LANDSCAPE LOGIC

LINKING LAND AND WATER MANAGEMENT TO RESOURCE CONDITION TARGETS

Technical Report No. 2

Future developments in native vegetation condition research in Tasmania and Victoria

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LANDSCAPE LOGIC is a research hub under the Commonwealth Environmental Research Facilities scheme, managed by the Department of Environment, Water Heritage and the Arts. It is a partnership between:

- **six regional organisations** – the North Central, North East & Goulburn–Broken Catchment Management Authorities in Victoria and the North, South and Cradle Coast Natural Resource Management organisations in Tasmania;
- **five research institutions** – University of Tasmania, Australian National University, RMIT University, Charles Sturt University and CSIRO; and
- **state land management agencies in Tasmania and Victoria** – the Tasmanian Department of Primary Industries & Water, Forestry Tasmania and the Victorian Department of Sustainability & Environment.

The purpose of Landscape Logic is to work in partnership with regional natural resource managers to develop decision-making approaches that improve the effectiveness of environmental management.

Landscape Logic aims to:

1. Develop better ways to organise existing knowledge and assumptions about links between land management actions and environmental outcomes.
2. Improve our understanding of the links between land management actions and environmental outcomes through historical studies of the effects of private and public investment on water quality and native vegetation condition.

Future developments in native vegetation condition research in Tasmania & Victoria

By Prof Jann Williams, NRM Insights P/L

Summary

Native vegetation condition has been identified as a high priority by the natural resource management, government and research partners of Landscape Logic, a national research hub funded through the CERF program (Commonwealth Environment Research Facilities). In Victoria, native vegetation condition is the major focus of landscape research in Landscape Logic and is of significant interest for the Hub's research program in Tasmania. To help ensure that the present investment in native vegetation research builds on, complements and benefits from existing and recent research relating to native vegetation in south east Australia, Landscape Logic held a workshop on native vegetation condition on 18–19 October 2007 in Burnie, Tasmania at the Cradle Coast Campus of the University of Tasmania.

The aims of the Landscape Logic workshop were to:

- Discuss recent research relevant to the assessment, monitoring and modelling condition of native vegetation condition in south-east Australia
- Identify the major research issues and gaps in knowledge for future research on native vegetation condition in Tasmania
- Identify and discuss opportunities to strengthen collaboration and integration of approaches across the region
- Identify the most appropriate future role for Landscape Logic to contribute towards an improved ability to assess and monitor native vegetation condition.

Acronyms

AGO	Australian Greenhouse Office
ARI	Arthur Rylah Institute (Victorian Government)
BRS	Bureau of Rural Sciences (Australian Government)
CERF	Commonwealth Environmental Research Facilities programme
COAG	Council of Australian Governments
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DEM	Digital Elevation Model
DEW	Department of Environment and Water (Australian Government)
DPIW	Department of Primary Industries and Water (Tasmania)
DSE	Department of Sustainability and Environment (Victoria)
EPBC Act	Environmental Protection and Biodiversity Conservation Act 1999
ERIN	Environmental Resources Information Network
ESCAVI	Executive Steering Committee for Australian Vegetation Information
ESP	Environment Stewardship Program
GAM	Generalised Additive Model
GIS	Geographic Information System
GLM	Generalised Linear Model
GPS	Global Positioning System
IBRA	Interim Biogeographic Regionalisation of Australia
LIDAR	Light Detection And Ranging
LTER	Long-term Ecological Research
MBIs	Market-based instruments
MfT	Matter for Target
NDVI	Normalised Difference Vegetation Index
NHT	Natural Heritage Trust
NLWRA	National Land and Water Resources Audit
NM&EF	National Monitoring and Evaluation Framework
NRM	Natural Resource Management
NRPCC	Natural Resources Programs Coordinating Committee
PWS	Parks and Wildlife Service
QA	Quality Assurance
RMIT	Royal Melbourne Institute of Technology University
SoFR	State of Forest Reporting
SoE	State of the Environment
VAST	Vegetation Assets States and Transitions
VCA	Vegetation Condition Assessment

Introduction

Ten spoken presentations were delivered over the workshop spanning policy, technical and operational issues associated with the assessment, monitoring and modelling of native vegetation condition. The content of these presentations is summarised in this report. Break-out groups provided a basis for additional discourse and integration of the science.

Several important themes arose during the workshop presentations:

Vegetation condition – fit for purpose

Fit for purpose/context/range of approaches: the need to be explicit about the purpose for which native vegetation condition is being assessed and/or monitored was a common and strong theme throughout the workshop presentations and discussions. Native vegetation condition may be assessed and monitored for many different purposes and it is essential to be clear about the purpose as this will determine or strongly influence the field methods employed.

Assessment/monitoring/reporting: the differences between field methods used for assessing native vegetation condition were noted by a number of speakers. While flexibility in methods is required to accommodate different management needs, several speakers noted the opportunity for greater integration of approaches. Currently, regional organisations in Victorian and Tasmania undertake the assessment and reporting of vegetation condition, but not monitoring. At the moment it is not possible to examine the drivers of change in vegetation condition with confidence.

Tools, techniques, data and site selection

- The potential to identify a core set of attributes that could be used to answer a number of key questions about native vegetation condition was raised often. Data management/quality/metadata/spatial data: several inter-related issues were raised in relation to data collection, management and storage. A need to move away from categories to quantitative data was identified, as well as the value of biological response indicators. The ability to monitor changes over time was identified as an area for further research.
- Site selection/networks (i.e. LTER): systematic and stratified selection of sites for vegetation condition assessment and monitoring will increase the value of the data collected. The lack of long-term monitoring data was identified as a gap in knowledge. It was suggested that at least one LTER site, in addition to the Warra LTER, could be warranted in Tasmania.
- Benchmarking is a critical component of vegetation condition approaches and should capture a full range of conditions.
- Modelling techniques such as VAST and statewide condition modelling were recognised as important tool to evaluate native vegetation condition.

Roles, responsibilities and partnerships

- Frameworks were presented on roles and responsibilities for R&D – it was felt that a framework was necessary for identifying who should do what, when and how and helped prioritise research and investment.
- Top-down and bottom-up: the need was identified to develop ways to integrate both top-down (intervention based on asset values and spatial priorities) and bottom-up approaches to vegetation condition (implementation options based on incentive levels and potential site-level changes).
- Partnerships, collaboration and integration: a number of government and non-government organisations were represented at the workshop and participants agreed that it was important for these groups to build and maintain linkages and share data and ideas on vegetation condition assessment and monitoring.
- (Realistic) expectations are needed: for example which Management Action Targets and Resource Condition Targets in regional NRM strategies can realistically be reported on; the limitations of these approaches need to be recognised. It's possible that the scientific rigour for reporting vegetation condition has been oversold.

Documentation and story-telling

The importance of documentation

Recording how different techniques were developed and used is important, such as in the guidelines developed for the Tasmanian Vegetation Condition Assessment (VCA) and the documentation underpinning VAST models.

Telling a story

Several presenters referred to the need to tell a good story when it comes to vegetation condition. This doesn't mean that only vegetation in good condition is referred to, but refers to the importance of having good data and analysis to support 'stories' about vegetation condition.

An important reminder arising from the meeting was that ''not one-size fits all when it comes to

technical approaches for assessing and monitoring native vegetation condition''. Rather, it is essential to clarify for what purpose vegetation condition is being assessed or monitored. There was agreement that different purposes required different approaches, whether that be on-ground data collection at varying levels of detail, modelling, remote sensing or a combination of techniques. A high degree of consensus, momentum and positivism was developed at the workshop. Identifying mechanisms for continued collaboration of the workshop participants was seen as an essential next step through mechanisms such as a dedicated website or working group.

An opportunity exists to use Landscape Logic as a vehicle to move vegetation condition research forward following the workshop. If a commonly agreed strategy for assessing, monitoring and reporting on native vegetation condition was developed and put to funding and management agencies, greater support and investment in native vegetation condition science and management was considered possible.

Actions from the workshop

- Identify the major research issues and gaps in knowledge for future research on native vegetation condition in Tasmania
- Identify and discuss opportunities to strengthen collaboration and integration of approaches across the region
- Identify the most appropriate future role for Landscape Logic to contribute towards an improved ability to assess and monitor native vegetation condition.

Background

The conservation and sustainable management of native vegetation is vital for safe guarding biological diversity and maintaining landscape processes and ecosystem services at a range of temporal and spatial scales (Doneley et al. 2005; Williams 2005). During the past decade, governments and the research community have invested in developing methods to assess and model the condition of native vegetation to support conservation and management goals (NLWRA 2001; Harris and Kitchener 2005; Michaels 2006; Parkes and Lyon 2006). This is particularly important in southern Australia and Tasmania where the nature and rate of land-use change is increasing due to factors like drought, climate change and restructuring in the agricultural sector (Barr 2004; Broad & Norton 2007).

Native vegetation has been identified as a high priority by the natural resource management, government and research partners of Landscape Logic, a national research hub funded through the Commonwealth Environment Research Facility (www.landscapelogic.org.au). In Victoria, native vegetation is the major focus of landscape research in Landscape Logic and is of significant interest for it's research program in Tasmania. To help ensure that the present investment in native vegetation research builds on, complements and benefits from existing and recent research relating to native vegetation in south-east Australia, Landscape Logic held a workshop on native vegetation condition on 18–19 October 2007 in Tasmania. In addition to this workshop report, a scientific paper on the key themes arising from the workshop will be published.

Workshop report

This report summarises the key outcomes of a one and a half day workshop entitled Futures for Native Vegetation Condition Research in Tasmania and Victoria. The workshop was held in Burnie, Tasmania at the Cradle Coast Campus of the University of Tasmania (UTAS). The meeting was convened by the Landscape Logic Spatial Analysis project team at UTAS and RMIT, led by Professor Tony Norton, and with assistance from Dr Kerry Bridle of the Tasmanian Institute of Agricultural Research (TIAR) at UTAS.

The workshop bought together some of Australia's leading experts on the management of native vegetation (see Appendix 1) to discuss current understanding of the condition (or health) of native vegetation in Tasmania and Victoria. It included catchment land and resource managers from Tasmania and Victoria, state and Australian government vegetation scientists and Landscape Logic researchers. Scientific methods to assess and monitor the health of vegetation across south-east Australia and new research required to help ensure that native vegetation is managed on a sustainable basis were the focus of discussion.

This report was prepared by Professor Jann Williams (NRM Insights Pty Ltd) for Landscape Logic.

Workshop aims

The aims of the Landscape Logic workshop were to:

- Discuss recent research relating to the assessment, monitoring and modelling condition of native vegetation in Tasmania and south-east Australia
- Consider the major research issues and gaps in knowledge as a basis to inform future research on native vegetation condition in Tasmania
- Identify and discuss opportunities to strengthen collaboration and integration of approaches across the region
- Consider the most appropriate future role for Landscape Logic.

[For workshop program, see Appendix 2.]

Report structure

This report is presented in four sections:

Section 1 provides a summary of the speakers who presented on the afternoon of the first day of the workshop and the morning of the second day

Section 2 presents the key points from the deliberations of four break-out groups that were presented to the workshop as a whole

Section 3 synthesises the emerging themes that arose from the workshop presentations, discussions, break-out groups and the final comments made by each participant

Section 4 presents key conclusions and agreed actions by participants for further consideration by Landscape Logic and its partners.

Section 1 – Summary of presentations to the workshop

DAY 1

Scaling up: Challenges to the assessment and monitoring of vegetation condition at a landscape level – Dr Andre Zerger (CSIRO Sustainable Ecosystems) and Associate Professor Simon Jones (RMIT University)

Andre Zerger and Simon Jones discussed predictive modelling and remote-sensing techniques used to scale up native vegetation condition information from the site to landscape scale. In order to determine which of these techniques are the most useful for scaling up site-level data on vegetation condition, some questions need to be answered. The first question relates to the purpose of the vegetation condition assessment to be undertaken and what the scaling up is to be used for.

Andre noted that while there was a relatively good understanding of vegetation extent and type at multiple scales, vegetation condition primarily was site-based and had a relatively limited temporal component.

The key messages on native vegetation condition that were outlined in the 2006 special issue of the *Journal Ecological Management and Restoration* (Volume 7, Supplement 1) were still felt to be important and relevant to policy. Vegetation condition information can be used for several purposes including priority setting for new conservation and management investments, regional monitoring and adaptive management. Currently, the purposes for which vegetation condition is measured are largely aspirational. There is limited research activity at the national level on scaling up information on vegetation condition using remote sensing or predictive modelling techniques.

Modelling vegetation condition at a catchment scale

Andre reported on a CSIRO/DECC research project recently completed in the Murray Catchment in NSW, which used predictive modelling to address the question of scaling up site-based measures of vegetation condition. Graeme Newell and others, who contributed to the Burnie workshop (see summary below), are also using predictive models to scale-up vegetation condition assessments in Victoria. In the NSW catchment, a comparison of the predictive ability of SPOT5 and Landsat data was made using statistical models (GAM/GLM) and GIS (spatial modelling predictions).

The goal was to test how well the 10 or so attributes of the biometrics assessment tool, as well as the final score, could be predicted using this approach.

The ability to predict the final biometric score was limited for both Landsat and SPOT5, with r^2 values of 0.2 and 0.24, respectively. Andre demonstrated that some individuals attributes faired better, with exotic plants having an r^2 of 0.5 and 0.54 for Landsat and SPOT5, respectively. For native grasses, which had similar r^2 values, NDVI, elevation and vegetation cover were the three best predictors. The project concluded that there was limited gain in using the more expensive SPOT5 data compared to Landsat. A comparison of the price of SPOT5 and Landsat data for two 100:000 map sheets illustrated the difference in cost. SPOT5 data would cost around $30,000 compared to around $1500 for Landsat imagery. Andre indicated that the vegetation condition maps that were generated by the project should be used as 'baseline' maps rather than for monitoring, especially given the high dependency of the model on static surrogates of vegetation condition such as topography.

There was some ability to transfer the results from the Murray catchment to other areas, but the conclusions were generally site specific. While remote sensing is central to the scaling-up challenge, Andre identified seasonality as a major limitation. The potential to use time series satellite imagery could help address this issue. Developing a better regional understanding of disturbance and land management practices across the landscape is also required to better predict vegetation condition and changes in condition over time.

Andre closed his presentation by asking 'What is the purpose of scaling up?'. This question is not unique to native vegetation condition, but also applies to approaches aimed at characterising, monitoring and managing vegetation extent and salinity. Andre illustrated this question with a graph that examined the trade-offs between accuracy and precision on the one hand, and scale on the other. Depending on the purpose of measuring vegetation condition, whether it be property vegetation planning or spatial priority setting, the optimal scale of the measurement and level of accuracy and precision will vary. While in the future it may be possible to increase the level of scaling up, Andre noted that the gains in precision and accuracy are not likely to be great. Whatever the purpose for measuring vegetation condition, deciding where the sites will be located and what will be measured at the site are key questions to be answered. Scaling up may not be required for all vegetation condition assessments. If it is important, then consideration should be given to the accuracy required of the modelling techniques.

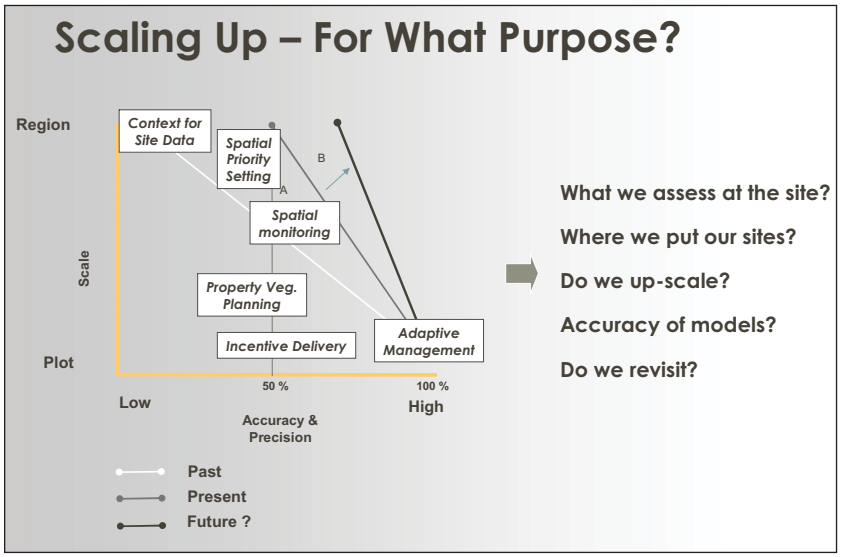


Figure 2. Scaling up – for what purpose? Reproduced from the presentation by Dr Andre Zerger and A. Prof Simon Jones.

Application of remote sensing for vegetation condition assessment

Simon Jones provided a focus on remote sensing technologies for native vegetation condition assessment, the quality of spatial data and ground sampling protocols. He summarised the level of interest in remote sensing for vegetation condition assessment in Australia, noting that it is important to consider who does what (Table 1).

Table 1. Interest in remote sensing of Australian native vegetation from stakeholders. Reproduced from presentation by Dr Andre Zerger & A. Prof. Simon Jones.

Task	CMOs	State govt	Science community	International protocols	NGOs
Mapping	Some	yes	Some	rare	Some
Monitoring	Yes	yes	Some	yes	Yes
Validation	Some	some	Yes	increasingly	No

Remote sensing data are both multi-spatial and multi-spectral. There are a number of biophysical variables that can be collected using remote sensing. Some of the most important data that should be measured, such as canopy multi-spectral reflectance (nadir or bi-directional) and leaf spectra (reflectance and transmittance) are not currently recorded, with the focus instead on measures such as meteorological data.

Simon described the two main passive remote sensing systems – synoptic sensing systems and high spatial resolution satellite sensors. The former sensors are owned by space agencies and data are relatively inexpensive to purchase (e.g. MODIS data) compared to data for the latter sensors are owned by the private sector.

LIDAR (Light Detection And Ranging) is a different type of sensor, being active and recorded using a low flying aeroplane. It is an expensive technology, which is useful in some contexts and for some purposes. Landscape Logic undertook a full wave-form survey of native vegetation in Tasmania in February 2007 which is probably the first of it's kind in Australia. Because LIDAR collects X, Y and Z coordinates and uses individual point returns, it is possible to correlate the signals to structural attributes of native vegetation and develop three-dimensional images.

On the topic of data quality ground and image data, Simon presented the 'Big 5' spatial data quality parameters that link to the ISO 19115 standards. The most important parameters, based on work by Sheffield *et al.* (2006) are positional accuracy, attribute accuracy, logical consistency, completeness and lineage (Figure 3). These parameters have led to the development of a ground-sampling protocol with a 20 x 50m plot size, which incorporates a 20 x 20m quadrat and a 50m transect (Figure 4).

Simon concluded by presenting a vision for an integrated vegetation condition monitoring strategy. The ideas presented drew from a paper in preparation (Lowell *et al.* 2007) and proposed different

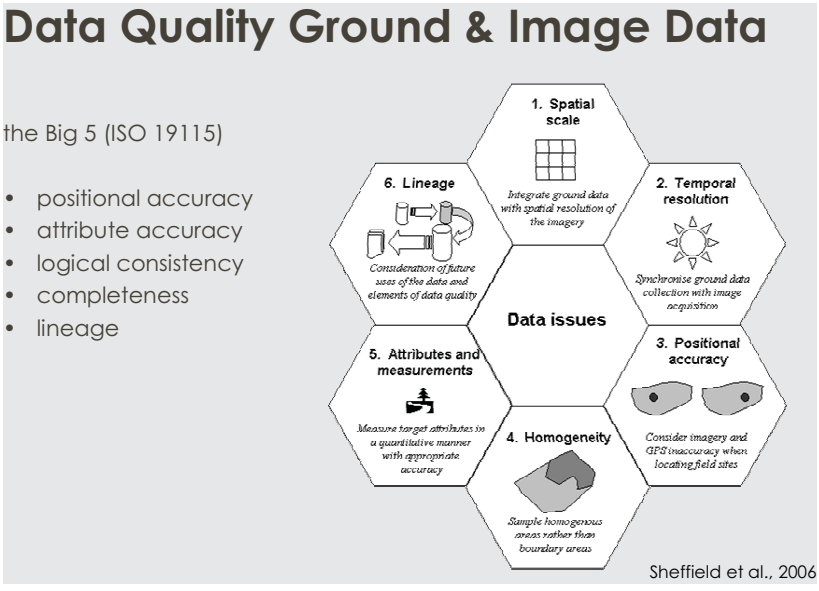
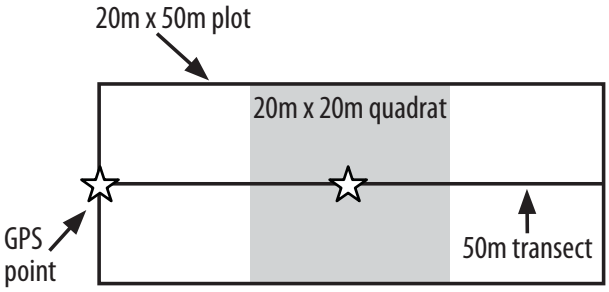


Figure 3. Five key elements of data quality. Reproduced from presentation by A/Prof. Simon Jones.

Figure 4. Ground-sampling protocol based on Gibbons et al. (2005) that was used to assist in characterising vegetation condition by Kathryn Sheffield – a PhD scholar with Landscape Logic. From the presentation by A/Prof. Simon Jones.



types of monitoring depending on the measurement purpose.

- Level 1 involves changes in major vegetation formations
- Level 2 identifies causal factors of change
- Level 3 provides for value judgments about the relative condition of native vegetation.

A potential approach for reporting the state of native vegetation condition was outlined that could involve a ''report card'' approach to summarise the results of the monitoring and trends. An inverted pyramid was presented to demonstrate the outcomes expected from the three levels of measurement purpose, what vegetation condition assessment approach could be used and where the relevant information could be acquired.

DAY 2

Introduction – Prof. Tony Norton (University of Tasmania)

Tony gave a brief introduction to the Landscape Logic website and the GIS/mapping tools that will be available to registered users of the website over the life of the research hub. The Victorian component of the new, on-line mapping tool was fully operational at the time of the workshop and the Tasmanian component will be operational shortly. He then went on to illustrate the range of GIS databases available for Tasmania that include climate surfaces, agricultural land use, and fine-scale hydrology. A number of data layers on native vegetation are available through the TASVEG coverage, including vegetation community type and extent, and threatened forest and non-forest vegetation.

To inform the development of the third regional investment program in Tasmania, as part of NHT 3, James Shaddock, Dr Bill Cotching and Tony Norton undertook an analysis of a number of variables across the state including native vegetation extent.

Only one catchment near Burnie currently supports less than 30% native vegetation by area. The story is different at the sub-catchment level, with a number of regions having less than 30% native vegetation and some less than 10% (Figure 5).

Using the Bureau of Rural Sciences digital information on agricultural land, it is possible to examine the extent of native vegetation on agricultural lands in Tasmania. Many areas of native vegetation appear under threat from the increasing intensification of land use (Broad and Norton 2007).

An important message from the presentation is the relatively small size and patchiness of remaining vegetation on agricultural land – approximately 5000 patches less than 25 hectares in size have been mapped. Silviculture is widespread, both through plantation establishment and native forest logging. These patterns are a legacy of past and current land use.

GIS layers are also available on wetland vegetation through the Tasmanian CFEV database and high priority wetlands have been mapped using this approach. These data have enabled comparisons between sub-catchments that support intensive land uses that may further threaten wetland vegetation.

Tony concluded that Tasmania is fortunate in having a range of GIS biophysical data-sets capable of informing the management of natural resources and native vegetation.

These data-sets need to be maintained and updated, and key information gaps filled. For example, maintaining and up-dating the TASVEG coverage on a regular basis is essential. Adding robust measurements of vegetation condition at landscape and regional scales would add significantly to these Tasmanian data-sets and enhance the opportunity for the conservation and sustainable use of vegetation.

State of play in Tasmania and research challenges – Dr Anne Kitchener, Dr Karyl Michaels, Dr Louise Mendel and Dr Louise Gilfedder (Tasmanian DPIW); Dr Neil Davidson (University of Tasmania).

This multi-author presentation gave an overview of the state of native vegetation condition activities in Tasmania. The DPIW component covered the business drivers and history of vegetation condition reporting in the agency, the development and implementation of the Vegetation Condition Assessment (VCA) methodology, the application of the VCA for monitoring in the Tasmanian Private Reserve System, and challenge and gaps. Neil Davidson spoke about the differences between data collected for reporting and monitoring vegetation condition, using research undertaken on remnants in eucalypt plantations as an example.

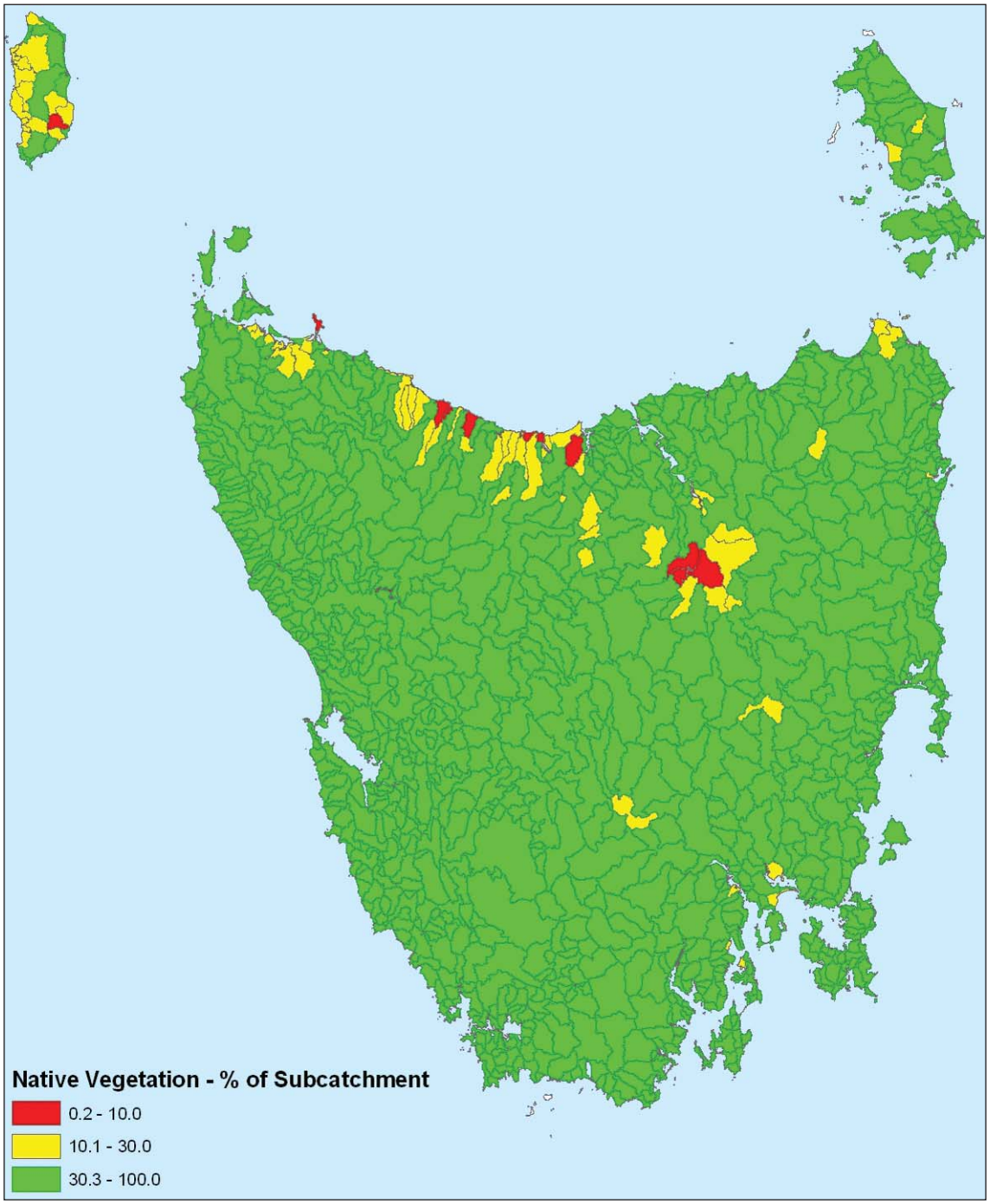


Figure 5. Extent of native vegetation by Tasmanian sub-catchment (red <10%, yellow 10-30%, green >30% by area).

Tasmanian context for assessing vegetation condition

Anne Kitchener noted that there are many reasons for assessing native vegetation condition in Tasmania:

- To inform natural resource management decisions
- To assess the effectiveness of NRM activities
- To make links between management and NRM outcomes
- To enable vegetation managers to assess the direction of change in the condition of their bush, and
- To meet state and national monitoring and evaluation reporting requirements.

Anne set the context for the Tasmanian presentations by describing where vegetation condition sat within the State and Territory, and national scene. The DPIW 2007–2008 Corporate Plan identifies the capture of quality land and water information as a priority (no. 5). The plan indicates that DPIW will work with regional NRM committees on joint initiatives to monitor and report on the condition of Tasmania's natural resources and implement a comprehensive vegetation mapping program that includes mapping vegetation condition and extent.

At present, there is no strategy in place in DPIW for measuring vegetation condition. This is related

to the status of the indicators for vegetation condition at the national level. Native vegetation condition is the proposed indicator for the Matter for Target (MfT) on 'Native Vegetation Communities Integrity', but has yet to be recommended by the National Coordination Committee, or endorsed by the Audit Advisory Council. This is in contrast to 'Vegetation Extent', which has AAC endorsement.

At the Tasmanian state level, legislative requirements to report on vegetation condition and extent currently exist under the *Resource Planning and Development Commission Act of 1997*. Tasmania Together has an indicator on the per cent of Tasmania covered by native vegetation, to meet the goal of the sustainable management of natural resources. From 2008, the Tasmanian State of the Environment (SoE) Report will require reporting on the extent and condition of a number of vegetation communities. These indicators are more flexible, in line with the Australian SoE report. Currently, DPIW is unable to fully report on vegetation condition or the Tasmania Together target related to the area of land covered by sustainably managed native vegetation.

Historical vegetation condition reporting by DPIW has focused on forest mapping through the Regional Forest Agreement process and more recently, across all vegetation types, using TASVEG. The condition attribute in TASVEG, which had three ratings, from poor to excellent, and an additional 'unknown' category, was abandoned early on because of the question 'condition for what?'. Information is collected on disturbance attributes at a polygon level for TASVEG but these are not populated consistently.

Vegetation condition benchmarks and assessment tools

Karyl Michaels described the development of benchmarks and a vegetation condition assessment tool in Tasmania. The Commonwealth government working group on native vegetation, ESCAVI, suggested that the approach to measuring native vegetation condition should use a common conceptual basis (an agreed frame of reference), use a consistent and quantified approach to acquiring and using information on the condition of native vegetation, and be clearly focused on where the condition (current and trend) requires attention. In the Tasmanian context, the benchmarks developed under TASVEG, and the Vegetation Condition Assessment (VCA) process, meet the first two points.

The aim of the Tasmanian benchmarks project was to set condition benchmarks and establish a monitoring methodology for the assessment and monitoring of native vegetation condition in Tasmania. The key outcomes were a methodology for assessing vegetation condition, which was aimed at NRM personnel and farmers; benchmarks to provide a reference point for condition assessment and a manual (guidelines to conducting vegetation condition assessments). The method is consistent and reliable, and allows an examination of changes and trends.

The benchmarks and condition assessment tool (VCA) were completed two years ago and are based on the Habitat Hectares approach, with some changes made to the way non-forest vegetation was assessed (Figures 6 and 7). Site components are scored against the 'benchmark' value for the same vegetation community. The method is not plot-based, although site location details are recorded. Benchmarks are based on the vegetation communities in TASVEG, with regional variants. Vegetation scientists had input into their development through a workshop process. Numerous training sessions have been held to build capacity in the use of the VCA. The variation in observer bias is consistent with that found in other methods – 93% of those trained were confident to use the technique in the field with practice.

Figure 6. Setting benchmarks for vegetation condition in Tasmania. Reproduced from the presentation by Dr Karyl Michaels.

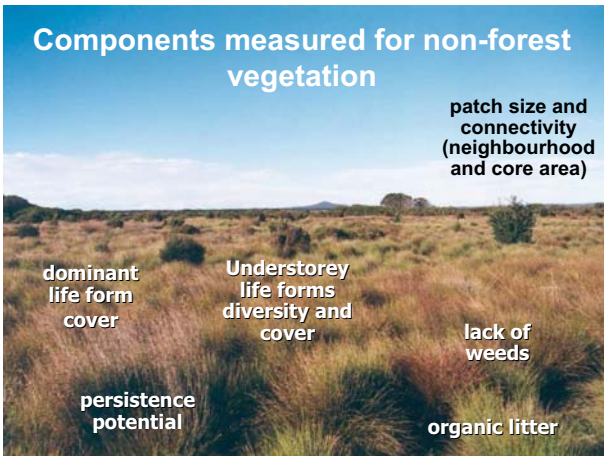


Figure 7. Components measured in assessing for non-forest vegetation condition in Tasmania. Reproduced from the presentation by Dr Karyl Michaels.

A second project on establishing base-line data is due to finish in 2007. The objective is to develop and commence implementation of a strategy to assess and monitor vegetation condition across the three Tasmanian NRM regions. Fifteen monitoring sites are being set up in each region, based on issues relevant to that area such as track management in the Arthur-Pieman area. NRM regions are not resourced to collect extra data on vegetation condition, so the cost of undertaking such assessments should be accommodated in future NRM investment planning.

DPIW is committed to maintaining and storing condition data, most likely as part of the Natural Values Atlas. This will happen in the future, with service level agreements being signed with NRM regions to enable regional data to be stored centrally.

Private land conservation – an example of vegetation condition assessment

Karyl Michaels' presentation focused on the use of the VCA by NRM regions and groups. The main user of the approach is currently the State government through their private land conservation program. This was the focus of Louise Mendel's presentation.

Louise indicated that in Tasmania there are over

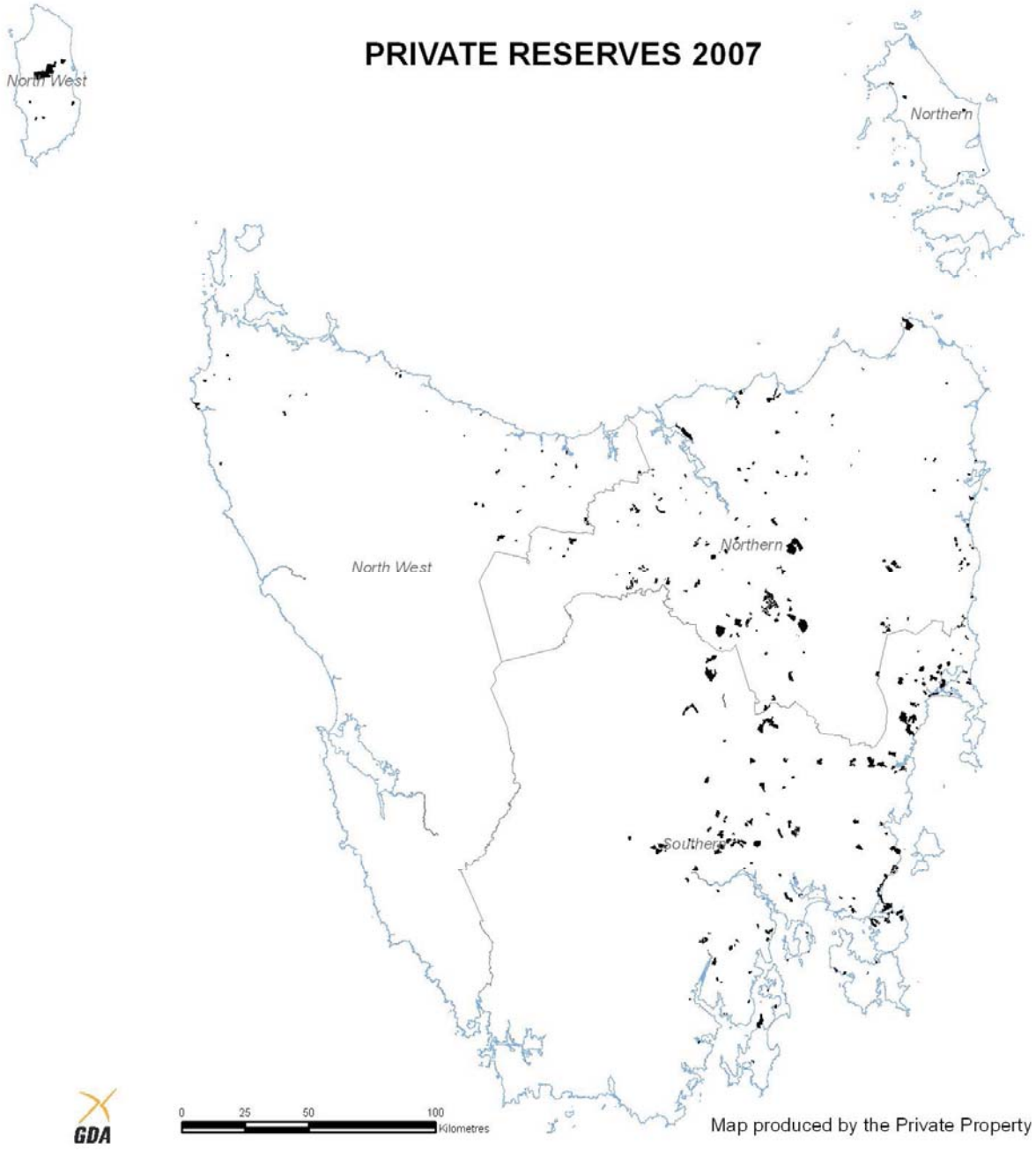


Figure 8. Distribution of private forest reserves in Tasmania. Reproduced from the presentation by Dr Louise Mendel.

350 conservation agreements, consisting of covenants and vegetation management agreements (Figure 8). Ninety-five per cent have been created through covenanting processes, mostly in perpetuity. A few of the management agreements are around 12 years old. Twenty-three blocks have been purchased for conservation and 45,500 hectares reserved. The Private Reserve estate has been created through a number of programs and managed by the Private Land Conservation Program from July 2006. Eighty per cent of the current reserves have been created through the Private Forest Reserve Program, which arose out of the Regional Forest Agreement process. The state has an ongoing responsibility to support these. Significant additional private reserve areas are in progress and negotiation, which could double the current area of reserves on private land.

Private reserves correlate with lowland and agricultural areas, with greater than 18,000 hectares of threatened plant communities in the current estate. One hundred and five threatened plant species have been recorded and 17 threatened fauna species. Dry sclerophyll forest accounts for around 82% of the total area in reserves, with around 4.4% of non-forest vegetation types included (covering grassland, wetland, heath-land, scrub, herb-field, peat-land and salt-marsh communities). The percentage of non-forest vegetation is likely to expand, but not proportionally.

Initially, the Tasmanian government has had a strong focus on creating reserves, then examining ongoing responsibilities. Management prescriptions have been developed for each site using expert input. The vegetation communities reserved in this process are known, but full plant species lists for all sites are not yet available. Some threatened plant species are known, but not all. Louise indicated that in January 2005 a Stewardship and Monitoring Program was established in Tasmania. The VCA was used to gain baseline data and for ongoing monitoring of reserves (Level 1 monitoring). Over 340 VCAs have been conducted in more than 100 reserves. An Access database and GIS were used to store and display data, with both VCA scores and raw data recorded. Analysis of the VCA data will help understand the ''state of the reserve system'' and inform further monitoring activities and reserve management.

The VCA information is reported back to the landowners. Louise emphasised that management of the private forest reserve estate is not just about vegetation, it is also about people. The landowners have many different needs and expectations, some very demanding, other less so.

A number of benefits of using VCAs in Tasmania were identified as the final part of Louise's presentation:

- VCAs provide a consistent method for a range of vegetation types
- They also provide baseline data on vegetation condition in individual reserves and across the private reserve estate
- It gives a method that can be used for ongoing monitoring, although only time will tell how useful the current VCAs will be. The usefulness will depend on the purpose the VCA has been designed for
- VCAs allow identification of issues and threats. For example, a lack of adequate regeneration (which is fairly common) or the presence of weeds
- They are aligned with state and national developments in vegetation condition
- A data set is being built that can feed into broader regional, state-wide and national vegetation condition studies.

Research gaps and challenges for vegetation condition assessment and monitoring

The final section of the DPIW presentation was on research gaps and challenges. This was prepared by Louise Gilfedder and delivered by Louise Mendel in her absence.

The first gap identified was the need to access plot-based data on vegetation condition from a range of land tenures, to use as an input to model vegetation condition across the state. A central repository for vegetation condition is being developed by DPIW, which will include records from a range of state agencies. It makes sense to add vegetation condition measurements from other projects in Tasmania to this database, for example from NRM regions and the University. Identifying who will capture the data and how it will be done needs to be determined.

The next challenge centred on how vegetation condition data can be scaled up from the site/patch scale to the regional, landscape and state scale, especially given the lack of a framework for monitoring sites state-wide.

A need was identified to monitor the reserve system on both public and private land tenures, in the context of monitoring biodiversity and vegetation condition on other land uses. This will allow the question to be addressed whether the trends on private reserves are happening elsewhere, or whether they are related to management.

Three final challenges and gaps were identified for Tasmania by DPIW:

- the need to gather metadata on long-term data on vegetation condition from old PWS and DPIW plots that span 30+ years. Tasmania has one LTER site at Warra in wet sclerophyll forest that is

aligned to the international network. The question was raised whether another one is needed in a different vegetation type such as scrub, wetlands or dry forest. This would help address the limited amount of long-term research in Tasmania.

- the need to be able to test the impact of management practices on biodiversity and ecosystem function. At present this is not possible since suitable measurements are not taken over appropriate time periods. Management prescriptions, such as allowing grazing over the winter months in private reserves, are based on the best information at the time. However, without long-term monitoring, it is not possible to say over what period these rigid prescriptions will be suitable.
- the need to develop a framework for vegetation condition assessment to inform landscape level conservation planning. To date, a landscape level model of biophysical naturalness has been used as a surrogate for disturbance regimes and vegetation condition. Data on biophysical naturalness were collected as part of the Regional Forest Agreement process in Tasmania, but only for forests and the data are limited. The VAST model, developed by BRS was identified as another potential approach to consider. The concept of landscape level conservation planning in DPIW is immature and considerable policy development is required in this area.

Vegetation condition assessment of forests

Neil Davidson continued the presentations on the assessment of vegetation condition in Tasmania, outlining the work he has undertaken for the CRC for Forestry on forest remnants growing in a plantation matrix.

In order to gain certification for wood harvested, plantation companies must demonstrate that the condition of remnants has been maintained or improved over the life of the plantation.

A workshop was held in June 2006 to examine different assessment systems for measuring the condition of native vegetation in plantations. The schemes that were assessed were:

- The Plantation Biodiversity Score from NSW, which takes a landscape approach developed by David Freudenberger (Cawsey and Freudenberger, 2005)
- Habitat hectares from Victoria, which is patch-based
- The remote assessment of health using multi-spectral data, also from NSW developed by Christine Stone (Stone and Simpson, 2006)
- The categorical approach used by Land for Wildlife in WA.

The material presented at Burnie draws on the findings of the 2006 workshop.

In Tasmania, section D3 (Flora and Fauna, p 59) of the Forest Practices Code relates to native forests that mainly occur as remnants. Where this occurs, consideration has to be given to:

- Retention of native forest remnants to aid in the maintenance of local flora and fauna biodiversity and landscape values; and
- *Restoration* of habitat including widening and linking wildlife habitat strips, particularly where species and communities of high conservation significance are known to occur.

The Forest Stewardship Council, which certifies plantation forestry management, has a principle (no. 6.3) on environmental impact that relates to the maintenance, enhancement and restoration of ecological functions and values. This includes genetic, species and ecosystem diversity. The Australian Forestry Standard also includes similar statements.

In order to maintain and improve vegetation condition at a landscape scale, it is important to define what remnant vegetation is. We need to decide what we want the landscape to look like and derive a definition from here. For example, paddock trees are currently not regenerating – is that what we want? The working definition that Neil uses for a remnant is ''paddock trees and areas of forest or non-forest vegetation greater than 2 ha in area or greater than 20% native plant cover''. The 2 ha limit comes from discussions with natural resource management agencies in Tasmania as a minimum size worth spending money on for restoration. It is considered a minimum size for a self sustaining patch for native plant species.

This threshold does not apply to total biodiversity, as different animals and birds have different habitat requirement. For example, living or dead paddock trees have been demonstrated as important stepping stones for birds and mammals (Lindenmayer *et al.* 2005). While edge effects are great for areas less than 2 hectares, they can provide a useful service at the landscape scale. Sites greater than 2 hectares can be self-maintaining if protected, and those greater than 10 hectares with high structural diversity and biodiversity will be in good condition. Overall, remnants that have high structural diversity foster biodiversity. Structural diversity is measured in vegetation assessment systems as a function of CWD (coarse woody debris), the number of dead stags, the diversity of vegetation guilds and age classes, and vegetation boundaries.

Neil identified a range of risks to the condition of remnants and biodiversity management. Edge effects and degradation were at the top of the list. Other risk factors were land clearing, under-storey removal by stock, nutrient enrichment by fertilisers and stock, weed invasion, wood gathering, frequent fire/disturbance and lack of regeneration. Both too

frequent or no disturbance can lead to poor vegetation condition and changes in micro-site conditions can impact on the establishment of native plant seedlings.

When describing assessment systems for vegetation condition, Neil stated that benchmarks are needed for all assessments. Some of the categorical assessments will be adequate for reporting, but more sophisticated approaches are needed for monitoring. The categories used in the techniques developed by David Freudenberger for plantations in NSW and by Ian Oliver (also in NSW) are too large to be used for monitoring purposes.

In contrast, McElhinney *et al.* (2005, 2006) developed 13 key attributes of structural complexity for dry sclerophyll forest in NSW that use quantitative measures for monitoring. These measures include perennial species richness (per 400m2), stand basal area (m2 ha-1), number of dead trees (per ha), total large log length (m ha-1) and litter dry weight (t ha-1).

Neil noted that it is not essential for forest companies to have compatible assessment systems. A wide range of vegetation assessment systems are available that will adequately categorise/score condition in 1–2 hours per site. This information can give an idea about vegetation condition and how to manage remnants, although they do not address the need to maintain disturbance regimes characteristic of different vegetation types. Current approaches to assessment at the landscape scale are incomplete as, for example, they do not consider paddock trees or small patches that can act as stepping stones.

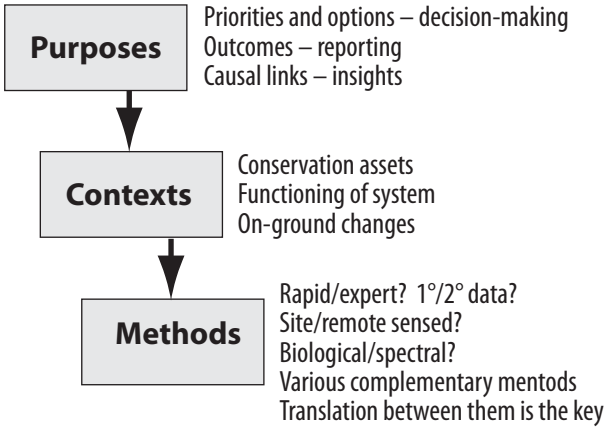
A sub-set of sites needs to be measured in greater detail to monitor sites over time and examine management impacts. Monitoring systems must be detailed and quantitative to demonstrate required outcomes for the plantation industry. These include maintaining the quality of high quality remnants and improving the condition of low quality remnants by improving structural diversity, minimising edge effect and degradation and enhancing regeneration.

A fundamental improvement in data collection is required for monitoring purposes. Data are typically required for at least 3–5 years to assess whether the trajectory of change in vegetation condition is acceptable. This is important for both seeing what the impacts of management practices are, and to meet community expectations.

State of play in Victoria and research challenges – David Parkes (Victorian DSE)

David Parkes started off a series of presentations on vegetation condition assessment and research in Victoria. He set the context for this work by discussing the uses of vegetation condition information for various NRM purposes in the state.

Figure 9. Contextual framework for NRM assessment and monitoring in Victoria. Reproduced from the presentation by Dr David Parkes.



The importance of purpose and context was demonstrated using Figure 9. A key point made by David was that there is not one method that will fit all purposes for which vegetation condition assessment and monitoring is intended. Defining the purpose and context for measuring vegetation condition will help identify the most appropriate approach and methods for the task.

David discussed the increasing trend in NRM investment decision-making to structure logic from the 'top-down' (the blue boxes in Figure 10, below). He emphasised that attention also needs to be paid to the bottom-up approach (the green boxes in Figure 10) and how to get people engaged in such a process. It is important that groups using different methods for assessing vegetation condition can 'speak to each other' – translation is the key.

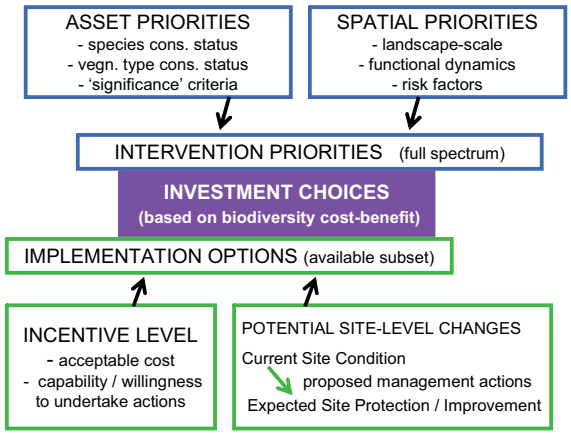


Figure 10. Conceptual framework for vegetation condition assessment and monitoring in Victoria. Reproduced from the presentation by Dr David Parkes.

Pilot studies addressing vegetation condition are being undertaken in Victoria that are using both top-down and bottom-up approaches to making investment choices. Vegetation modelling is part of the top-down approach and feeds into examining asset and spatial priorities. Vegetation condition assessment informs site-level changes, as does

research into metrics (such as undertaken by Emma Gorrod, University of Melbourne), change prediction and monitoring. The research that Josh Dorrough and others have been undertaking on exploring different management options on grazing properties is an example of trying to predict change (Dorrough *et al*). Some pilot studies include cost-benefit analyses of biodiversity values.

Reporting on vegetation condition at the moment is the story of what's in front of you, with 'guestimates'' being crystalised into Victorian Catchment Management Authority reports and aggregated at a state-wide level. The hope is that this well lead to further investment, as well as raise awareness of the importance of vegetation condition. Determining how a site is being degraded, and how this can be avoided by potential averted loss 'gains' does not fit into monitoring easily. There are a number of market based tender schemes in Victoria where there can be some perverse outcomes depending on the attribute being monitored.

David described a new direction being taken at the moment in Victoria by Matt White and colleagues at the Arthur Rylah Institute (Victorian DSE) that is examining the functionality of landscapes. The idea is to examine the permeability of landscapes to different groups of species given different patch and matrix characteristics and any additional (perceived) future pressures at the landscape scale. Measuring the condition of native vegetation is only one part of these dynamic landscapes. Native vegetation is a useful surrogate for biodiversity, but not the whole story. Catchment Management Authorities also need reliable models of landscape function to help assess the relative merit of different interventions from a 'functional' view.

Mapping vegetation condition classes is an issue. In order to do this effectively, the primary purpose has to be determined. For example, if it is to set priorities, what scale is needed? Currently, people tend to rely on sources such as expert group opinion. David described a more systematic approach they are developing that focuses on net gain in vegetation condition on public and private land. An overview is taken on current condition, which is a combination of natural variation and the net outcome of post-settlement disturbance. Condition classes are documented on public and private land, in addition to estimated trajectories and the dominant drivers of vegetation condition and net gain inputs. This leads to a ''landscape mosaic'' narrative on public land and a ''decline/recovery'' narrative on private land. Both narratives can contribute to Net Gain and can tell a story about vegetation condition across the landscape. This approach is summarised in Figure 11, and in David Parke's presentation at the back of the workshop summary.

In closing, David Parkes came full circle to the question posed at the start of his presentation. What is the purpose and characteristics of vegetation

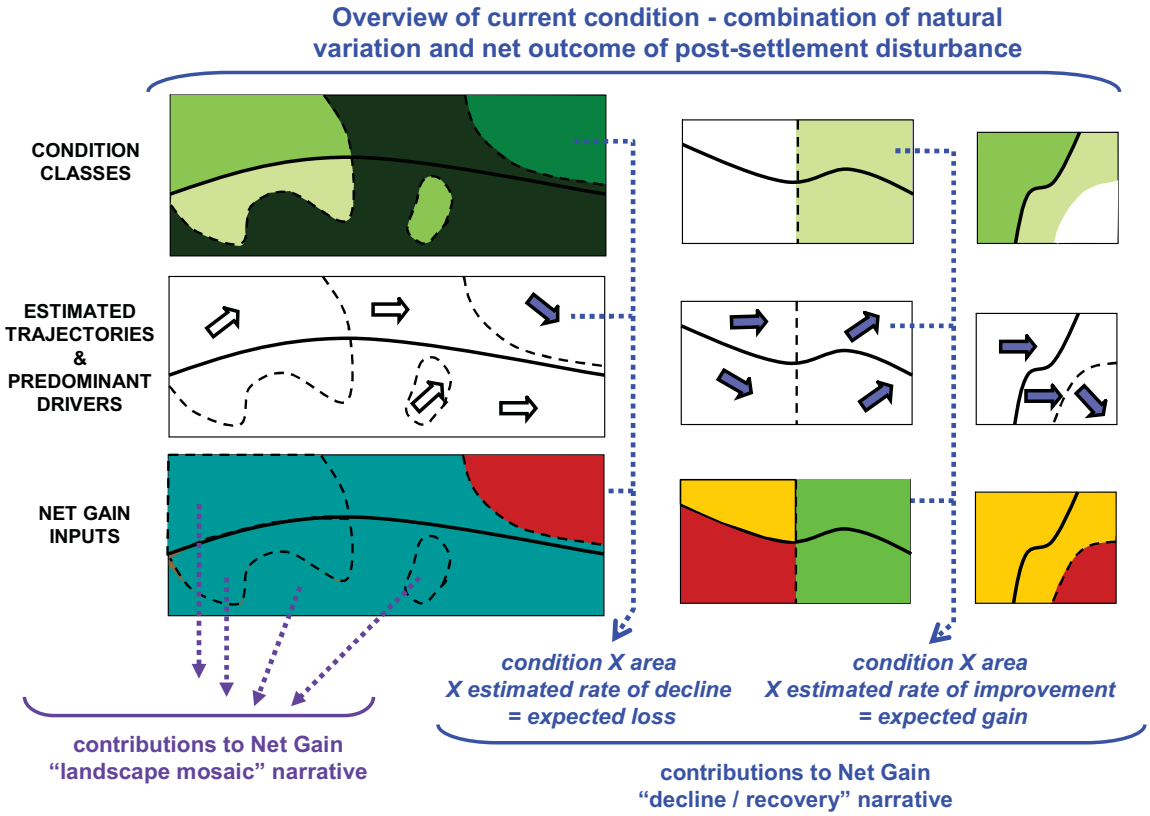


Figure 11. Approaches to characterising net gains and net losses to vegetation in Victoria. Reproduced from the presentation by Dr David Parkes.

monitoring, assessment and reporting? He argued that rapid on-ground comparisons can be complimentary to the deeper insights which are often generated by research (Table 2). An important point is that assessment of vegetation condition provides a snapshot at a site, reporting provides some indication of expected changes, but monitoring is needed to detect actual change. The same questions related to monitoring were identified for both rapid comparisons and research projects – what time period is appropriate and how sensitive does the method need to be to detect change in vegetation condition?

Table 2. Contribution of different vegetation condition assessment and monitoring activities to understanding of changes in condition and the drivers of change. Reproduced from the presentation by Dr David Parkes.

purpose/ characteristics	**Rapid comparison** Implies across a range of options	**Deeper insight** Implies selective/ specific design
Assessment Site (snapshot) Scaled-up (" ")	free range broad area models	mark and return, treatments, retro study area models
Reporting Site (expected change) Scaled-up (" ")	snapshots x management assumptions	complex models
Monitoring Site (actual change) Scaled-up (" ")	time period? sensitivity?	time period? sensitivity?

Advances in modelling and mapping Victoria's native vegetation – Dr Graeme Newell (Arthur Rylah Institute, Vic. DSE)

Graeme started his presentation noting that an interest in vegetation condition was not that novel. Maps of condition can be found going back to 1841 where good grazing and water-holes were mapped on a 5120 acre property at Mt Martha, Victoria.

Graeme and his colleagues (David Parkes, Matt White and Peter Griffioen) have been taking a sophisticated approach to spatially modelling the site condition component of Habitat Hectares, which represents 75% of the score. The modelling is based on 15,000 site assessments of condition across Victoria, derived from a variety of sources. Around 13,500 sites are from incentive schemes in northern and southern Victoria collected between 2003–2007. The remaining sites were drawn from state-wide forest condition surveys, collected between 5–10 years ago, that have been modified to fit the Habitat Hectare scores. Despite the number of sites, data for significant areas such as the Big and Little Desert National Parks and the Alpine National Parks are limited.

Landsat data were sourced from the Australian Greenhouse Office. The cost of data acquisition from this source is relatively low, but the imagery has limitations such as cloud cover. To overcome these limitations the data were averaged over time between the years 1989–2005 to create a mosaic for the state. Images from 10 separate years (1989, 1991, 1992, 1995, 1998, 2000, 2002, 2004, 2005) were used. The mean +/- SD of the NDVI was calculated using these data.

Environmental data (e.g. rainfall and temperature), radiometrics and a Digital Elevation Model were used for the state to develop explanatory variables in the models. Continuous data were used instead of categories to derive the models. The team tried to avoid the use of land cover maps, but in the end had to create their own with 10 land cover classes identified. This 'stack' of data was used in combination with the site-based data and neural networks to develop the models of vegetation condition. There was variation in the quality of the vegetation condition mapping across the state. From 100 'statistical' models, the 30 best spatial models were selected. The mean +/- standard deviation was calculated for each 25m2 cell within the spatial layer covering the state. Approximately 80% of the variance was explained for site condition across the approximately 15,000 sites. The model over-predicted at the lower end of the score and under-predicted at the higher end.

The aim of the research was to model the aggregate Habitat Hectare score for all sites to generate a vegetation condition map for the state (Figure 12).

Since this process required the creation of a spatial model of each vegetation attribute contributing to the Habitat Hectares score, these attributes were also mapped at the state level. The processing of State-wide data-sets to create these maps could be completed within 20 minutes given suitable computing resources.

Graeme explained that the development of modelling approaches follows a number of steps:

1. Aggregated Site Condition Score
2. Sum of Component Scores
3. Modelled Component data
4. Contrast to Modelled Benchmarks
5. Score for each Component
6. Sum of Component Scores.

He ended the presentation by identifying the following list of preferred inputs to maximise the reliability of the modelling approach and derived models:

- Lots of field data
- Stratification, currency, programs
- Good data QA and spatial accuracy (including checks using aerial photographs and GPS)
- 'Real data' and raw data – continuous data sets are preferred

- 'Biologically responsive' predictors
- Computing 'grunt' and modelling 'smarts'
- 'Landscape logic' – not all models can be validated, so some ecological nouce, heuristics and rules of thumb are necessary
- Land use history
- Dollars and time: this sort of modelling doesn't happen overnight.

Understanding relationships between management actions and changes in vegetation condition – Dr David Duncan (Arthur Rylah Institute, Vic DSE)

David introduced the project he was leading for Landscape Logic in Victoria, which is examining and characterising vegetation change and condition over time. In particular, the aim of the project is to investigate the impact of past management interventions on the extent and quality of native vegetation condition, initially in the Goulburn Broken, North Central and North East Catchment Management Authorities.

This is designed to help improve the capacity to report on landscape scale change in native vegetation condition, and to develop new tools and models that will assist decision making and assessment processes. This is important because the Victorian CMAs have the responsibility of reporting on the effectiveness of their actions.

The project started with a literature review on changes over time such as happens with litter accumulation (studied in relation to fire risk). Jennifer Ticehurst (Landscape Logic, The Australian National University) has been assisting the research with Bayesian belief networks that attempt to emphasise what scientists and land managers already understand about the dynamics of these systems.

Currently a search is being undertaken for historical data to document and quantify changes in vegetation condition over time, but there are not many sites available. A couple of hundred vegetation assessments have been located prior to 2003, which can be supplemented by flora assessment information and photo-point data held by DSE and the CMAs. These will be revisited to examine changes over time. Arn Tolsma (Arthur Rylah Institute) has collected data on 24 sites in 2004, which include detailed measures of habitat hectare components. The value of these data to the project will be examined. Relevant and complimentary work is being undertaken by people like Emma Gorrod at the University of Melbourne.

Developments at the national level – Peter Lyon (Australian Department of Environment and Water Resources)

Peter started his presentation by suggesting that policy-makers need to be involved in discussions about vegetation condition as this information must address policy needs. Policies and programs are

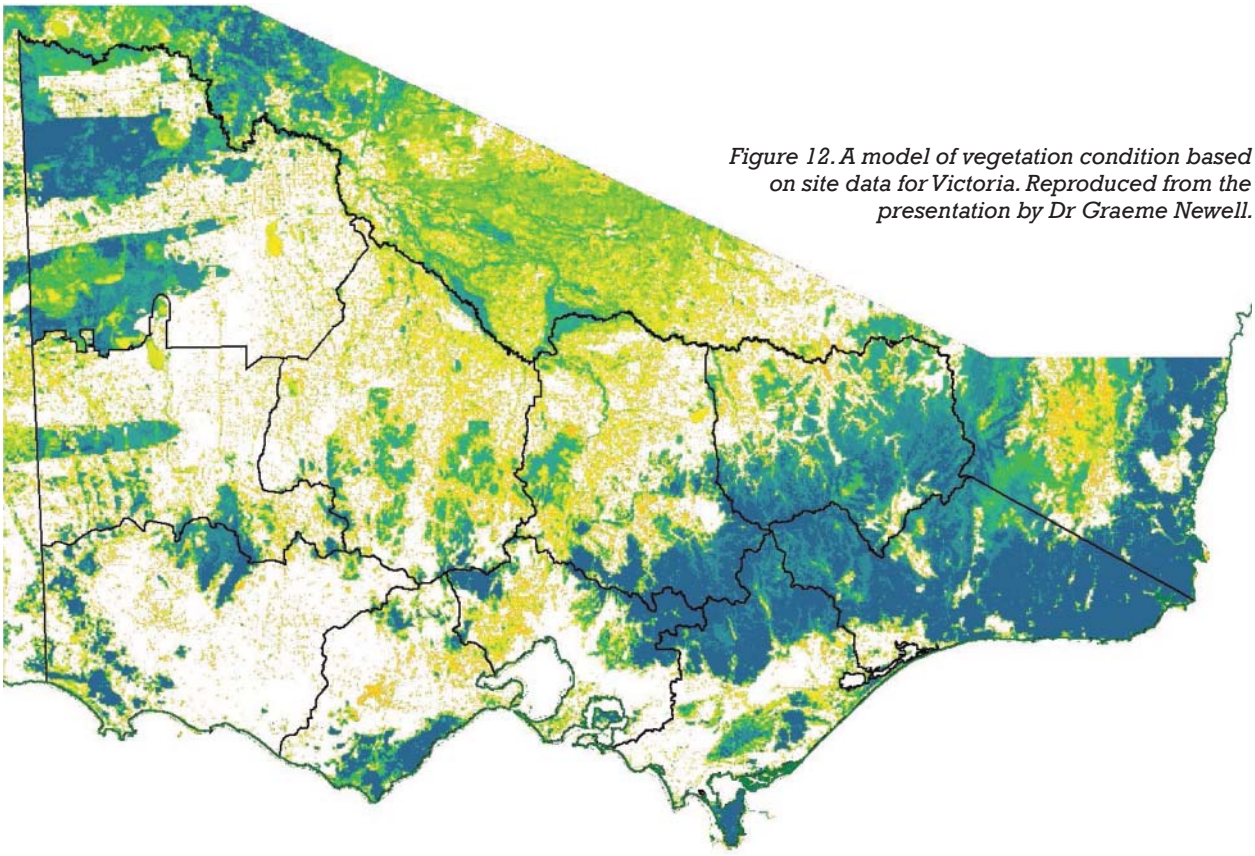


Figure 12. A model of vegetation condition based on site data for Victoria. Reproduced from the presentation by Dr Graeme Newell.

blunt instruments for dealing with complex issues, but the best available information help make policies as effective as possible.

Information is required on native vegetation condition because it is a potentially powerful surrogate for many other more complex ecological relations and states. A method to measure vegetation condition reliably across vastly different types under all kinds of past/present/future pressures is fundamental to better policies and programs. There is pressure to develop such an indicator as soon as possible for vegetation condition, but it needs to be right and practical. The way to achieving this is to have events like this workshop so policy-makers and researchers can interact. Relationships between researchers and policy-makers will continue to be critical.

Peter illustrated a number (but not all) of the national and Australian Government activities underway on vegetation condition (Table 3), noting that the two categories were different. He then discussed the range of policies, programs and approaches to assessment and monitoring used at the national level and by the Australian governments.

Table 3. National and Australian Government activities related to vegetation condition at the national level. From the presentation by Peter Lyon.

National activities – vegetation condition

	National (NRPPC)	Australian government
Policy and programs	National Vegetation Framework National Strategy for Biodiversity Conservation Ecosystem Services, Connectivity, etc.	EPBC Act NHT and Landcare MBIs (ESP, hotspots) Water Plan AGO
Assessment and monitoring	NLWRA (since 1997) SSCAVI (since 2001) National NRM M&E Framework (2002)	BRS ERIN, NLWRA DEW – AWD CSIRO SoE Reporting

National activities are overseen by the Natural Resources Program Coordinating Committee (NRPCC) which is a committee of COAG and includes senior executives from the states, territories and Australian government. This group focuses on the Monitoring and Evaluation (M&E) framework and has commissioned a review of the National Strategy for Biodiversity Conservation. A national approach to the assessment of ecosystem services is also under consideration by the Committee.

The Australian Government has a number of explicit policies and programs it is responsible for such as the Environmental Protection and Biodiversity Conservation Act 1999 and Natural Heritage Trust where vegetation condition is a major consideration. People working on Matters for Targets in the NHT need to be looking at linkages across targets for salinity, water quality and vegetation. Some of the questions that arise at this level is how well the EPBC Act and M&E framework sit together and whether market-based instruments (MBIs) such as the recent Environmental Stewardship program of the Australian government are aligned to achieve the best policy outcomes.

Peter shared the take home messages from a presentation given by Dr Charlie Zammit (DEW) to the Land and Water Australia Native Vegetation and Biodiversity R&D workshop in June 2007. The emerging frontiers for environment policy identified by Charlie were characterised by:

- More explicit targeting of priority outcomes
- Clear preference for using market incentives, with up to a 15 year commitment
- Greater investment and use of sound science
- Commitment to longer investment time frames
- Clear expectation for better performance reporting
- Sharper focus on building enduring partnerships, and
- The emergence of resilience thinking across policy domains.

Peter described some of the activities related to vegetation condition assessment and monitoring at the national level and within the Australian government (Table 3). National stories can be told by agencies such as the National Land and Water Resources Audit (NLWRA). For example, in 2001 the NLWRA published a landscape health map for Australia, which is a first cut at a map of landscape condition across the continent.

At the national level, the Executive Steering Committee for Australian Vegetation Information (ESCAVI) is moving from assessment to monitoring and is active in the development of indicators for regional target setting, including native vegetation condition. The Committee includes representatives from all states and territories and the Australian Government. It is working towards more consistent national vegetation data and building a better National Vegetation Information System. In this system, the information on vegetation extent is adequate, but of limited use for monitoring.

A number of departments, agencies and organisations that are part of the Australian government, such as BRS and ERIN are involved in developing monitoring and reporting systems. The SoE report, which is released every five years, is required under the EPBC Act and provides a conduit for regular reporting.

Peter wound up his presentation by examining where different states and territories were in relation to vegetation condition. Victoria is the only state with a state-wide condition map. Tasmania is a recent player in vegetation condition assessment, but is

very active. An ESCAVI pilot is being undertaken in Western Australia related to benchmarking. The Northern Territory has mapping at the 1 to 1 million scale, but not many regional groups. NSW has good information at the site level. Issues surrounding data availability and quality are relevant to all jurisdictions.

Developments at the national level: assessing vegetation condition at the landscape level

Richard Thackway (Bureau of Rural Sciences)

The final presentation for the workshop was given by Richard Thackway who started by identifying the reasons why native vegetation information was important at the national level. These included:

- Reporting the status of vegetation e.g. SoE, SoFR, Vegetation Assessments
- Assessing impacts of land management practices on vegetation type, extent and condition
- Accounting multiple ecosystem services provided by vegetation types
- Assessing options i.e. trade-offs and costs/benefits of on-ground management actions
- Prioritising investments in on-ground actions in the context of NRM targets
- Monitoring and reporting performance toward vegetation targets.

Richard then presented an adaptive management cycle for policy or decision making that has five steps:

1. Characterise/assessments/define problems, issues
2. Set goals, objectives, prioritise
3. Design and implement programs (e.g. MBIs, regulation, education)
4. Check on ground management
5. Resource condition.

Currently, steps 4 and 5 are inadequately addressed. That is, the monitoring part of the management cycle needs to be strengthened. Key science based inputs into this cycle include spatial information systems, understanding of ecological function, impacts of land management practices, vegetation and land cover types, desired condition states, tools (visualisation, monitoring, decision support, trade-offs) and stakeholder surveys.

Progress is being made. In 1997 a nationally consistent approach was developed for native vegetation extent. The states are currently updating this information, using 2004–05 as a baseline and reporting changes over the 2006–07 period. A nationally consistent approach has also been developed for vegetation types through the National Vegetation Information System (NVIS), with the States constantly updating their information. There are, however, still real gaps in the national data-base such as in NSW.

When it comes to a nationally consistent approach to vegetation condition, as noted by Peter Lyon, there is tension between having a method as soon as possible and getting it right. Relationships between researchers and policy-makers will continue to be critical.

One of the National Monitoring and Evaluation Framework (NM&EF) indicators specifies the type and condition of vegetation in each IBRA subregion. The native vegetation condition indicator of NM&EF of ESCAVI has five classes, which relate to different condition descriptions and the estimated current condition as a percentage of the extent. The VAST states (which excludes landscape context attributes such as connectivity, area, size) and descriptions, which were developed by BRS, match the NM&EF classes well.A possible approach to national reporting on vegetation condition is to use the NM&EF indicator that identifies ''The proportion of each native vegetation type in each IBRA subregion that is estimated to be in specified condition classes based on a selected set of attributes''. Inputs would include IBRA, the Major Vegetation Groups in NVIS (each native vegetation type) and VAST (specified vegetation condition classes) at the scale of 1km grids.

Diagnostic criteria for VAST include:

- Vegetation benchmark (NVIS V DVT) ~ VAST I
  - Vegetation structure
  - Vegetation composition
- Changes in state from benchmark VAST II->VI
  - Vegetation structure (e.g. height, cover, growth form, strata)
  - Vegetation composition (e.g. dominant species)
  - Regenerative capacity (e.g. age class, growth stage)
- Evidence of land management practices (these are a driver of the VAST model)
  - Transitioning a vegetation type from one state to another.

When using the VAST model, it is important to understand and document the site attributes and explanatory variables, as well as land management practices and benchmarks used to create the input condition data-sets. Assumptions, limitations and the date of the material used in VAST must be recorded. Mapped condition states must correlate with on-ground measurements and use relevant landscape scale data-sets, otherwise the model has limited value. The VAST results can be checked via a third party and LIDAR can be used to show how VAST performs. The steps taken in developing a VAST data-set was outlined in detail in the presentation.

Richard illustrated the use of VAST with a number examples including mapping VAST for grassy woodlands in the ACT, assessing changes in VAST over time on John Ive's sheep grazing property near

Yass and a third in the Hume Shire of NSW. In the last example, Ian Davidson drove all the roads in the region using SPOT imagery, aerial photos and binoculars. A land capability data-set was developed, which was considered a surrogate for soil fertility. Ian and Mark Sheahan then undertook a biometric assessment across the region. Other examples provided were in northern Victoria and the Northern Territory.

A further example of the work Richard is undertaking using the VAST model is with Sue McIntyre at CSIRO Sustainable Ecosystems. He is working with her to map the landscape alteration states (intact, variegated, fragmented and relictual) that she and Richard Hobbs converted in 1999 into VAST states (McIntyre and Hobbs 1999). A 100m grid data-set is being used. The input data-set in this study is from Bogan Gate and Jervis Bay in NSW and represented at a scale of 1:100,000. The McIntyre and Hobbs framework has been used in an IUCN report to identify options for management actions within landscape alteration levels (Terry *et al* 2006).

Richard concluded his presentation with the following points about the VAST model:

- VAST provides a common language for land managers, scientists and policy-makers
- VAST has been successfully tested by data-set custodians in the intensive and extensive land use zones
- VAST demonstrates relationships between land management practices and veg condition states and transitions and landscape level vegetation futures
- Guidelines are needed for translating, compiling and reporting veg condition i.e. spatial and temporal, extent and change
- The model works best if the user has an understanding of the data.
- There is no substitute for on-ground knowledge and site data. The more on-ground sites that are available, the better it gets.

In relation to the way ahead, the recommendations made by Richard included:

- Collect more site-based data
- Provide guidance on methods for spatial extrapolation
- Improve links between vegetation extent and change, type and condition
- Develop future vegetation scenarios of condition states and transitions for a landscape matrix to inform adaptive management
- Link vegetation types and condition states for M&E of multiple outcomes/ecosystem services
- Develop tools for visualising mapped condition states using large scale remotely sensed images e.g. Google Earth. These can help educate and inform users.

More details on VAST are published in Thackway and Lesslie (2005, 2006).

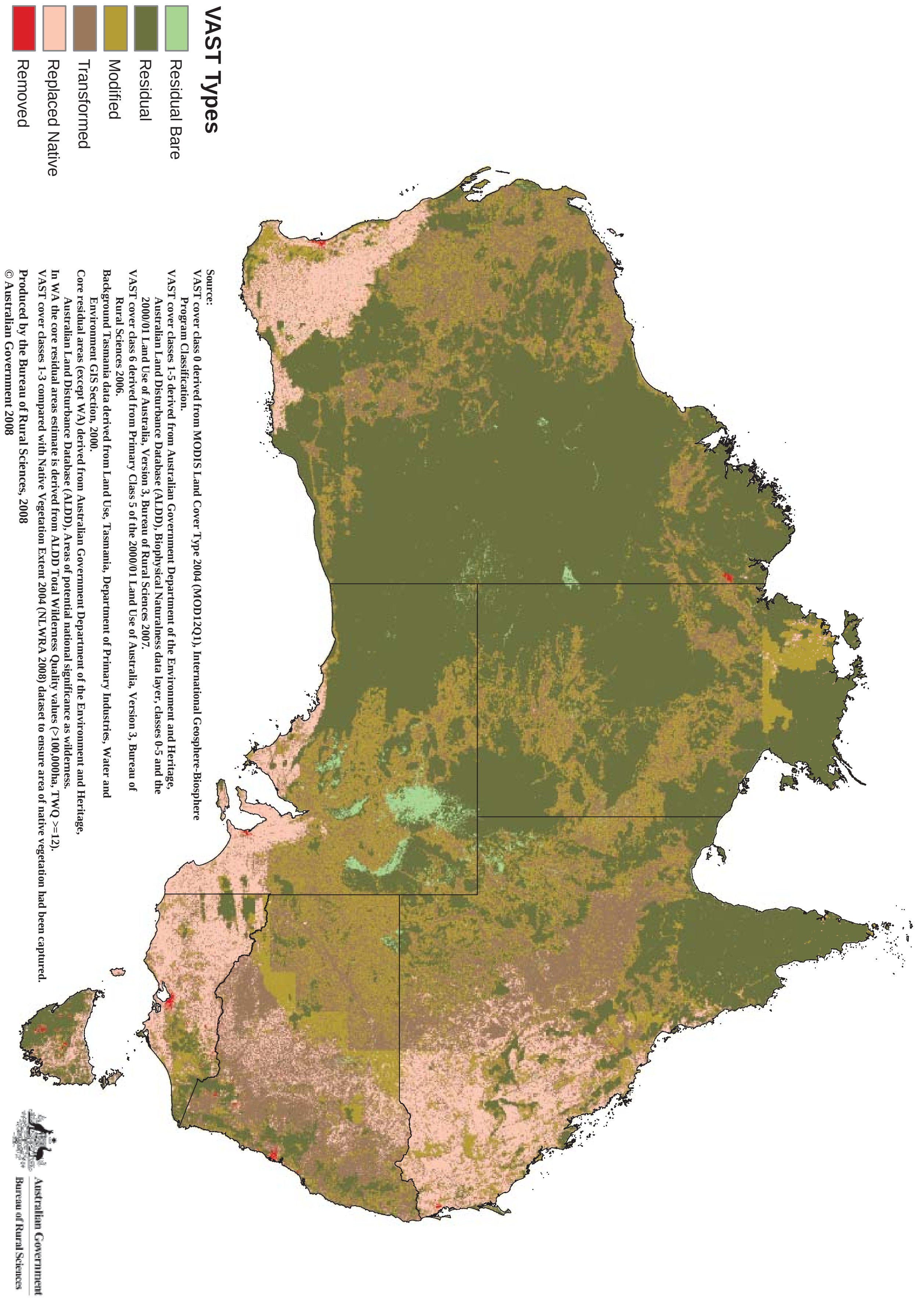


Figure 13. VAST modelled output of vegetation condition at a national scale. The is an updated version of the map which appeared in the presentation by Dr Richard Thackway.

Section 2 – Summary of break-out group discussions

In this session, workshop participants broke into 4 groups of 7–8 people to discuss needs, issues and ideas from the workshop and to identify the next steps and priorities. Each group wrote their key points down on butcher's paper and reported back to the group as a whole. The summaries from each group are presented below. Common themes that arose from this session are incorporated into the following section on 'themes arising from the workshop'.

Group 1

The first group to report believed that targeted retrospective research that identified response functions would help regional groups and that good 'recipes' and frameworks were required. The group considered that there were issues related to data curation and management, but that existing data could be added into the mix. It was felt that State level support was needed for the collection of vegetation condition data in Tasmania. The group liked VAST as a tool to assist and tell landscape stories. A lot of the discussion of the group was around VCA and the nexus between assessment and monitoring. They identified a need to build on different approaches such as those described by Neil Davidson in his presentation.

Group 2

The second group agreed that to move forward a set of principles was needed rather than prescriptions. It was important that the approach taken to vegetation condition was built for the purpose it was intended for. The group recommended that the table discussed by David Parkes on rapid comparison and deeper insight (Table 2) should be an attachment to the workshop summary so that people can fill it out, identify connections between rows and columns, incorporate case studies and identify where gaps in assessment are.

Going through this exercise should help identify the roles for regional organisations, Landscape Logic, state and Commonwealth governments and researchers. It would also help show where modelling and site assessment fits in. The group felt that there was a need for more activity following the workshop to maintain the momentum. This could involve a working group, website and/or self-help group and potentially be led by Landscape Logic. The considerable consensus amongst workshop participants was commented on by this group.

Group 3

Group 3 identified 2 types of monitoring: long-term change and in-depth monitoring. They noted the value of farmers and local knowledge in describing past land use practices. Identifying thresholds and the recoverability of vegetation systems were both seen as important. While there are different legislative processes in Victoria and Tasmania, and hence different leverages, it was felt that Landscape Logic could present a united front to the Commonwealth Government.

Priorities included the need to design a reporting and monitoring system and broaden the land use types where vegetation condition information was collected in Tasmania. A reliable long-term partner was also needed in Tasmania for GIS support such as ARI in Victoria. It was felt that VAST could be useful in Tasmania to provide spatial context and act as a prioritisation tool.

Group 4

The fourth group noted that Tasmania was still building it's base compared to Victoria. The group were all Tasmanian except for one member, so the following summary focuses on the Tasmanian context. The need for a systematic approach and guiding principles were identified for Tasmania that provided both consistency and flexibility. This recognised the importance of using different approaches for different purposes ('fit for purpose') and that priorities can change over time. Central data management was identified as an important next step in Tasmania as well as strengthening collaboration and identifying roles and responsibilities. A convincing story needed to be told to DPIW, who were still not fully engaged with vegetation condition assessment and monitoring. Commitment is needed at the state level for the approach to be sustainable. The first step was to do an audit of what data was available on vegetation condition across organisations and individuals, and identify gaps in data and research priorities. The question of how to mesh data sets would need to be addressed before extensive modelling was undertaken. The group concluded that it was important to maintain the momentum set up by the workshop and meet again as a group across different agencies and organisations.

Section 3 – Themes arising from the workshop

A number of themes arose during the workshop presentations, the break-out discussion groups and the comments each participant made at the end of the workshop about where to next and where the workshop participants could most effectively collaborate on native vegetation condition research. These ideas are summarised below.

Vegetation condition – fit for purpose

Fit for purpose/context/range of approaches: the need to clarify why vegetation condition is being used was a common and strong theme throughout the workshop presentations and discussions. In some cases, approaches such as Habitat Hectare that was developed for one purpose is being used for another. For example, the developer of the Habitat Hectare approach did not have great expectations for it as a monitoring tool. This illustrates the importance of identifying the purpose of vegetation condition research and selecting the most relevant approach from those available.

Assessment/monitoring/reporting: the differences between these approaches were identified by a number of speakers, with monitoring requiring more detailed data collection than vegetation condition assessment. At the moment regional organisations in both Victoria and Tasmania are able to undertake the assessment and reporting of vegetation condition, but not monitoring. At the moment it is not possible to examine causality between vegetation condition assessment and other variables.

Related to this point was a discussion about whether the world is trying to move from rapid comparisons of vegetation condition across sites to deeper insights and more detailed assessments over time and space. Or are these approaches trying to stay in separate spaces? The challenge is to engineer connections between the two.

Tools, techniques, data and site selection

- The potential to identify a core set of attributes that could be used to answer a number of questions was raised a few times.
- Data management/quality/metadata/spatial data: several inter-related issues were raised in relation to data collection, management and storage. For example, spatial data should be comparable, reliable and consistent. A need to move away from categories to quantitative data was identified, as well as the value of biological response indicators. The ability to monitor changes over time was identified as an area for further research.
- Site selection/networks (i.e. LTER): systematic and stratified selection of sites for vegetation condition assessment and monitoring will increase the value of the data collected. The lack of long-term monitoring data was identified as a gap in knowledge. It was suggested that at least one more LTER site, linked into the international network, could be warranted in Tasmania.
- Benchmarking is a critical component of vegetation condition approaches and should capture a full range of conditions.
- Methods are needed for translating between VCAs created for different purposes. This will be made easier by collecting raw data rather than categories and collecting representative samples.
- Modelling techniques such as VAST and statewide condition modelling were recognised as important tools to ask questions.
- Scale: scaling-up from the site to the regional level and beyond was acknowledged as an important aspect of vegetation condition assessment and monitoring. Modelling and remote sensing provide tools to make the link, but robust on-ground data is essential for meaningful model outputs.

Roles, responsibilities and partnerships

- Roles and responsibilities: two tables on roles and responsibilities – one presented by Simon Jones and one by David Parkes – sparked considerable interest amongst workshop participants. It was felt that these provided a framework for identifying who should do what, when and how and helped prioritise research and investment.
- Top-down and bottom-up: the need was identified to develop ways to integrate both top-down (intervention using asset and spatial priorities) and bottom-up approaches to vegetation condition (implementation options based on incentive levels and potential site-level changes).
- Partnerships/collaboration/integration: a number of government and non-government organisations were represented at the workshop, all with some interest in vegetation condition monitoring and assessment. Workshop participants agreed that it was important for these groups to build and maintain linkages and share data and ideas on vegetation condition assessment and monitoring. Continued discourse between policy-makers and researchers was also considered essential.
- (Realistic) expectations are needed: for example what Management Action Targets and Resource Condition targets in regional NRM strategies can report on; the limitations of these approaches

need to be recognised. It's possible that the scientific rigour for reporting vegetation condition has been oversold.

Documentation and story-telling

The importance of documentation: recording how different techniques were developed and used was important, such as in the guidelines developed for the Tasmanian VCA and the documentation underpinning VAST models.

Telling a story: several presenters referred to the need to tell a good story when it comes to vegetation condition. This doesn't mean that only vegetation in good condition is referred to, but refers to the importance of having good data and analysis to support 'stories' about vegetation condition – whether they are good or bad.

Section 4 – Workshop outcomes and actions

The workshop discussed major priorities for new research on assessing and monitoring the condition of vegetation communities across Tasmania and Victoria, including the use of new ground survey techniques, wireless sensor networks, and satellite imagery to monitor vegetation. This research will help to identify and mitigate threats to vegetation and inform the selection of private land with significant vegetation warranting enhanced protection through measures such as covenants.

A number of common themes were identified across the one and half days of the workshop, as recorded in the previous section. These spanned a range of issues including the importance of robust data collection, management and storage.

One of the most important outcomes of the meeting was identifying that there was not one-size fits all when it comes to technical approaches for assessing and monitoring native vegetation condition, with a need to clarify for what purpose vegetation condition is being assessed or monitored. There was agreement that different purposes required different approaches, whether that be on-ground data collection at varying levels of detail, modelling, remote sensing or a combination of all the above. Different tools can be used as long as they are in the relevant context.

A high degree of consensus, momentum and positivism was developed at the workshop. Identifying mechanisms for continued collaboration of the workshop participants was seen as an essential next step through mechanisms such as a dedicated website or working group. An opportunity exists to use Landscape Logic as a vehicle to move vegetation condition research and related on-ground applications forward following the workshop. If a commonly agreed strategy was identified and put to funding and management agencies, more support, uptake and investment in vegetation condition assessment and monitoring was considered likely to be achieved.

References

Barr N. (2004) *The micro-dynamics of change in Australian agriculture 1976–2001*. Canberra, Australian Bureau of Statistics.

Cawsey EM, Freudenberger D (2005) *Biodiversity Benefits of Commercial Environmental Forestry: The Plantation Biodiversity Score*. CSIRO. <www.csiro.au/files/files/pi2d.pdf>.

Doneley T, Hinchcliffe J, Williams J (2005) *Native vegetation and property management: a guide to research and resources*. Greening Australia, Canberra.

Dorrough J, Yen A, Turner V, Clark SG, Crosthwaite J, Hirth JR (2005) Livestock grazing management and biodiversity conservation in Australian temperate grassy landscapes. *Australian Journal of Agricultural Research* **55(3)** 279–295.

Gibbons, P, Ayers D, Seddon J, Doyle S, Briggs S (2005) *BioMetric Version 1.8. A Terrestrial Biodiversity Assessment Tool for the NSW Property.*

Harris S, Kitchener A (2006) *From forest to fjaeldmark. Descriptions of Tasmania's vegetation*. DPIW. Printing Authority of Tasmania, Hobart.

Mc Elhinny C, Gibbons P, Brack C, Bauhus J (2006) Fauna-habitat relationships: a basis for identifying key stand structural attributes in temperate Australian eucalypt forests and woodlands. *Pacific Conservation Biology* **12**, 89–110.

Mc Elhinny C, Gibbons P, Brack C, Bauhus J (2005) Forest woodland stand structural complexity: Its definition and measurement. *Forest Ecology and Management* **218**, 1–24.

McIntyre S, Hobbs R (1999) A framework for conceptualizing human impacts on landscapes and its relevance to management and research models. *Conservation Biology* **13**, 1282–1292.

Michaels K (2006) A manual for assessing vegetation condition in Tasmania. Version 1.0. In *Resource Management and Conservation*, DPIW, Hobart.

NLWRA. (2001) *Australian Native Vegetation Assessment 2001.* National Land Water Resources Audit, Canberra.

Stone C, Simpson JA (2006) Leaf, tree and soil properties in a Eucalyptus saligna forest exhibiting canopy decline. *Cunninghamia* **9**: 507-520.

Terry A, Ullrich K, Riecken U (2006). *The Green Belt of Europe: From Vision to Reality*. IUCN, Gland, Switzerland and Cambridge, UK.

Thackway R, Lesslie R (2005) *Vegetation Assets, States and Transitions (VAST): accounting for vegetation condition in the Australian landscape*. BRS Technical Report, Bureau of Rural Sciences, Canberra.

Thackway R, Lesslie R (2006) Reporting vegetation condition using the Vegetation Assets, States, and Transitions (VAST) framework. *Ecological Management and Restoration.* **7** (Suppl. 1):53–62.

Vegetation Plan Developer: Operational Manual. NSW Department of Environment and Conservation.

Williams J (2005) *Native vegetation and regional management: a guide to research and resources*. Greening Australia, Canberra.

Appendix 1
List of attendees

Dr Matt Appleby
Andrew Baldwin
Tim Barlow
Sue Berwick
Dr Kerry Bridle
Dr Neil Davidson
Grant Dickins
Dr Dave Duncan
Aaron Gay
Emma Gorrod
Jennifer Hemer
Ian Higgins
A/Prof. Simon Jones
Semone Keppel
Dr Anne Kitchener
Peter Lyon
Dr Karyl Michaels
Dr Louise Mendel
Dr Graeme Newell
Prof. Tony Norton
Dr David Parkes
Geoff Robinson
James Shaddick
Kathryn Sheffield
Dr Richard Thackway
Dr Jenifer Ticehurst
Don Thompson
Prof. Jann Williams
Dr Andre Zerger

Appendix 2
Workshop Program

Futures for Native Vegetation Condition Research in Tasmania & Victoria

Thursday 18 October 2007

3.00-6.00pm	Afternoon arrival into Burnie & accommodation check-in
6.00-6.20pm	Welcome, introductions, outline of workshop aims
6.20-7.00pm	Scaling Up: Challenges to the assessment and monitoring of vegetation condition at a landscape level – led by Andre Zerger & Simon Jones
7.30-10.00pm	Dinner, Bayviews Restaurant, Burnie

Friday 19 October 2007:

8.30-8.50am	Introduction – Tony Norton
8.50-10.10am	State of Play in Tasmania & Research Challenges – led by Anne Kitchener, Karyl Michaels, Louise Mendel & Neil Davidson
10.10-10.30am	Morning Tea
10.30-11.50am	State of Play in Victoria & Research Challenges – led by Graeme Newell, David Duncan & David Parkes
11.50-12.15am	Review of Approaches and Discussion
12.15-12.45pm	Lunch
12.45-2.20pm	Developments at the national level – led by Richard Thackway & Peter Lyon
2.20-3.10pm	Strengthening collaboration & implications for future research (Smaller group discussion & reporting back)
3.10-3.30pm	Afternoon Tea
3.30-3.50pm	Next steps and role for Landscape Logic – led by Kerry Bridle & Jennifer Hemer
3.50-4.00pm	Reflections and close – Tony Norton