East Gippsland	1 217	966	63	6%
Gippsland	2 676	1 235	178	13%
North-east	2 318	1 052	174	14%
West	5 762	714	247	26%
Western Australia	4 136	1 932	303	14%
Totals	43 929	14 531	6 778	32%

1. Forest is 'a vegetation type dominated by woody vegetation having a mature or potentially mature height exceeding 5 m, with overstorey canopy cover >20%'.
2. Source: Ryan et al. (2002).

Table 5 Private and leasehold forest² within and outside RFA regions ('000 ha)

	Closed forest	Open forest	Woodland	Total
Within regional forest agreement regions				
Privately managed forest	238	5 961	2 407	8 606
Outside regional forest agreement regions				
Private forest	1 201	10 164	22 043	33 408
Leasehold	532	4 219	61 352	66 103
Totals				
Privately managed ¹	1 971	20 343	85 882	108 117
Public	2 656	18 832	26 231	48 760
All forest	4 627	39 175	112 033	156 877
% privately managed ¹	42	52	77	69

Sources: National Forest Inventory database (2000), and McElhinny (2000).

Notes:

1. Privately managed forests includes private ownership and privately leased public land.
2. Areas are based on 1998 data.

Other private native forest inventory projects

New England region

A private native forests inventory was undertaken of the Southern New England Tablelands region and a report published in 2001 (McDonald and Brandis 2001). The work was commissioned by the New England-North West Regional Development Board and was done by Paul Macdonald (Jether Enterprises Pty. Ltd.) and John Brandis, private native forests adviser to the board.

The study area was private land within approximately 100 km of Walcha, and included five local government areas—Armidale-Dumaresq, Nundle, Parry, Uralla and Walcha.

Landsat data was used to create images for each of the 1:25 000 map sheets that covered the study areas and tenure layers were added. The forest areas down to 20 ha in size were mapped onto those map sheets from aerial photographs using the then Department of Land and Water Conservation's geographic information system. Rural residential subdivisions less than 25 ha were excluded.

Each area was classified into main tree species group and an indicative growth rate ranging from 1.0 to 4.5 m³/ha/year was applied to estimate potential timber production. Silvicultural condition was classified into three classes: P (unlikely to yield commercial timber); M (some silvicultural practice applied); G (good silvicultural practice applied; full productivity can be expected).

The total area of private native forest found was 297 000 ha, which is 22% of total land area in the five local government areas. Only about half of that forest area, an estimated 154 000 ha gross area, was considered to have any potential for commercial timber production.

North coast New South Wales

An inventory of the private native forests and plantations in the north coast region of New South Wales was undertaken in 1994 (Northern New South Wales Forestry Services, 1994). That study was updated in 2002. In both cases, the work was done by Northern New South Wales Forestry Services. Northern Rivers Private Forestry undertook a further update in 2005. The purposes of these studies include providing estimates of potential timber yield.

The 2002 study covered local government areas from Tweed in the north to Bellingen in the south and included Ballina, Byron, Coffs Harbour City, Copmanhurst, Dumaresq, Grafton City, Guyra, Kyogle, Lismore, Maclean, Pristine Waters, Richmond Valley, Severn, Tenterfield and Tweed. Private native forests were found to cover approximately 631 000 ha within those local government areas and the area potentially available for timber harvesting was estimated at approximately 363 000 ha.

Forests in the study area were mapped at 1:25 000 scale and gross, productive, and net productive areas were identified. Eleven broad forest types based on dominant species and high, medium and low site quality classes were used. Potential timber yields were predicted by using an indicative growth rate for each forest type and site quality combination. These rates ranged from 1.0 to 4.5 m³/ha/year. Sawlog and pulpwood yields were then estimated by assuming proportions for each forest type and site quality combination. Local timber industry knowledge was used to ensure that the estimates used reflected local conditions. This approach to timber yield assessment does not allow for stand age, structure or previous logging but gives a guide to the general level of potential long term yields.

Mid north coast New South Wales

A similar project to that undertaken for the north coast region was undertaken in 1996. The study area covered the local government areas of Hastings, Great Lakes, Gloucester, Dungog and Greater Taree City.

Private native forests were found to cover 358 690 ha and the net productive area potentially available for timber harvesting was estimated at approximately 238 600 ha. Mapping and potential timber assessments were undertaken by the same approaches used for the north coast 2002 study.

South-east Queensland

This project was undertaken by MBaC Consulting Pty. Ltd. for the Department of Agriculture Fisheries and Forestry and Timber Queensland and was completed in November 2003 (MBaC 2003a). The south-east Queensland region extends from the New South Wales – Queensland border, to near Gladstone in the north-east and Toowoomba in the south-west, a total area of 6.2 million ha. An inventory method was required to achieve an effective and statistically valid estimate at reasonable cost for an extensive, relatively low value resource. A model-based method was used to achieve this goal with the development of simple models relating limited ground data to remotely sensed data and using these relationships to extrapolate to the entire project area on remotely sensed data alone.

Key points:

- These forests provide biodiversity conservation, protection of riparian zones, aesthetic values, minor forest produce and grazing.
- Of the 1.37 million ha of private native forest, approximately 750 000 ha were considered commercial.
- The estimated timber volume was 46 million m³. That volume was comprised of 5.4 million m³ of conventional sawlogs (1.4 million m³ compulsory, 3.4 million m³ optional and 0.8 million m³ posts and piles) and 9.7 million m³ of fencing timbers.
- Approximately 640 000 ha contained minimum merchantable volumes of > 5 m³/ha. This consisted of 5.1 million m³ comprised of compulsory sawlogs (1.25 m³/ha), optional sawlogs (3.05 m³/ha) and posts and piles (0.7 m³/ha).

- Approximately 280 000 ha contained what the timber industry often refers to as the minimum viable commercial volume being the equivalent of about 2 m³/ha compulsory standard sawlogs equating to 8 million m³/ha conventional sawlog volume or 2.8 million m³ standing timber.
- The potential impact of conservation requirements would reduce the availability of conventional volume by 114 000–286 000 m³.
- Annual growth in conventional volume was estimated to be about 100 000 m³/year (70% compulsory, 20% optional, 10% pole/pile) and total volume growth of about 800 000 m³/year.
- The main determinant of resource availability was landowners' inclination to sell timber from their land. If 90% of landowners are interested in harvesting timber then this would equate to 4.5 million m³ being potentially available but at 50% this would be only 2.4 million m³.

A range of scenarios was developed to assess various timber product standards and resource availability resulting from landholder access and from addressing conservation priorities.

Western Hardwoods Region, Queensland

This project was undertaken by MBaC Consulting Pty. Ltd. for the Department of Agriculture Fisheries and Forestry and Timber Queensland and was completed in December 2003 (MBaC 2003a). This report used the knowledge gained in the South East Queensland Private Native Forest Inventory to provide a cost-effective method for rapidly assessing timber and some environmental values.

The Western Hardwoods Region of Queensland extends from the New South Wales – Queensland border, to near Charters Tower in the north, Charleville in the west and Toowoomba and Gladstone in the east. The total area is 31.5 million ha, of which private native forests cover just 4.4%.

The Statewide Land and Trees Survey (SLATS) Foliage Projected Cover (FPC) dataset, which is derived from LANDSAT 7 data attributed with ground measurements, was used to extrapolate ground information over the region. Regional ecosystem (RE) mapping was used to provide a basis for floristic stratification and describe the bounds of the native forest. The RE mapping recognises groupings of REs into broad vegetation groups, which were a focus for this work.

Access to private land was a major constraint. Sampling sites were selected to target canopy densities, rather than forest types. The result was 32 sample plots covering the 1.54 million ha of remnant and non-remnant, potentially harvestable, accessible, private native forests.

A sample plot of 25 ha (500 m by 500 m) was used. Up to 25 sample points were located in a systematic grid across each plot. The strong correlations between foliage projected cover and total volume and basal area found in the South East Queensland private native forest inventory project were used as the basis for extrapolating sample plot volume to the entire forest area for the Western Hardwoods Region.

Areas are shown in Table 6 below.

Table 6 Private native forests, Western Hardwoods Region, Queensland

Component	Area (ha)
Total land area	31 500 000
Area potential recoverable forest types (calculated from LU) >10% FPC	1 541 908
Assumed micro-steep and environmental retentions (10%)	154 191
Assumed net available area	1 387 717
Remnant	1 211 087
Non remnant	176 630

Total timber volume on the 1.387 million ha was estimated to be 49.5 million m³ ±16% contained, an average of 35.6 m³/ha. Much of that volume is uncommercial. The Method of Assessment of Recoverable Volume of Logs (MARVL) was used to assess reductions to account for estimated internal defects based on external bole characteristics.

Net potential recoverable volume, which includes sawlogs, poles/piles, small rounds and fencing logs, was assessed as 10.8 million m³ or 14.2 m³/ha (±34%). This was comprised of:

- compulsory sawlogs: 0.5 million m³ (±70%)
- optional sawlogs: 3.4 million m³ (±32%)
- poles and piles: 0.4 million m³ (±103%)
- small rounds: 2.7 million m³ (±51%)
- fencing timber 3.8 million m³ (±30%).

Figure 2 Private and leasehold native forests and regional forest agreement regions

