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JANIS and Natural National Estate Conservation Requirements

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JANIS AND NATURAL NATIONAL ESTATE CONSERVATION REQUIREMENTS

NSW NATIONAL PARKS AND WILDLIFE SERVICE AND ENVIRONMENT AUSTRALIA

A report undertaken for the NSW CRA/RFA Steering Committee
project number NE 35/EH

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Report Status

This report has been prepared as a working paper for the NSW CRA/RFA Steering Committee under the direction of the Environment and Heritage Technical Committee. It is recognised that it may contain errors that require correction but it is released to be consistent with the principle that information related to the comprehensive regional assessment process in New South Wales will be made publicly available.

For more information and for information on access to data contact the:

Resource and Conservation Division, Department of Urban Affairs and Planning

GPO Box 3927
SYDNEY NSW 2001

Phone: (02) 9228 3166
Fax: (02) 9228 4967

Forests Taskforce, Department of Prime Minister and Cabinet

3-5 National Circuit
BARTON ACT 2600

Phone**:** 1800 650 983
Fax: (02) 6271 5511

This project has been jointly funded by the New South Wales and Commonwealth Governments. The work undertaken within this project has been managed by the joint NSW / Commonwealth CRA/RFA Steering Committee which includes representatives from the NSW and Commonwealth Governments and stakeholder groups.

The project has been overseen and the methodology has been developed through the Environment and Heritage Technical Committee which includes representatives from the NSW and Commonwealth Governments and stakeholder groups.

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EXECUTIVE SUMMARY

This report has been prepared for the joint Commonwealth/State CRA/RFA Steering Committee, which oversees the comprehensive regional assessments (CRAs) of forests in New South Wales.

The CRAs provide the scientific basis on which the State and Commonwealth governments will sign regional forest agreements (RFAs) for the major forests of New South Wales. These agreements will determine the future of the State's forests, providing a balance between conservation and ecologically sustainable use of forest resources.

This report was undertaken to document the establishment of conservation requirements for all the elements of biodiversity (including forest ecosystems, fauna and flora species, old growth and wilderness) considered in the Eden CRA. NSW NPWS in consultation with Environment Australia (EA) and State Forests of New South Wales (SFNSW) developed a process that enabled the formulation of these conservation requirements.

An assessment of national estate values has also been undertaken as part of the CRA process. This report describes how natural national estate values have been derived in this project. It identifies data layers and areas of potential national estate value; though these identify indicative areas. The attributes and indicative areas will be taken into account in compiling and delineating national estate places for endorsement by the Australian Heritage Commission and, after standard statutory requirements, entry onto the Register of the National Estate.

Rule sets were applied to data layers derived during previous CRA projects. Habitat protection targets for forest ecosystems, species, old growth and wilderness were produced. Expert panels reviewed these protection targets and provided relative rankings for vulnerability to threatening processes and suggestions to aid the best expression of targets during negotiations. Target tables and vulnerability rankings were produced for each element of biodiversity. Areas of national estate significance, in terms of centres of endemism, refugia, relictual species, and high diversity or richness, were described.

Results are presented in a series of tables and discussion papers attached in the appendices. Protection targets were produced in a format compatible with C-Plan, the software package used to assess the resource, heritage and biodiversity values of land in the Eden CRA region. Targets were integrated with other data layers within C-Plan so that strategies for achieving the best conservation outcomes could be devised.

1. INTRODUCTION

1.1 JANIS

The conservation requirements project was the final project to be undertaken for the biodiversity assessments in the Eden CRA region. The Environment and Heritage Technical Committee requested NPWS, in consultation with Environment Australia (EA) and State Forests of New South Wales (SFNSW), to develop a process that would enable the formulation of conservation requirements for all elements of biodiversity under consideration.

The primary aim of the project was to derive the JANIS conservation requirements for the elements of biodiversity considered in the Eden CRA region, such as forest ecosystems, species (flora and fauna), old growth and wilderness. A secondary aim of this project was to ensure natural National Estate assessments were undertaken, with an efficient use of resources, and that these were included where practicable to add value in determining conservation requirements.

Conservation requirements were derived according to the JANIS criteria for forest biodiversity, old growth and wilderness (JANIS 1997). The resultant outputs were checked against the relevant National Estate and other criteria in the NSW Scoping Agreement to ensure that these criteria were also met. National Estate values, which have JANIS equivalents but no specific reservation targets, were derived and assessed against the National Estate criteria. These included areas of high biodiversity, refugia, relicts, centres of endemism, disjunct species and species poorly correlated with forest ecosystems.

The conservation requirements project determined the amount and spatial configuration, of each element of biodiversity, that needed to be identified for the Eden CRA, ensuring that the appropriate habitat protection targets were defined for integration. The JANIS and National Estate criteria formed the basis for determining the habitat protection targets. Where JANIS and the National Estate overlapped, the National Estate assessments were based on identifying the best expression, based on regionally determined thresholds, of the JANIS values.

It was recognised early in the process that the establishment of habitat protection targets for forest ecosystems, old growth and wilderness would involve a relatively straight forward translation of the JANIS reserve criteria to the relevant data layers, subject to alterations determined by expert panels and the Environment and Heritage Technical Committee which oversees environment and heritage assessments in the NSW CRA process. However, details for species were less well defined in JANIS, so the formulation of habitat protection targets for species of flora and fauna became the responsibility of another project (Response to Disturbance) in consultation with NPWS and SFNSW.

Expert panels were used to review protection targets and to make suggestions for conservation outcomes. All conservation targets produced during this project were integrated within the C-Plan matrix, which enabled the formulation of strategies for negotiations.

The conservation requirements project was dependent on all the data layers derived from the Eden CRA. The area being assessed included all the forested public and private lands in the Eden CRA region. The Eden methodology was developed in a very short time frame and may not necessarily form the basis for or be similar to, the formulation of requirements for other CRA regions in NSW.

1.2 NATIONAL ESTATE

The National Estate is defined in the *Australian Heritage Commission Act 1975* as:

> *"... those places, being components of the natural environment of Australia, or the cultural environment of Australia, that have aesthetic, historic, scientific or social significance or other special value for future generations as well as for the present community."*

The Australian Heritage Commission's responsibility is to identify the National Estate and, under section 30 of the Act, to advise the Commonwealth Government on the conservation of national estate places and the potential impact on national estate values of proposals relating to those places. The Act also requires the establishment of the Register of the National Estate. The Register includes places of importance at a local, regional, State or national level. The identification and assessment of places for inclusion on the Register is guided by the national estate criteria (see Appendix 4.11).

In the regional context, identification of the National Estate requires a comparative assessment of the significance of places having one or more National Estate value or attributes as identified by the criteria. This requires developing an appropriate regional context, identification of national estate values, and establishing a 'threshold' of significance to identify areas of 'significant value'.

This report identifies data layers and areas of potential significant national estate value, though these are indicative areas only. The attributes and indicative areas will be taken into account in compiling and delineating national estate places for endorsement by the Australian Heritage Commission and, after standard statutory requirements, entry onto the Register of the National Estate.

Under the National Forest Policy Statement (NFPS 1992) Commonwealth, State and Territory Governments also agreed to the assessment of National Estate values of forests. Attachment 1 of the NSW CRA/RFA Scoping Agreement requires the CRAs to "identify, assess and document national estate values including natural and cultural heritage in NSW to satisfy Commonwealth obligations under the *Australian Heritage Commission Act 1975*."

Key points from the Scoping Agreement include:

- Identification to be undertaken jointly by the Australian Heritage Commission (the Commission) and NSW in accordance with national estate criteria for identifying places of significance;
- Values identified and methodologies utilised to be jointly agreed between the Commission and NSW government;
- Identification, delineation and mapping of national estate values and places;
- Assessment of current levels of protection of national estate values and places;
- Identification of conservation principles for the protection of national estate values and places;
- Documentation of agreed methodologies; and
- Documentation sufficient for interim listing in the Register of the National Estate (RNE) where appropriate.

2. CRITERIA

2.1 JANIS CRITERIA

The JANIS report, *Nationally Agreed Criteria for the Establishment of a Comprehensive, Adequate and Representative Reserve System for Forests in Australia* (1997), provides the national criteria for the conservation of forest biodiversity, old growth forests and wilderness. These criteria form the foundation for conserving all elements of biodiversity, old growth and wilderness under consideration in the Eden CRA. The relevant JANIS criteria are summarised as follows:

2.1.1 Forest ecosystems

JANIS reference: 6.1.2

(1) As a general criterion, 15% of the pre-1750 distribution of each forest ecosystem should be protected in the CAR reserve system with flexibility considerations applied according to the regional circumstances, and recognising that as far as possible and practicable, the proportion of dedicated reserves should be maximised.

(2) Where forest ecosystems are recognised as vulnerable, then at least 60% of their remaining extent should be reserved. A vulnerable forest ecosystem is one, which is:

- approaching a reduction in areal extent of 70% within a bioregional context and which remains subject to threatening processes; or
- not depleted but subject to continuing and significant threatening processes which may reduce its extent.

(3) All remaining occurrences of rare and endangered forest ecosystems should be reserved or protected by other means as far as practicable.

(4) Reserves should be replicated across the geographic range of the forest ecosystem to decrease the likelihood that chance event such as wildfire or disease will cause the forest ecosystem to decline.

2.1.2 Species

JANIS reference: 2.1 The objectives of biodiversity conservation for forests:

- to maintain viable populations of native forest species throughout their natural ranges, and
- to maintain genetic diversity of native forest species.

JANIS reference: 6.1.2

(5) The reserve system should seek to maximise the area of high quality habitat for all known elements of biodiversity wherever practicable, but with particular reference to:

- the special needs of rare, vulnerable or endangered species,
- special groups of organisms, for example species with complex habitat requirements, or migratory or mobile species,
- areas of high species diversity, natural refugia for flora and fauna and centres of endemism and,
- those forest species whose distribution and habitat requirements are poorly correlated with forest ecosystems.

(6) Reserves should be large enough to sustain the viability, quality and integrity of populations.

For the Eden CRA, the species criteria have been addressed primarily by the Response to Disturbance project. However, areas such as high species diversity, natural refugia for flora and fauna, centres of endemism, and those forest species whose distribution and habitat requirements are poorly correlated with forest ecosystems will be dealt with by the national estate criteria.

2.1.3 Old growth

JANIS reference: 6.2.2

(1) Where old growth forest is rare or depleted (generally less than 10% of the extant distribution) within a forest ecosystem, all viable examples should be protected, wherever possible. In practice, this would mean that most of the rare or depleted old growth forest would be protected. Protection should be afforded through the range of mechanisms described in section 4.

(2) For other forest ecosystems, 60% of the old growth forest identified at the time of assessment would be protected, consistent with the flexibility approach where appropriate, increasing to the levels of protection necessary to achieve the following objectives:

- the representation of old growth forest across the geographic range of the forest ecosystem,
- the protection of high quality habitat for species identified under the biodiversity criterion,
- appropriate reserve design,
- protection of the largest and least fragmented areas of old growth, and
- specific community needs for recreation and tourism.

2.1.4 Wilderness

JANIS reference: 6.3.1

Ninety percent or more if practicable, of the area of high quality wilderness that meets the minimum area requirements should be protected in reserves.

(1) Potential wilderness areas will need to:

- have a minimum NWI rating of 12. In addition, minimum thresholds for each of the wilderness quality indicators will be set within the regional context. This threshold will take into account the importance of the indicators, and in particular the biophysical naturalness component as a primary indicator.
- The guideline for size that is considered generally appropriate for areas encompassing forested wilderness is 8,000 hectares. However, a threshold of less than 8,000 hectares may apply to areas contiguous with the sea or which adjoin wilderness areas in adjacent regions. Higher thresholds may apply within a region where wilderness is extensive.
- The presence of potential areas of nodal areas within higher wilderness quality may provide an indication of their significance and may guide the future management of identified wilderness areas.
- Other factors that are not considered in determining the NWI rating may need to be considered, in determining wilderness quality. These factors may include the impacts of exotic plants and feral animals on biophysical naturalness.

(2) Determining wilderness boundaries:

- Potential areas identified using the NWI database will be considered in a regional context to ensure their viability as wilderness, including considerations of shape.
- Both ecological and management features such as topography, water catchment boundaries, roads and other transport routes, may be useful when delineating boundaries.

2.2 NATIONAL ESTATE VALUES

The identification and assessment of places for inclusion on the Register of the National Estate is guided by the national estate criteria (see Appendix 4.11).

The JANIS criteria did not set targets for reservation of the National Estate but established the objective of maximising protection of the National Estate in the reserve system. National estate assessments introduce a quality component into the achievement of the JANIS targets. In this way integration is more likely to select the 'best' 15% or the 'best' 60% of a particular JANIS value to meet targets.

For the purposes of the CRA/RFA process the national estate criteria and the assessment of national estate values was divided into three broad categories, based on their degree of correspondence with the JANIS criteria and assessments. These are:

Category 1 National Estate values

Where there is a direct correspondence between national estate values and JANIS criteria with a specific JANIS target, the JANIS assessment provided the primary data layer from which the

national estate values were identified. This was the case for:

- Old growth forests
  (A.2 Continuing processes)
- Old growth forests by alliance or community
  (B.1 Natural rarity)
- Wilderness
  (B.1 Natural rarity)
- Principal characteristics of vegetation class
  (D.1 Principal characteristics of class)
- Rare flora communities
  (B.1 Natural rarity)

Category 2 National Estate values

Where there is a direct correspondence between national estate values and JANIS criteria and no specific JANIS target, the national estate assessment identified the areas of significant value. These significant areas were then considered as having high conservation value under the relevant JANIS criteria. This was the case for:

- Flora and fauna refugia
  (A.1 Past processes, A.2 Continuing processes)
- Flora and fauna species - relictual and/or Gondwanic species
  (A.1 Past processes)
- Flora and fauna species endemic to region
  (A.1 Past processes)
- Flora and fauna species - disjunct populations
  (A.1 Past processes)
- Flora and fauna species at edge of natural range
  (A.1 Past processes)
- Flora and fauna species richness
  (A.3 Richness and diversity)
- Migratory fauna species (RAMSAR, CAMBA, JAMBA sites and others)
  (A.2 Continuing processes)
- Rare flora and fauna species and their habitats
  (B.1 processes)

Category 3 National Estate values

Where there are no JANIS criteria that correspond with the national estate value.

- Undisturbed catchments
  (A.2 Continuing processes)
- Flora communities diversity
  (A.3 Richness and diversity)
- Areas of unusual habitat richness
  (A.3 Richness and diversity)
- Natural landscapes
  (B.1 Natural rarity)
- Wetlands
  (B.1 Natural rarity & D.1 Principal characteristics of class)
- Fauna species - disjunct populations
  (A.1 Past processes)
- Remnant vegetation
  (A.2 Continuing processes)
- Important wildlife habitats
  (A.2 Continuing processes)
- Vegetation succession
  (A.2 Continuing processes)
- Flora species richness
  (A.3 Richness and diversity)
- Geological and geomorphological values
  (A.3 Richness and diversity, B.1 Natural rarity, D.1 Principal characteristics of class)
- Natural research, reference and teaching sites
  (C.1Natural research, references, teaching sites)

Assessments relating to a number of these criteria were not undertaken directly in the Eden CRA process, but were incorporated as part of other projects. These are listed below with an explanation as to how they were considered:

- Wetlands - All wetlands were identified as part of the Forest Ecosystem project and were included in the national estate refugia analysis.
- Flora species at edge of natural range - Expert opinion was that a specific assessment of this value in the Eden region would be very difficult as many species reach the southern or northern limit of their natural range in the Eden region.
- Fauna species endemic to region - According to expert opinion, there are no vertebrate species endemic to the Eden region. However further taxonomic work may alter this opinion.
- Migratory fauna species (RAMSAR, CAMBA, JAMBA sites and others) - No RAMSAR sites, or sites significant for CAMBA or JAMBA

species are known to occur in forested areas in Eden region.

- Fauna species - disjunct populations - Priority fauna species with disjunct populations were identified and considered in the Response to the Disturbance project (Environment Australia 1997).
- Remnant vegetation - Remnants of rare or old growth vegetation types were identified in JANIS assessments.
- Important wildlife habitats - Important areas of wildlife habitat would include old growth forest, refugia, wetlands, areas of high plant diversity, rainforest and riparian areas. These were all identified in other JANIS or national estate assessments.
- Areas of unusual habitat richness - Areas of high vegetation diversity and/or richness could be considered as a surrogate for identifying areas of unusual habitat richness.

Assessments relating to the following criteria were not able to be undertaken in the Eden CRA process due to the limited time available:

- Vegetation succession
- Faunal species richness
- Flora species richness
- Fauna species at edge of natural range

State-wide projects have been initiated for the identification and assessment of geological and geomorphological values, and natural research, reference and teaching sites. The results of these projects are not available in time for the Eden CRA/RFA.

3. METHODOLOGY

3.1 BACKGROUND

Conservation requirements, for the Eden CRA region, were derived in the following way:

For those JANIS values where there were specific reservation targets, explicit decision rules were formulated on the basis of the rules defined in the JANIS criteria. For those JANIS values where there were not specific reservation targets, explicit decision rules would be formulated on the basis of expert advice. The resulting rule sets are described in the sections below. Using these rule sets, habitat protection targets for each entity were calculated and each was ranked according to its relative vulnerability. Vulnerability rankings were used to formulate procedures in integration. The agreed rule sets and analytical techniques were then applied to the derived data layers to provide reservation targets for each entity. Provisional rules were developed to guide the expert panels on how to effectively apportion overall targets across the landscape with full consideration of patch size, internal variation and appropriate protection mechanisms.

Expert panels reviewed the derived targets and suggested best expressions of the values, i.e. areas of national estate significance. These conservation targets were then applied to the final data layers prior to integration.

All datasets and conservation requirements were compatible with the C-Plan software in preparation for integration. Additional information was supplied by expert panels to ensure that protection targets would be sought effectively across the landscape within differing levels of reservation.

Stakeholders were involved in the endorsement of the process for target setting and actual targets. They were also involved in the selection of experts to assist in target setting.

3.2 FOREST ECOSYSTEMS

3.2.1 Rule set for obtaining JANIS conservation requirements for forest ecosystems

The process for formulating levels of reservation for forest ecosystems was based on the relevant JANIS criteria outlined in section 2.1.1.

Vulnerable ecosystems include those where threatening processes have caused significant changes in species composition, loss or significant decline in species that play a major role within the ecosystem, or significant alteration to ecosystem processes.

A rare ecosystem is one where its geographic distribution involves a total range generally less than 10,000 hectares, a total area of generally less than 1000 hectares or patch sizes of generally less than 100 hectares, where such patches do not aggregate to form significant areas.

An endangered ecosystem is one where its distribution has contracted to less than 10% of its former range or the total area has contracted to less than 10% of its former area, or where 90% of its area is in small patches which are subject to threatening processes and unlikely to persist. Where forest ecosystems are recognised as rare or endangered, then 100% of their remaining extent should be targeted for reservation.

In terms of rare, vulnerable and endangered ecosystems it is recognised that a range of approaches varying from reservation to prescription management will be needed to ensure the persistence of forest ecosystems.

Each forest ecosystem was ranked according to its relative vulnerability to threatening processes (such as inappropriate fire regimes, logging, clearing, weeds, disease, etc) and the likelihood of these threats occurring. In the first instance these

rankings would be used to adjust reservation targets where appropriate and secondly to guide fall back options during negotiations such that most threatened forest ecosystems receive reservation primacy in dedicated reserves and the least threatened receive greater levels of informal reservation and or prescriptive management where this is judged desirable.

Other JANIS criteria to be taken into account were:

- To ensure representativeness, the reserve system should, as far as possible, sample the full range of biological variation within each forest ecosystem, by sampling the range of variation typical of its geographic range and sampling its range of successional stages. Forest ecosystems are often distributed across a variety of physical environments, and their species composition can vary along environmental gradients and between the microenvironments within the ecosystem. This approach will maximise the likelihood that the samples included in the reserve system will protect the full range of genetic variability and successional stages associated with each species, and particularly those species with restricted or disjunct distributions.
- In fragmented landscapes, remnants that contribute to sampling the full range of biodiversity are vital parts of a forest ecosystem. These areas should be identified and protected as part of the development of integrated regional conservation strategies.
- Areas of national estate significance within each forest ecosystem will be highlighted.

An expert panel made up of Doug Binns (SF), David Keith (NPWS), Phil Gilmore (Independent) and Karl Bossard (EA) reviewed the rule set and resulting targets. It was the responsibility of this expert panel to award vulnerability rankings to each forest ecosystem and highlight management considerations relevant to negotiations.

Appendix 3.1 contains a description of the target table derived from the application of the rule set and results from the expert panel workshop. Appendix 4.2 details the proceedings of the expert panel workshop.

3.2.2 Changes to the rule set

Prior to negotiations the Environment and Heritage Technical Committee decided that vulnerability rankings would not be used to adjust conservation targets for forest ecosystems. It was felt that if the targets were increased due to their higher vulnerability to threatening processes, then forest ecosystems with low vulnerability should have their targets adjusted down. This was not acceptable to all members of the committee and therefore it was resolved by the Steering Committee to adjust targets by vulnerability rankings only where threats are precluded by tenure over less than 30% of the pre-1750 extent.

3.3 SPECIES

Conservation requirements for flora and fauna species of significance (based on JANIS criteria) followed on from the Response to Disturbance (RTD) project for the Eden CRA. Results obtained during the response to disturbance project were used in the target setting and ranking of vulnerability to threatening processes.

Two tasks were undertaken to determine conservation requirements for significant species in the Eden CRAs:

- finalisation of species targets and preparation of data for C-Plan,
- finalisation of species reservation requirement or vulnerability rankings (see also the Response to Disturbance report).

3.3.1 Fauna

Species targets

JANIS principles relating to species are detailed in section 2.1.2. The following steps for setting priority fauna species conservation were undertaken as part of the Response to Disturbance project.

- Fauna habitat models and definitions for core, intermediate and marginal habitat quality were reviewed and altered as required. Where there was no appropriate model, a) a surrogate model was built using vegetation and other information, b) buffer zones were applied to point locations or c) management recommendations only were

specified to ensure appropriate conservation of the species.

- The carrying capacity of core, intermediate and marginal quality habitat for each species was set.
- A single habitat protection target area was selected from the range of values (see the Response to Disturbance report). A minimum patch size area for each species was also defined.
- The habitat protection targets were applied spatially by drawing areas (sub-regions) on maps of the fauna habitat models to guide the allocation of the minimum patch size areas of protection across the Eden CRA region. This task included specifying the number of patches, minimum patch size and dispersal distance information. Digital layers such as vegetation communities, forest growth stage, logging history and point locations assisted in this process. (Only one spatial configuration was drawn per species, one that aimed for optimal habitat protection).
- Brief management recommendations were formulated and additional habitat protection design information was recorded for each species.

Reservation requirement ranks

Species were ranked on their relative need for the protection target to be met by dedicated reservation as opposed to informal reservation or prescription. The ranking was designed to ensure that dedicated reservation would be applied to those entities that require it most. See the Response to Disturbance project report for details.

3.3.2 Flora

Species targets

Species targets refer to populations of priority flora species and were determined by an expert panel (made up of Doug Binns and Ross Peacock from State Forests of NSW, Michael Doherty from CSIRO, David Keith from NSW National Parks and Wildlife Service, and Phil Gilmour as an independent consultant). The following rule sets were used when determining targets for significant flora species in the Eden CRA:

- A minimum target of five populations was agreed to by the expert panel;
- Those species which were considered to be at a higher risk of extinction were identified and their targets were adjusted upwards to ten populations based on the following six rules for adjusting global minimum targets:
  1) short-lived seed bank;
  2) requires undisturbed habitat for recruitment;
  3) no known mechanism for recovery after disturbance;
  4) small area of occupancy (local populations) and susceptibility to soil disturbance;
  5) habitat restricted to fragmented areas and susceptible to habitat loss; and
  6) highly restricted distribution (<10km).
- For species that qualified for the above adjustment, and had fewer than ten known populations, the number of known populations were targeted; and
- There were some exceptions to the above criteria and these species were not adjusted even though they met one of the above and are documented in the Response to Disturbance flora workshop report compiled by Environment Australia.

In order to determine the number of populations of significant flora species occurring in the Eden study area, the following process was used. (This did not alter targets set by experts, but just determined how many populations were in reserves and how many were outside the reserve system):

- A database of verified flora species locations was created and reviewed by the expert panel. Old records with poor spatial precision were excluded;
- This database was used to create a GIS layer showing species presence/absence by tenure;
- From this layer a report was generated showing species occurrence within planning units. Species presence within a planning unit was defined as one population, regardless of the number of individuals;
- Two adjustments to targets were necessary before data were loaded into C-Plan. Where the total number of ‘populations’ exceeded the

conservation target, the target was adjusted to the total number. Second, the number of populations within reserves was subtracted from the adjusted target to give a 'residual' population target outside reserves.

3.4 OLD GROWTH

3.4.1 Background

The following criterion are defined within JANIS (1997) to ensure appropriate reservation of old growth forest:

1) Where old-growth forest is rare or depleted (generally less than 10% of the extant distribution) within a forest ecosystem, all viable examples should be protected, wherever possible; and

2) Where old growth forest is greater than 10% of the extant distribution within a forest ecosystem, 60% of the old-growth forest identified at the time of assessment should be protected with a flexible approach where appropriate, increasing to the levels of protection necessary to achieve the following objectives:

   - assess the representation of old growth forest across the geographic range of the forest ecosystem;
   - the protection of high quality habitat for species identified under the biodiversity criterion;
   - appropriate reserve design;
   - protection of the largest and least fragmented areas of old growth; and

- specific community needs for recreation and tourism.

3.4.2 Obtaining conservation requirements

Prior to the meeting of the expert panel on old growth the following criteria were outlined in order to achieve the conservation requirements for old growth, as recommended in JANIS, for the Eden CRA:

- obtain provisional old growth targets by calculating the extent of forest as a % of each forest ecosystem.
- assess whether old growth forest is rare or depleted;
- identify largest and least fragmented areas of old growth;
- determine representation of old growth forest across the geographic range of each forest ecosystem;
- adjust target after consideration of fragmentation and landscape disturbance;
- identify High Quality Habitat old growth forest;
- identify aesthetic and cultural values of old growth areas;
- determine minimum viable patch size;
- select other 'growth stages' when forest ecosystem target exceeds old growth target;
- rank old growth forest types in terms of their sensitivity to threatening processes; and
- incorporate spatial considerations into target selection.

The expert panel, made up of Bob Bridges (SFNSW), Paul O'Connor (NPWS), Tony Norton (Independent), Sara May (EA), and Jane Coram (AGSO), decided upon the following changes to the criteria in order to best achieve the conservation targets in the limited time available:

- fragmentation and contiguity analysis of old growth forest not possible for Eden CRA;
- adjustment of targets for landscape disturbance based on a sliding scale; and
- acceptance of forest ecosystem rankings for vulnerability to threatening processes.

Appendix 3.2 (a) and (b) provides details of the expert panel's suggestions.

After the meeting of the expert panel the criteria were reviewed by the Environment and Heritage Technical Committee and the landscape disturbance adjustment, recommended by the expert panel was accepted. The nominated approach to deriving high quality habitat old growth was also accepted. (i.e. High Quality Habitat Old Growth (HQHOG) defined as the union of all core fauna species models intersected with candidate old growth). The Environment and Heritage Technical Committee did not accept the translation of forest ecosystem vulnerabilities to old growth and a special meeting was called to discuss this

issue. The following change was made in response to the this meeting:

- sensitivity or vulnerability to disturbance ranking be determined using proportions of old growth area in 1997 relative to the sum of young and recently disturbed forest for each forest ecosystem;

Changes to the derivation of HQHOG as explained above were made prior to reference point development as it became clear that the above approach was not achieving its aim of preferentially selecting the core patches of old growth. An alternative approach that attempted to define HQHOG as old growth habitat where species find optimal habitat for foraging or nesting was then attempted with a list of species reviewed by Environment and Heritage Technical Committee members. Although there were dissenting views about individual species the union of the core habitat of the following list of species intersected with candidate old growth was agreed to by Environment and Heritage Technical Committee and used to define HQHOG for:

- Tiger Quoll
- Powerful Owl
- Sooty Owl
- Greater Glider
- Yellow-bellied Glider
- Stuttering - Barred Frog

The Joint RFA / CRA Steering Committee requested that old growth targets not be adjusted for landscape disturbance and revert to the provisional old growth target split according to the JANIS criteria 1 & 2 i.e. 100% or 60%. This change was implemented except for adjustment of individual old growth types with a 60% target that had been identified as being rare or highly depleted. These types were allocated a 100% target.

3.4.3 Target setting and conservation requirements

Appendix 3.3 contains a description of the target table for old growth forests.

3.5 WILDERNESS

3.5.1 Background

JANIS details a specific target for wilderness (see section 2.1.4). It states that "90% or more if practicable of the area of high quality wilderness that meet minimum area requirements should be protected in reserves". It further suggests means for determining potential wilderness areas and for determining potential wilderness boundaries.

For the purpose of the RFA, and National Estate assessment, the JANIS criteria defined the identification of 'high quality wilderness'. This involved using an up-to-date National Wilderness Inventory (NWI) to identify areas of at least 8,000 hectares of NWI Wilderness Quality 12 or above. The Environmental Heritage and Technical Committee determined that the NWI needed to recognise national manageable boundaries.

The following set of rules was adhered to in delineating wilderness boundaries:

- wilderness areas should preferably have a low perimeter-to-area ratio;
- wherever possible boundaries should include complete catchments and the entirety of distinctive topographic features such as massifs, plateaux, gorges and escarpments;
- where the use of natural features is inappropriate, boundaries should follow features or infrastructure which are clearly identifiable 'on the ground', such as roads, transmission lines, fence lines, or native vegetation/cleared land interfaces;
- boundaries should be set to include buffers wherever possible to protect high quality wilderness from future disturbances on adjacent land;
- boundaries should be set at a minimal distance (20 metres) from bordering roads and other disturbed sites;
- relatively small disturbed areas which are capable of being restored may be included within a delineated wilderness if to do so would:
  - enhance the wilderness quality of the surrounding or adjacent wilderness; or
  - result in the amalgamation of otherwise separate nodes of high quality wilderness;

- boundaries associated with impoundments should follow the high water mark; and
- the use of point-to-point straight lines or contour lines that are not apparent 'on the ground' should be avoided wherever possible.

Although the delineation process aimed to capture all land of high quality wilderness within wilderness boundaries, in some instances small areas were excluded due to shape and viability considerations. Conversely, in other places, small areas of relatively low wilderness quality were incorporated within boundaries for practical management reasons.

3.5.2 Target setting

The report on the wilderness assessment project, carried out as part of the Eden CRA (Environment Australia and National Parks and Wildlife Service, 1997), describes in more detail the process involved in provision of the wilderness data layer. As part of the conservation requirements project a target of 90% of the area evaluated as wilderness in this process needed to be identified for addition to the reserve system. To determine the current wilderness reservation status, the delineated areas of NWI high quality wilderness were intersected with the existing land tenure boundaries.

3.6 NATIONAL ESTATE

3.6.1 Background

Identification of national estate values in a regional context involves a comparative assessment of the significance of places having one or more attributes or values derived from the national estate criteria.

A place is deemed significant for a particular national estate value when the expression of the value at the place is assessed to be at or above a certain threshold of significance. Thresholds of significance are developed for each value, and are based on the level of current knowledge about the nature and extent of natural values, and their distribution in the landscape at local, regional and national levels.

The assessment of national estate values in a regional context requires:

- identification and mapping of relevant values in the region;
- assessment of the expression of values in particular areas against thresholds of significance;
- identification of areas with values above appropriate thresholds of significance.

A workshop of experts. consisting of Brendan Mackey (ANU). Phillip Gilmour (independent ecologist), Dan Faith (CSIRO), Craig Moritz (University of Queensland), Bruce Wellington (independent ecologist) Bronwen Wicks (EA), Philip Hodgson (EA), Karl Bossard (EA), Geoff Moore (NSW NPWS), Simon Ferrier (NSW NPWS) and Ian Barnes (SFNSW), was held to provide advice concerning the use of the available data layers for the Eden region for identifying places with national estate values associated with: endemism; refugia; relictual and/or Gondwanic species; species with disjunct populations or populations at their biogeographic limits; and with high diversity or richness (see Appendix 4.10).

3.6.2 Identifying indicative areas of National Estate significance

Old Growth Forests
(A.2 Continuing processes & B.1 Natural rarity)

The old growth forest identified according to the JANIS criteria was used as the primary dataset for identification of indicative national estate old growth values. (Further details of the old growth assessments undertaken in the Eden CRA can be found in the report *Old Growth Forest Related Projects Eden CRA*, National Parks and Wildlife Service (1997) and in Sections 3.4 and 4.3 of this report.)

Areas of indicative national estate old growth significant for ecological processes (under criteria A.2) are considered to be those that have high integrity and natural context (as identified by the NWI biophysical naturalness index) and above a minimum size threshold to ensure the viability and quality of the forest stand. Areas of indicative rare old growth are also of national estate significance (under criteria B.1).

An overlay of the least disturbed areas as identified by the biophysical naturalness index (BN=5) was overlaid on the JANIS old growth layer. A minimum viable forest patch size (5 hectares) was applied. (This was also the minimum polygon size for air photo interpretation).

Wilderness
(B.1 Natural rarity)
For the purposes of the Eden CRA assessment, national estate wilderness was considered to be equivalent to JANIS wilderness. That is, areas with a minimum NWI rating of 12 and a minimum size of 8,000 hectares were considered to have significant national estate wilderness value. Further details of the wilderness assessments undertaken in the Eden CRA can be found in the report *Wilderness Assessment and Identification in the Eden Region* (Environment Australia and National Parks and Wildlife Service 1997) and in Sections 3.5 and 4.4 of this report.

Flora Communities
(D.1 Principal characteristics of class & B.1 Natural rarity)

In the Eden CRA 'forest ecosystems', 'plant communities' and 'forest vegetation types' are all considered to refer to the same vegetation units and are used interchangeably.

The forest ecosystem data layer of the CRA was used as the primary dataset. A workshop of experts was convened to review JANIS ecosystem targets and advise on forest ecosystem areas that would meet the threshold national estate significance.

The expert workshop, as part of the process of establishing JANIS targets, identified those forest ecosystems that were rare and therefore requiring a 100% target for inclusion in the CAR reserve. These rare forest ecosystems were considered to meet the threshold for national estate rare flora communities.

Rare flora and fauna species and their habitats
(Criterion B.1)

Habitat of rare and threatened flora and fauna species identified according to the JANIS criteria was used as the primary dataset for the identification of indicative national estate areas for this value.

Significant habitat for a range of rare and threatened fauna species was identified in the Response to Disturbance Project (Environment Australia, 1997).

Significant habitat for rare and threatened flora was not identified for the Eden CRA due to the paucity of floristic data. However, a specified number of known populations for each rare and threatened flora species occurring in the Eden region was identified for inclusion in the CAR reserve system. Further details can be found in Sections 3.3 and 4.2, and Appendices 4.2 – 4.7 of this report.

Threshold: All areas identified as significant for rare and threatened species were considered to meet the threshold for national estate significance.

Flora and Fauna Refuge Values
(Criteria A.1 and A.2)

The workshop of experts established the following steps to identify refugia or potential refugia in the Eden region:

Refugia to long term climatic change

Identify and map all areas of rainforest, isolated mountain tops and areas with steep altitudinal gradients.

Steep altitudinal gradients were defined as slopes >308. Isolated mountain tops were defined as the area including the summit and extending down to a contour between 75 m and 100 m below the summit. Plateau areas were defined as the area including the plateau down to approximately 175 m below the highest points on the plateau (both defined using a 25 m Digital Elevation Model).

Drought refugia

Identify and map all areas of rainforest, riparian vegetation, old growth wet forest and wetlands.

Fire refugia

Identify and map all areas of rainforest, wetlands and mountain tops.

Threshold (for all refugia): All occurrences >† 10 hectares of these areas were considered as refugia or potential refugia.

Relictual and/or Gondwanic flora species
(A.1 Past processes)

The opinion of the expert workshop was that areas of rainforest and mountain tops were the most likely habitat for relictual or Gondwanic species.

Threshold: All occurrences of Dry Rainforest ≥†5†hectares (all areas very small), and areas of ≥†20†hectares of other rainforest types were considered to be above threshold. All of Bunga Head Rainforest was included, as it is the only occurrence of this rainforest type.

Flora and fauna species endemic to region
(A.1 Past processes)

The workshop of experts identified all known endemic flora species for the Eden region. There are no known endemic vertebrates in the Eden region and this assessment gave no consideration to endemic invertebrates. Consequently this assessment was confined to endemic flora.

Point locality information was plotted for all species and a 1 km^2 was overlayed on this.

Threshold: All areas with two or more endemic species within a single grid or within two adjacent grids were considered to be above threshold.

Flora species - disjunct populations
(A.1 Past processes)

All known occurrences of flora species with disjunct populations in the Eden region were identified by expert opinion.

Point localities information for all identified species was plotted and a 1 km^2 grid was overlayed on this.

Threshold: All areas with two or more species within a single grid or within two adjacent grids were considered to be above threshold.

Undisturbed catchments
(A.2 Continuing processes)

The methodology and results of this assessment are covered in the report *Extensive Natural National Estate Values: Eden CRA Region* (Environment Australia 1998). Identification was based on an assessment of catchment disturbance defined by the Wild Rivers Database.

Natural landscapes
(B.1 Natural rarity)

The methodology and results of this assessment are covered in the report *Extensive Natural National Estate Values: Eden CRA Region* (Environment Australia 1998). Identification was based on biophysical naturalness as defined by the NWI, with areas greater than 1,000 hectares and BN=5 being considered to be above threshold.

Flora community diversity
(A.3 Richness and diversity)

The method of identifying this value was based on previous regional national estate assessments in other RFA regions.

The forest ecosystem layer was overlayed with a 1†km^2 grid. This grid size was chosen based on the coverage of the data and the required resolution.

The number of unique ecosystem types in each grid was determined. Multiple occurrences of an ecosystem type in a grid and cleared land were not included.

Threshold: Grids with eight or more ecosystem types were considered to be of high diversity and above threshold. (The count ranged from 1 - 15 ecosystem types per grid cell.)

4. RESULTS

4.1 FOREST ECOSYSTEMS

Preliminary targets, based on total area for each forest ecosystem, were calculated prior to the expert panel workshop (i.e. pre 1750 vs extant forest ecosystem coverage) using the data layer obtained from the forest ecosystem mapping project. The expert panel decided upon target values for distribution and patch size, based on their knowledge of the forest ecosystems and the areas in which they are located, other feasible alternatives had limitations. Appendix 4.1 shows the conservation targets obtained for each forest ecosystem and summarises information provided by the expert panel. Appendix 4.2 details the results of the expert panel workshop including areas identified as being of National Estate significance. These results provide additional information to assist in preparations for negotiations.

4.2 SPECIES

The Response to Disturbance project provided information that was used to develop conservation requirements for species. Environment Australia, State Forests of NSW and NSW National Parks and Wildlife Service were all jointly involved in tasks associated with the Response to Disturbance project.

4.2.1 Fauna

Species targets

The following conservation requirement information was provided by the Response to Disturbance project;

- review of fauna models with definitions of core, intermediate and marginal habitat quality,
- carrying capacity values,
- habitat protection target areas,
- minimum patch sizes,
- species subregions and number of patches per subregion,
- information on specific habitat requirements and associated management recommendations.

Refer to, Appendix 4.3: Details of maps created for species with area targets, Appendix 4.4: Summary of final agreed target areas and associated information and Appendix 4.5: Habitat Models and Subregion Maps to see how fauna targets were applied spatially.

Some of the spatial and area targets developed in the Response to Disturbance fauna expert workshops were not defined clearly and needed to be resolved prior to data preparation for C-Plan. These were:

- The total target areas for the Greater Glider were smaller than the sum of minimum patch size areas allocated to the sub-regions within Eden. Thus the target area was increased by 400 hectares to meet this sum.
- Some species required large target areas to adequately protect suitable habitat but the patches allocated for reservation in the workshops were considerably less than the target area. In order to meet the shortfall, SFNSW stream buffers and Preferred Management Priority areas (PMPs) contributed to meet the total habitat protection target. The species concerned were; the four forest owls, Tiger Quoll, Common Death Adder and all bird species except for the Red-browed Tree-creeper. See Appendix 4.4.
- Some species models had subregions identified for management only or important for further survey (i.e. they have no area targets). Since C-Plan required area targets to be assigned to subregions, these areas are effectively the same as any other area outside target associated subregions and thus these subregions were not incorporated in the final habitat models.

- Habitat models for the Grey-headed Flying Fox and Koala were subject to some debate and were finalised post-workshop through negotiations between stakeholders and fauna experts. The Tiger Quoll model had to be corrected post-workshop as habitat quality definitions were inadvertently assigned to the wrong vegetation types. This was amended after the workshops with one of the three experts present.

Preparing the data for C-Plan

The process for preparing this data is described as follows:

- Species subregions identified in the response to disturbance workshop were digitised and classified on screen using the appropriate fauna model as a backdrop;
- Fauna models were "cleaned' to remove any fragments of modelled habitat less than 30% of double the species home range. This ensured that isolated fragments not capable of supporting a population were not included in the C-Plan matrix. This process was the same as that used during the NSW Interim Assessment Process;
- These processed fauna models were then intersected with the planning unit layer to produce a table giving hectares of each habitat type per planning unit;

Core, intermediate and marginal habitat quality was multiplied by the relevant carrying capacity values (ability of habitat to support species) defined in the Response to Disturbance project. These values for each habitat type were then summed to give a total carrying capacity for each planning unit. These values were then imported into the C-Plan matrix.

4.2.2 Flora

Appendix 4.6 contains the target table for significant flora species considered in the Response to Disturbance project. Each species has a target for reservation, indicating the number of populations of that species sought outside the current reserve system. This table also contains the rankings of the species' vulnerability to threatening processes and the order in which the species were to be entered into C-Plan. Vulnerability rankings or reservation requirement ranks were considered in the negotiation process.

Approximately 20 species were not given a target as there were no accurate location or ecological data available. It was recommended that these species be surveyed in the ongoing Regional Forest Agreement assessment process.

During target setting, species that were considered to be exceptional cases due to their unusual responses to disturbance were:

1. *Hakea macreana, Santalum obtusifolium* and *Cymbidium suave* were considered by Doug Binns and Michael Doherty to be of low vulnerability thus one point was subtracted from the scores of these species.
2. *Caladenia clarkiae, C.* sp. aff *reticulata, C. hunteriana* and *Pterostylis plumosa* were considered to be of exceptionally high vulnerability to threatening processes and thus one point was added to their rankings

4.3 OLD GROWTH

Appendix 4.7 contains the complete target table for old growth. Other results to come out of this process to aid negotiations were a contextual layer of aesthetic old growth and recommendations from the expert panel to aid in negotiations (see Appendix 3.2).

Increases in targets from 60% to 100% were done on the basis of the JANIS criteria and objectives. Information relevant to specific objectives is contained in Appendix 3.2.

4.3.1 Recommendations for determining conservation requirements in future CRAs

A number of suggestions were made by the expert panel to improve the derivation of conservation requirements for old growth, such as:

- rule sets applied to old growth layers to obtain targets for the Eden CRA area are specific to this CRA region. The process needs to be expanded and modified before being applied to other regions;
- vulnerability should be linked directly to target adjustment;
- need to develop methods for analysing contiguity and fragmentation of old growth forests in other regions; and
- improved fauna and flora species models should improve the ability to derive high quality habitat old growth.

4.4 WILDERNESS

To determine the reservation status for JANIS high quality wilderness, the delineated areas of NWI high quality wilderness were intersected with the existing land tenure boundaries. This integration found that 87,457†hectares of the 90,877 hectares (96%) are currently within dedicated reserves (Tables 1 and 2).

As discussed above, for management purposes, the delineation of high quality wilderness may incorporate non-high quality wilderness. As a result, there is a small portion of private land included in the delineated NWI area in Genoa. There is also a small portion of State forest within the Nadgee NWI area. Within the Brogo NWI Wilderness area there are small pockets of freehold/leasehold land, other crown land, and a portion of Murrabrine State Forest.

TABLE 1: EXTENT OF NWI HIGH QUALITY WILDERNESS IN DEDICATED RESERVES

Place	Total Area (hectares)	Area in Reserves (hectares)	Proportion in Reserves (%)
Brogo	66,442	63,128	95
Nadgee	16,907	16,887	99
Genoa	7,528	7,127	95
Total	90,877	87,142	96

TABLE 2: EXTENT OF NWI HIGH QUALITY WILDERNESS ON DIFFERENT LAND TENURES

Tenure	Brogo (hectares)	Nadgee (hectares)	Genoa (hectares)
National Park or Nature Reserve	63,128	16,887	7,127
State Forest	2,664	19	0
PMP 1.3*	294	0	0
Other Crown Land	208	1	0
Private Land	108	0	400
Reserved Crown Land	29	0	0
Leasehold Crown Land	11	0	1

*PMP 1.3 is the State Forests of NSW Preferred Management Priority Classification for areas reserved as Flora Reserves and Forest Preserves (Forestry Commission of NSW 1993)

While the minimum wilderness reservation requirements of JANIS have been met, the EHTC report requires that, *practicability (or validation) assessment will need to be conducted* if a reservation level less than 100% is sought.

None of the three delineated areas of high quality wilderness are currently located entirely within dedicated reserves. The majority of Murrabrine State Forest, within the delineated Brogo wilderness, represents the largest single unreserved area of high quality wilderness.

Optimal protection of wilderness values in the Eden region will require that all areas of NWI high quality wilderness be reserved. Where this is impractical (i.e. private land) other protective mechanisms will be required. Although identified wilderness, under the Wilderness Act, are not formally taken into account in determining reservation targets under JANIS, they should be considered when determining boundaries which maximise the protection of NWI high quality wilderness.

4.4.1 Negotiations considerations

The JANIS target of 90% was easily achieved within the existing reserve system. Two of the areas (Nadgee & Genoa) which met the JANIS criteria are already within declared wilderness under the NSW Wilderness Act. The other area of NWI Wilderness, Brogo, also has a large proportion of the area already declared.

It is therefore recommended that these areas not declared under the NSW Act be given consideration during the negotiations to be added to the existing wilderness in this area.

4.5 NATIONAL ESTATE

4.5.1 Old growth forests

When the biophysical naturalness data layer was applied to the JANIS old growth data layer, approximately 80% of identified old growth was found to be within areas of high biophysical naturalness (BN=5) and therefore meet this national estate threshold. The same minimum viable forest patch size (5 hectares) was used in both assessments.

Approximately one third of the remaining area of old growth forest below the high biophysical naturalness threshold (i.e. 8% of the total old growth area) consisted of rare communities of old growth (Criteria B.1). These rare old growth forest communities are also a JANIS criteria which have a 100% target for inclusion in a CAR reserve. All occurrences of rare old growth were considered to meet the national estate threshold.

A separate national estate old growth map was not considered necessary given the high congruence (approximately 88%) between the JANIS old growth data layer and indicative areas of national estate old growth value.

4.5.2 Wilderness

Areas with a minimum NWI rating of 12 and a minimum size of 8,000 hectares were considered to have significant national estate wilderness value. These areas are detailed in the report *Wilderness Assessment and Identification in the Eden Region* (Environment Australia and National Parks and Wildlife Service, 1997).

4.5.3 Principal characteristics of vegetation class

The expert panel identified significant areas that were notable representative examples of a number of forest ecosystems. These areas are detailed in Appendix 4.2. The expert panel also identified specific flora communities as being significant. These were:

- all areas of rainforest greater than 20 hectares;
- all flora communities occurring on rhyolite and lowland basalt (Lochiel group).

Where the expert panel was not able to identify specific outstanding examples of particular flora communities, they advised that forest ecosystems identified for inclusion in the CAR reserve system would be of sufficient quality to meet the national estate criteria for those flora communities.

The areas identified as a result of this process are delineated on Map 1 (Indicative Areas Significant for Plant Communities). Approximately 44% of the indicative areas delineated as significant for flora communities occur in national park or nature reserve. Nearly 62% of the indicative areas occurring on public land (Table 3). Approximately 34% of the total area occurs in places already listed in the Register of the National Estate.

TABLE 3: LAND TENURE OF THE AREA ASSESSED AS SIGNIFICANT FOR FLORA COMMUNITIES

Tenure	Approximate Area(hectares)	Proportion of Total (%)
National Park or Nature Reserve	4,280	44
Private Land	3,712	38
State Forest	1,287	13
PMP 1.3*	214	2
Reserved Crown Land	157	2
Other Crown Land	114	1

*PMP 1.3 is the State Forests of NSW Preferred Management Priority Classification for areas reserved as Flora Reserves and Forest Preserves (Forestry Commission of NSW 1993)

4.5.4 Rare, vulnerable or endangered species

National Estate areas important for rare, vulnerable or endangered species are considered equivalent to JANIS areas important for rare, vulnerable or endangered species. Details concerning the identified areas can be found in the report, *Response to Disturbance of Forest Species in CRA Regions in NSW - Eden Region*, Environment Australia (1997) and in Sections 3.3 and 4.2, and Appendices 4.2 – 4.7 of this report.

4.5.5 Centres of endemism

Approximately 50% of the total area identified as centres of floristic endemism occurs in national park or nature reserve and 41% of the total area is on private land (Table 4). Nearly 48% of total area occurs in places already listed in the Register of the National Estate.

TABLE 4: LAND TENURE OF THE AREA ASSESSED AS CENTRES OF FLORISTIC ENDEMISM

Tenure	Approximate Area (hectares)	Proportion of Total (%)
National Park or Nature Reserve	1,605	50
Private Land	1,326	41
State Forest	271	8
Other Crown Land	31	1

Reserved Crown Land	6	<1

The identified Centres of Endemism are shown on Map 2. See Appendix 4.8 for a list of endemic flora species for the Eden CRA region.

4.5.6 Refugia

Forest communities, mountain tops and steep gradients delineated as refugia or potential refugia are listed in Table 5 and delineated on Map 3.

TABLE 5: TYPES OF AREAS DELINEATED AS REFUGIA

Refugia to Long Term Climatic Change
Rainforest included: Bunga Head Rainforest Coastal Warm Temperate Rainforest Cool Temperate Rainforest Dry Rainforest Hinterland Warm Temperate Rainforest Myanba Eucalypt - Fig Forest *Isolated mountain tops included*: Burragate Peak - Jingera Rock (areas above ~750 m) Mount Imlay (areas above ~800 m) Mount Poole (areas above ~675 m) Mumbulla Mountain (areas above ~675 m) Murrabrine (Mountain) (areas above ~725 m) Nadgee Mountain (areas above ~450 m) Nungatta Plateau (areas above ~800 m) Waalimma Peak (areas above ~625 m) Wolumla Peak (areas above ~675 m) Nalbaugh Plateau (areas above ~975 m) *Steep Gradients included*: Areas with steep (≥308) altitudinal gradients.
Drought Refugia
Southern Riparian Scrub Northern Riparian Scrub Riverine Forest Wet Old Growth Forest Mountain Wet Layered Forest (Shining Gum) Mountain Wet Layered Forest (Brown Barrel) Tantawangalo Wet Shrub Forest Mountain Wet Fern Forest (Brown Barrel-Gum) Hinterland Wet Fern Forest (Gum) Hinterland Wet Shrub Forest (Stringybark) Mountain Wet Herb Forest (Messmate-Gum) Basalt Wet Herb Forest (Brown Barrel-Gum) Flats Wet Herb Forest (Ribbon Gum) Brogo Wet Vine Forest (Red Gum) Brogo Wet Shrub Forest (Peppermint-Blue Box) Wadbilliga Wet Shrub Forest Swamp Heath Lowland Swamp Swamp Forest Subalpine Bog Floodplain Wetland Estuarine Wetland
Fire Refugia
Identified rainforest, wetlands and mountain tops.

Approximately 72% of the total area identified as refugia occurs in national park or nature reserve and 86% of the total area is on public land (Table 6). Nearly 57% of total area occurs in places already listed in the Register of the National Estate.

TABLE 6: LAND TENURE OF THE AREA ASSESSED AS SIGNIFICANT AS REFUGIA

Tenure	Approximate Area (hectares)	Proportion of Total (%)
National Park or Nature Reserve	43,522	72
Private Land	8,179	14
State Forest	6,862	11
PMP 1.3*	787	1
Reserved Crown Land	474	<1
Other Crown Land	447	<1
Leasehold Crown Land	155	<1
State Forest Plantation	42	<1

*PMP 1.3 is the State Forests of NSW Preferred Management Priority Classification for areas reserved as Flora Reserves and Forest Preserves (Forestry Commission of NSW 1993)

4.5.7 Relictual species

Areas significant for relictual and/or Gondwanic species included identified rainforest and mountain tops and are delineated on Map 4.

Approximately 78% of these areas occur on public land, with 66% of the total area occurring in national park or nature reserve, (see Table 7). Approximately 51% of total area occurs in places already listed in the Register of the National Estate.

TABLE 7: LAND TENURE OF THE AREA ASSESSED AS SIGNIFICANT FOR RELICTUAL SPECIES

Tenure	Approximate Area (hectares)	Proportion of Total (%)
National Park or Nature Reserve	10,576	66
Private Land	3,513	22
State Forest	1,565	10
Leasehold Crown Land	405	<1
PMP 1.3*	181	1
Reserved Crown Land	67	<1
State Forest Plantation	20	<1

*PMP 1.3 is the State Forests of NSW Preferred Management Priority Classification for areas reserved as Flora Reserves and Forest Preserves (Forestry Commission of NSW 1993).

4.5.8 Disjunct species

The areas identified as significant for species with disjunct populations are delineated on Map 5. It should be noted that the limited flora point locality data affected the usefulness of this analysis.

Approximately 99% of these areas occur on public land, with 54% of the total area occurring in national park or nature reserve, (see Table 8). Nearly 99% of total area occurs in places already listed in the Register of the National Estate.

Appendix 4.9 details information on disjunct flora species.

TABLE 8: LAND TENURE OF THE AREA ASSESSED AS IMPORTANT FOR SPECIES WITH DISJUNCT POPULATIONS

Tenure	Approximate Area (hectares)	Proportion of Total (%)
National Park or Nature Reserve	1,026	54
State Forest	650	34
PMP 1.3*	198	10
Private Land	27	1

*PMP 1.3 is the State Forests of NSW Preferred Management Priority Classification for areas reserved as Flora Reserves and Forest Preserves (Forestry Commission of NSW 1993)

4.5.9 Flora community diversity or richness

The areas identified as being significant for high flora community diversity or richness are delineated on Map 6.

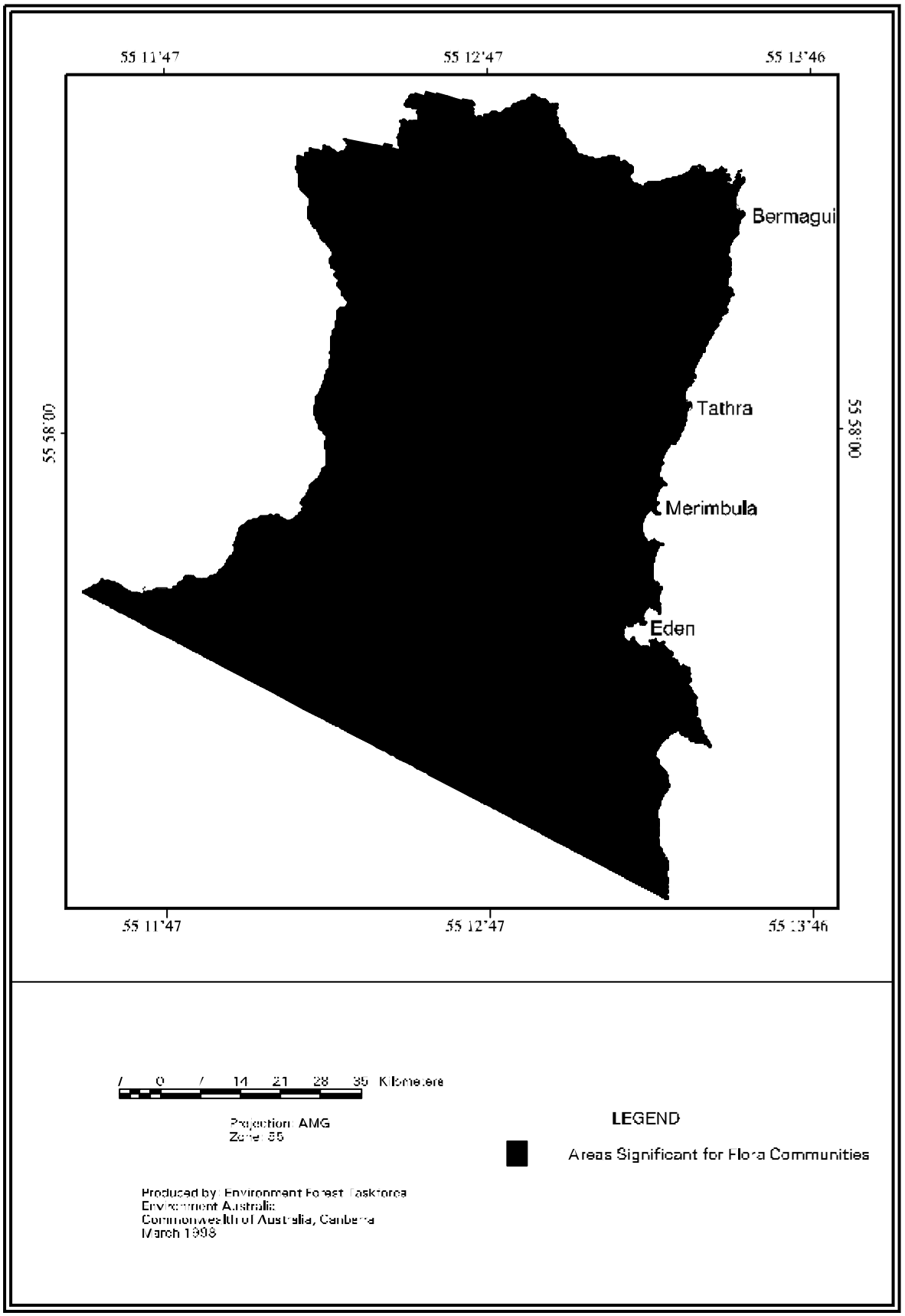
Approximately 49% of these areas occur in existing national park or nature reserve (see Table 9). Approximately 38% of total area occurs in places already listed in the Register of the National Estate.

TABLE 9: LAND TENURE OF THE AREA ASSESSED AS HAVING HIGH DIVERSITY OR RICHNESS

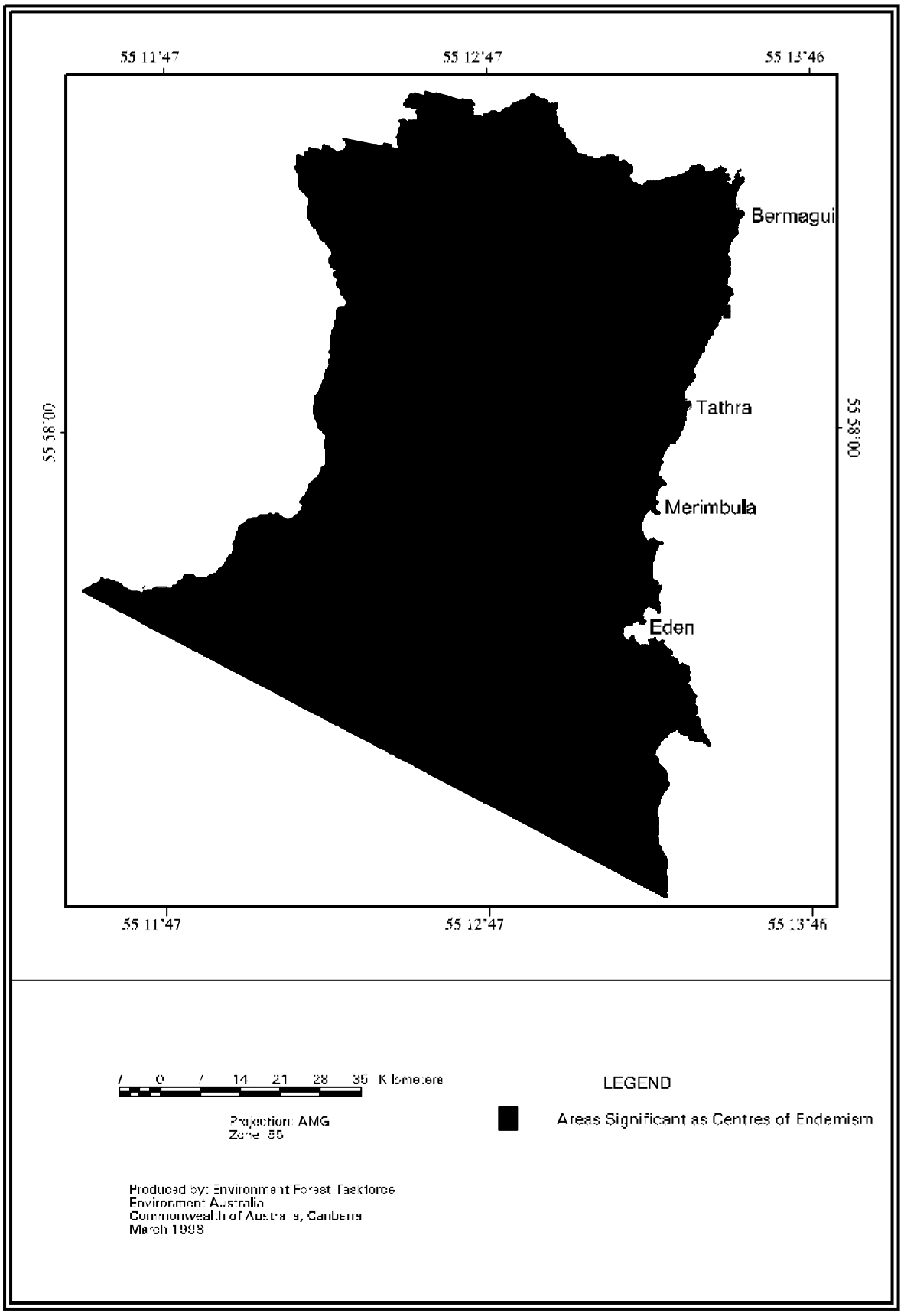
Tenure	Approximate Area (hectares)	Proportion of Total (%)
National Park or Nature Reserve	37,195	49
State Forest	22,562	30
Private Land	13,871	18
PMP 1.3*	896	1
State Forest Plantation	641	1
Reserved Crown Land	422	<1
Other Crown Land	308	<1
Leasehold Crown Land	206	<1
Coastal Inlet	81	<1

*PMP 1.3 is the State Forests of NSW Preferred Management Priority Classification for areas reserved as Flora Reserves and Forest Preserves (Forestry Commission of NSW 1993).

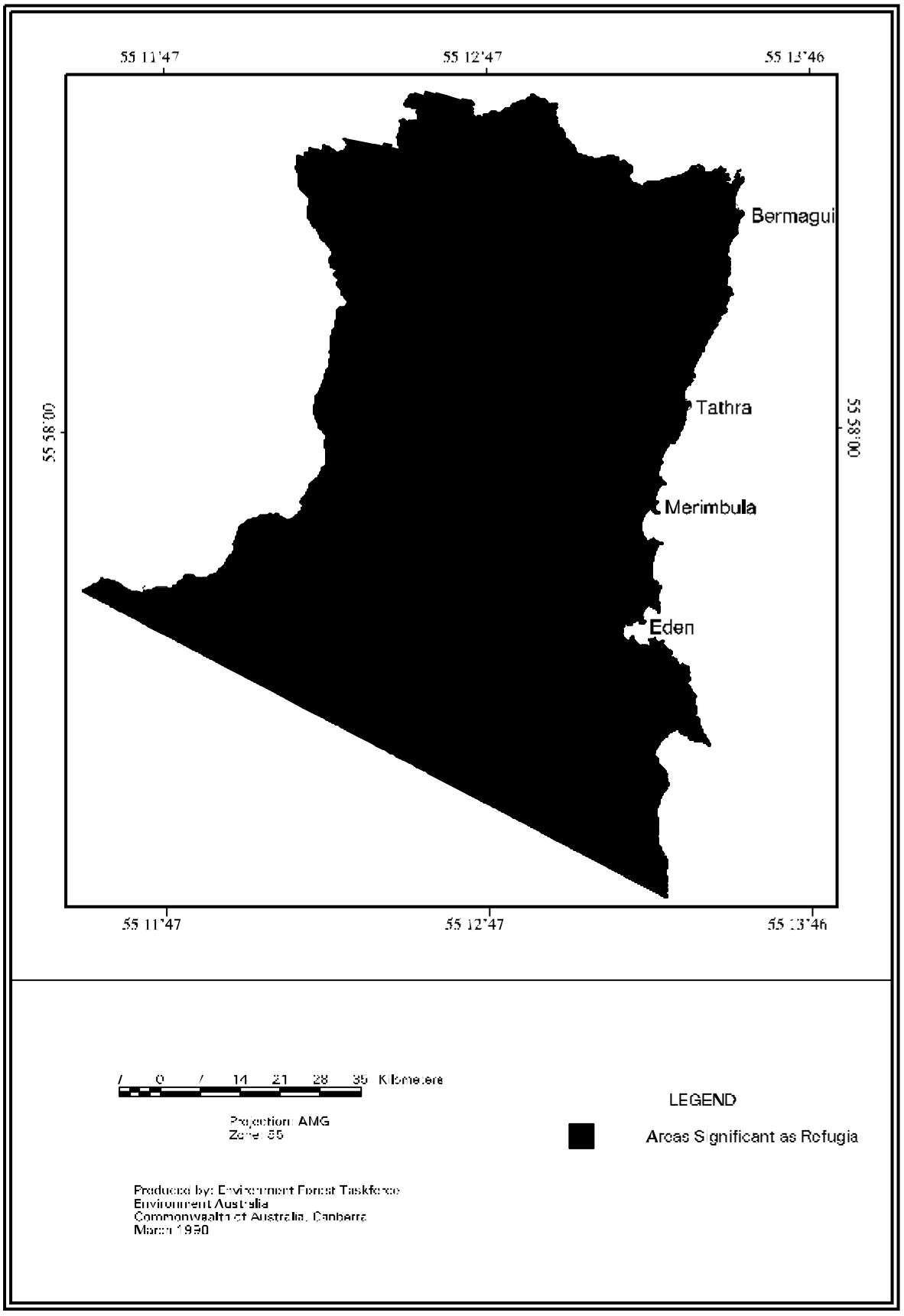
Map 1: Indicative areas significant for flora communities (National Estate criterion D.1)



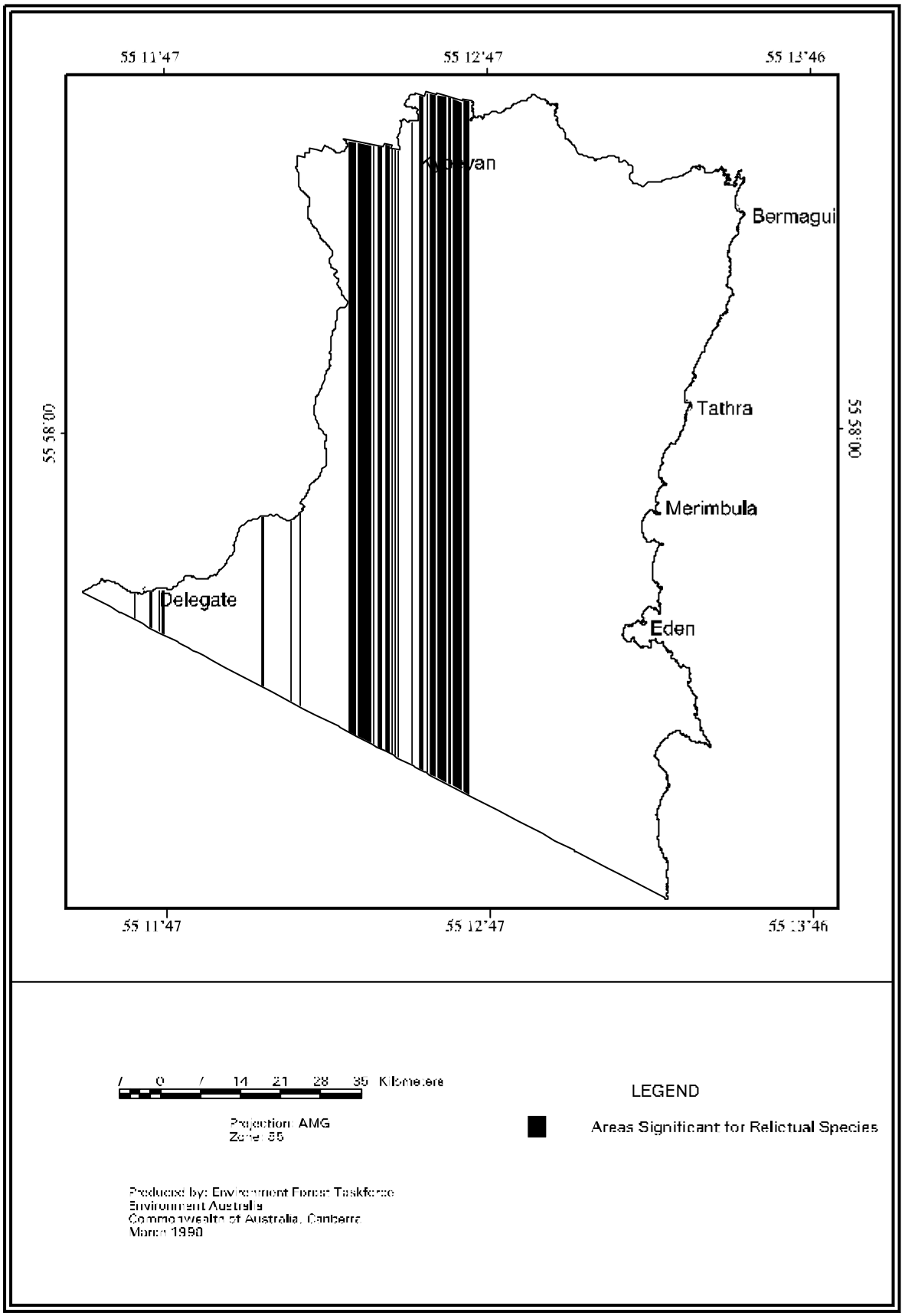
Map 2: Indicative areas significant as centres of floristic endemism (National Estate criterion A.1)



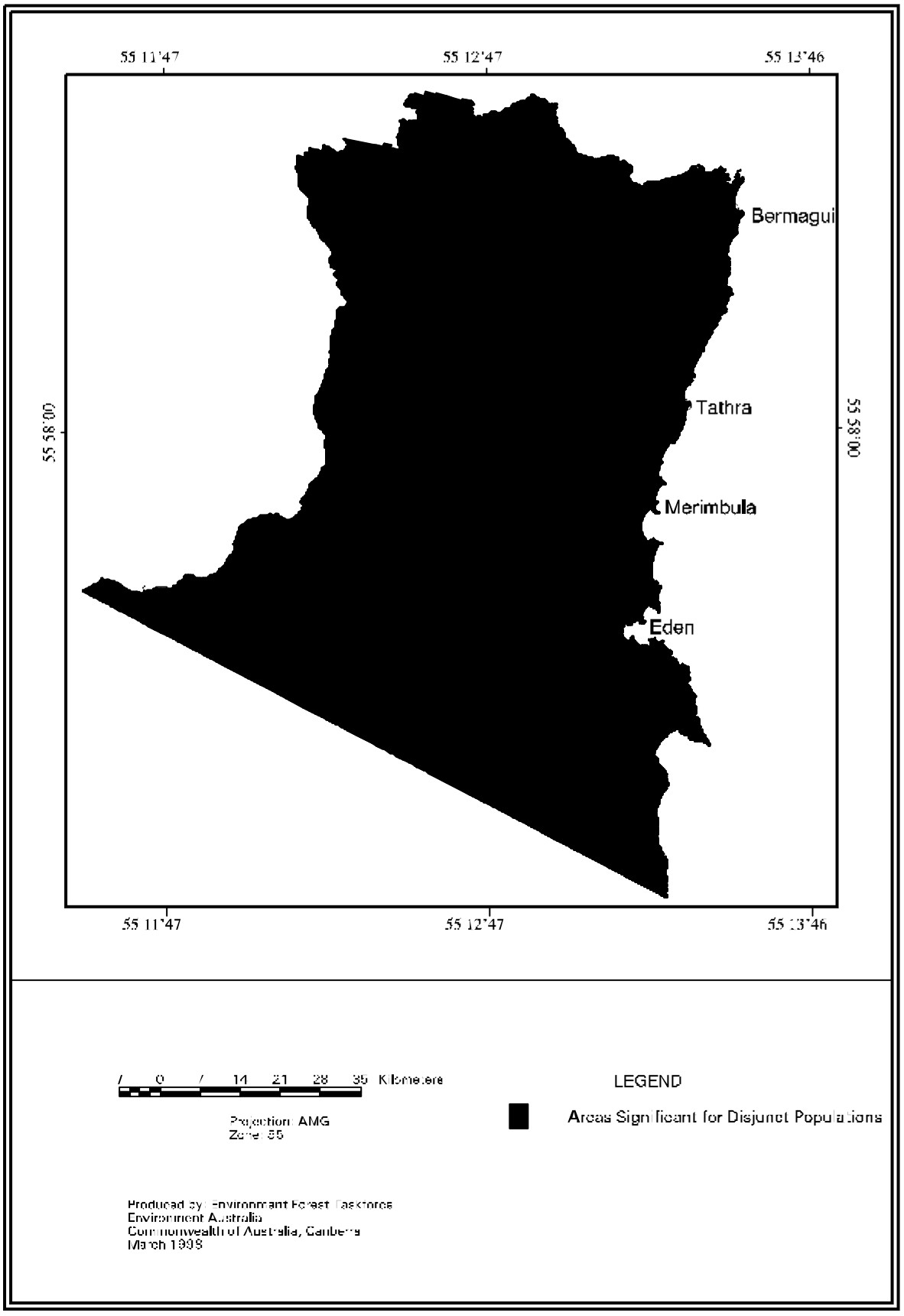
Map 3: Indicative areas significant as refugia
(National Estate criterion A.2)



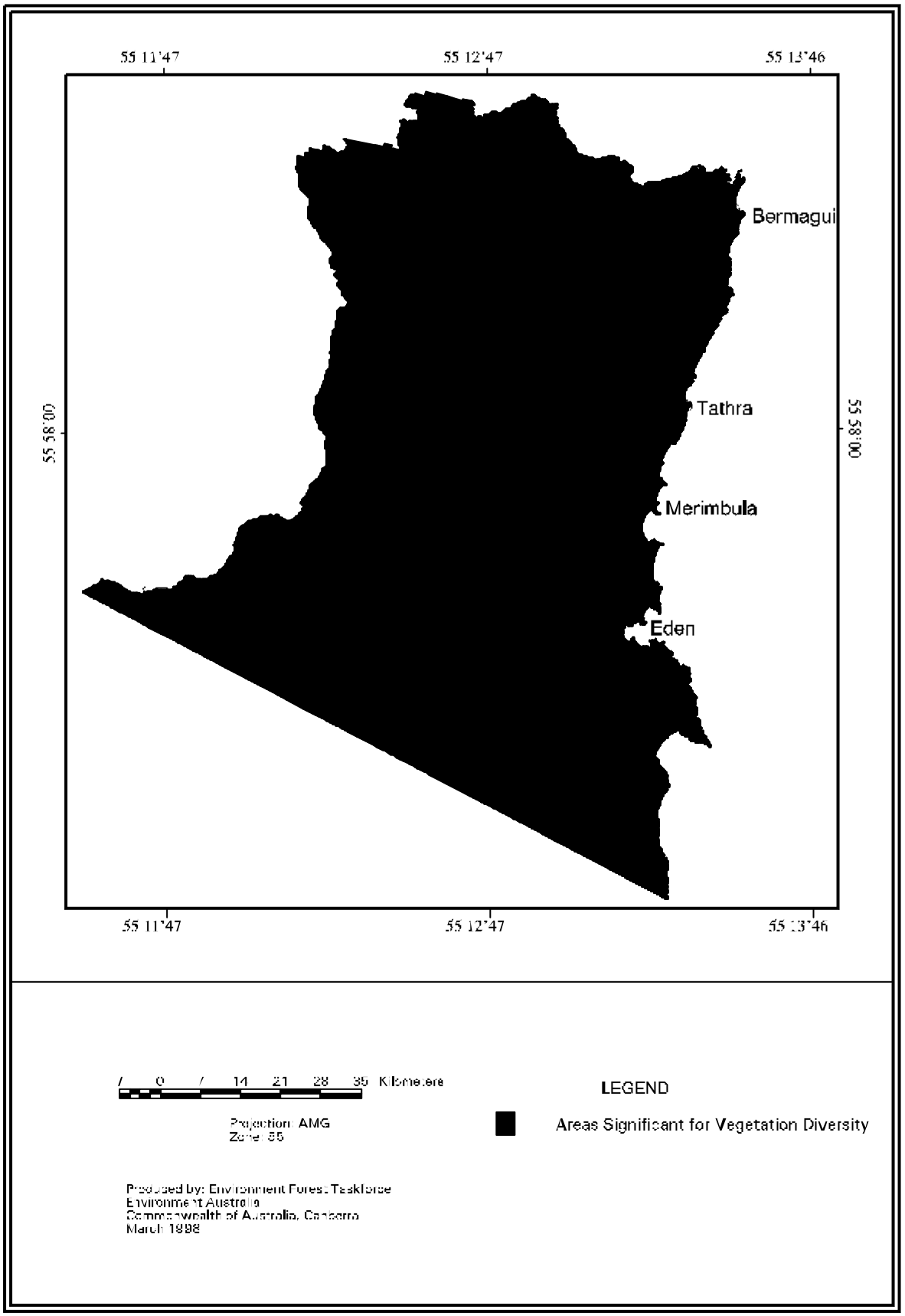
Map 4: Indicative areas significant for relictual, primitive and/or Gondwanic species (National Estate criterion A.1)



Map 5: Indicative areas significant for species with disjunct populations (National Estate criterion A.1)



Map 6: Indicative areas significant for vegetation diversity or richness (National Estate criterion A.3)



5. CONCLUSION

The conservation requirements project, for the Eden CRA, developed a process enabling the formulation of conservation requirements for all elements of biodiversity under consideration. Habitat protection targets were achieved for forest ecosystems, species (flora and fauna), old growth and wilderness. Experts in each area of biodiversity under consideration provided rankings for vulnerability to threatening processes and advice on the best expression of protection targets.

Indicative areas of significant natural national estate value were also identified.

Targets achieved during the conservation requirements project were entered into C-Plan. These results combined with advice provided by the expert panels ensured that the reservation needs of each of the elements of biodiversity, considered in this assessment, were recognised prior to negotiations.

Determination of conservation requirements for the Eden CRA was carried out under tight time restrictions. Most recommendations for improving the process revolved around having more time for data analysis. Although the process carried out for the Eden CRA region will not necessarily be used in other CRA regions the experience gained will be valuable in the formulation of future strategies.

6. REFERENCES

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7. APPENDICES

Appendix 3.1 - Supporting documentation for forest ecosystems target table

Appendix 4.1 contains a spreadsheet detailing the areas addressed to fulfil the JANIS criteria for forest ecosystems. A full listing of the fields contained in the spreadsheet are outlined below, and the individual tasks necessary to ensure that the criteria are effectively dealt with.

Description and definition of fields:

1. Forest Ecosystem Identification number and name.

2. The pre-1750 extent of each forest ecosystems (hectares). This was calculated from the forest ecosystem data layer.

3. The current extent of each forest ecosystem (hectares) based on the most recent API and forest ecosystem data layer.

4. The percentage of that forest ecosystem that has been cleared.

% cleared = 100-(Extant forest ecosystem *100/pre-1750 forest ecosystem)

5. Total area = the nominal habitat protection target based on total area (HPT1) expressed (%)

HBT1 is estimated in the following way:

Status	Definition	Reservation
Endangered	The total area has contracted to less than 10% of its former area (i.e. depleted by ≥90%)	100% where practicable of extant vegetation
Rare	The total area ≤ 1,000 hectares. Calculated independently in each bioregion	100% where practicable of extant vegetation
Vulnerable	• Those forest ecosystems depleted by ≥70% (i.e. those retaining <11-30% of their pre-1750 distribution) within a bioregional context and which remains subject to ongoing threatening processes **or** • not depleted but subject to continuing and significant threatening processes which may reduce its extent.	60% at least of extant vegetation
Other	Forest ecosystems depleted by <70% of their pre-1750 distribution (i.e. those retaining >30% of their pre-1750 distribution)	15% where practicable of pre-1750 vegetation

NB: For Eden, rare forest ecosystems are calculated independently from each IBRA bio-region.

6. Total distribution - the nominal habitat protection target based on total distribution (HPT2) expressed (%).

HBT2 is estimated in the following way:

Status	Definition	Reservation
Endangered	- the distribution has contracted to less than 10% of its former range	100% where practicable
Rare	- a geographic distribution ≤ 10,000 hectares	100% where practicable

7. Patch size considerations - for rare and endangered forest ecosystems only, the nominal habitat protection target based on patch size considerations (HPT3) expressed as (%)

HBT3 is estimated in the following way:

Status	Definition	Reservation
Endangered	90% of its area is in small patches (≤ 100 hectares) which continue to be subject to threatening processes	100% where practicable
Rare	patch size ≤ 100 hectares not aggregated to significant areas.	100% where practicable

8. The nominal habitat protection target %. The maximum percentage value obtained in fields 8, 9, or

9. The nominal habitat protection area (hectares) (NHPA)

The nominal habitat protection area is expressed in (ha) and is based on the maximum value obtained from HPT1, 2 or 3 where:

NHPA1 (hectares) = Pre-1750 forest ecosystem * max (HPT1,2 or 3)/100.

10. Vulnerability to threatening processes:

Rank each forest ecosystem according to their relative vulnerability to threatening processes (eg. inappropriate fire regimes, logging, clearing, weeds, disease etc and the likelihood of these threats occurring). The forest ecosystem received a ranking for its sensitivity to each threatening process. See Appendix 4.1.2 for further details on how this process was carried out.

Vulnerability to threatening processes and likelihood of these occurring	Ranking
Is the forest ecosystem under consideration sensitive to threatening processes such as: fire, logging, clearing, disease, other?	1. Very High 2. High 3. Intermediate 4. Low 5. Very low

11. This field contains an overall ranking for the ecosystems' sensitivity to threatening processes.

This ranking is to be assigned by members of the expert panel on forest ecosystems. Initially these rankings were to equate to specific target adjustments for forest ecosystems, this was later rejected. In the end it was agreed that only flat targets would be used and rankings would help guide fall back options during negotiations such that the most threatened forest ecosystems receive reservation primacy in dedicated reserves and the

least threatened receive greater levels of informal reservation and or prescriptive management where this is judged desirable.

12. Spatial consideration - replication across the geographic range:

Is the forest ecosystem adequately replicated across its geographic range? Ensure that it is and identify the appropriate areas on the supplied map. This will be done manually.

13. Spatial consideration - sampling of full range of biological variation:

Has the full range of biological variation been sampled for this forest ecosystem? (e.g. altitudinal, latitudinal, rainfall etc.). Again, ensure that the likely gradients are identified and demonstrate how the sampling of these can be best achieved across its distribution. This will be done manually.

NB: Fields 12, 13, and 14 identify those forest ecosystems that require special consideration during negotiation due to either their patchy distribution across the landscape, where profound biological variation exists or where the "best bits" are unlikely to receive consideration. For these forest ecosystems, specific recommendations will need to be made to assist manual operations during negotiations.

14. National Estate:

Are the national estate criteria adequately addressed by the JANIS criteria identified above? (i.e. have we identified the best bits?) Expert panel to highlight areas that may be of national estate significance

15. Maximum target value in % columns 5, 6, or 7.

16\17. Shows the targets that should be applied to either the pre-1750 vegetation or the extant vegetation coverage.

18. Shows the JANIS target of 15% of pre-1750 distribution in hectares for all forest ecosystems.

19. Shows the area in hectares for those forest ecosystems with 60 or 100% targets.

20. Final target in hectares. i.e. the greatest value from columns 18 or 19.

21. Comments and suggested management practices to ameliorate threatening processes.

Appendix 3.2 Expert panel recommendations

(a) Minutes of the old growth workshop on target setting for conservation requirements

Friday 26/9/97

Tobruk House, Canberra

Those in Attendance: Bob Bridges (SFNSW), Paul O'Connor (NPWS), Tony Norton (Independent), Sara May (EA), Jane Coram (AGSO) Peter Beukers (NPWS) and Helen Achurch (NPWS Minutes).

1. Introduction and background to workshop tasks

Background

- application of rule set;
- derivation of old growth layer;
- calculation of provisional old growth targets;
- consideration of disturbance and fragmentation of old growth on a regional level changed to consideration on a forest ecosystem level;
- Explanation of changes to old growth guidelines resulting from comments by C. Mackowski and D. Pugh;
- Brief discussion of tasks for the expert panel (as per old growth guidelines and spreadsheet).

Suggested changes to old growth guidelines:

- in task 1 - 'Area of existing Forest Ecosystem' be changed to read 'Area of extant Forest Ecosystem', for consistency of terminology;
- in Description and definition of fields, No. 9 - 'Whether the forest ecosystem'... should be changed to read 'Whether the old growth forest ecosystem';
- C Macowski's proposed approach to target adjustment should read: b) 90% of existing old growth.... and c) 80% of existing old growth.....;
- the table for ranking vulnerability should read: 5. Very High.....1.Very low.

Provisional old growth targets were reviewed by the panel.

2. Definitions of landscape disturbance and fragmentation to be used for adjusting targets for JANIS Criterion 2 types.

The expert panel was asked to review the suitability of the definitions of landscape disturbance and fragmentation contained in the original old growth guidelines and those additional definitions supplied by C Macowski and D Pugh. The following points were raised:

- the panel felt that 10% of pre-1750 was a conservative estimate of forest ecosystem old growth; a more appropriate figure of between 25-30% should be used (further justification of this estimate to be supplied by Tony Norton);
- % of old growth may vary between forest ecosystem types;
- contiguity of forest ecosystem old growth difficult to assess;
- in the Eden CRA, degree of disturbance rather than fragmentation should be considered due to time constraints and the time necessary for adequate analysis of fragmentation.

The expert panel agreed on an alternative rule set for adjusting targets after considering landscape disturbance:

- if old growth as a percentage of extant vegetation is <10% for that forest ecosystem then it receives a 100% target and no need to consider old growth as a percentage of pre-1750 due to JANIS;

- if old growth <=3% of pre-1750 vegetation then it receives 100% target; or
- if old growth is >=30% of pre-1750 vegetation then it receives a target of 60%; or
- if old growth is between 3% and 30% of pre 1750 veg then assign target based on a sliding scale. (% protected by % pre 1750 see attached documentation from Expert Panel).

This rule set makes the assumption that "natural" area of old growth forest is 30% of total forest ecosystem (see expert panel's justification for choosing this figure). The sliding scale was applied to all forest ecosystems. All forest ecosystem types received a 60% minimum target. Target adjustments are shown in column 12 of the spreadsheet and justifications for the adjustment are in column 18. Corresponding revised old growth hectare areas are shown in column 14 of the attached spreadsheet.

Justification for process for determining adjustments for disturbance and fragmentation:

- the expert panel reviewed the three suggested definitions and found them too complex to achieve in the time (esp in relation to contiguity);
- contiguity needs to be assessed in relation to each forest ecosystem type and was difficult to assess due to lack of information.

Additional recommendations:

- targets should be the minimum amount that should be protected in the context of the whole forest ecosystem and shape of area;
- this rule set is specific to this region and needs to be modified for other regions;
- need to relate vulnerability to this process in future regions;
- need to develop ways of analysing contiguity and fragmentation. Planning for this should start early enough so that it can be applied to the target setting process in other regions.

Experts identified the largest and least fragmented areas of old growth on the old growth map.

Rare and depleted forest ecosystem types

Advice was received from David Keith (NPWS) regarding those forest ecosystems that satisfy rare and depleted classifications. (See column 11) r = rare, hd = highly depleted and c = worthy of consideration.

The types identified by David Keith (see attached fax) which did not already have a 100 % old growth target were forest ecosystems 2, 11, 21, 23B, 24, 25, 28, 29, 36 & 58. **It should be noted that no additional increase in target for these types over & above the fragmentation & disturbance was factored into targets for these types (the draft had suggested a 100% target).** Consequently the target figure varies from 67 % to 100 % target. The Environment & Heritage Technical Committee will have to decide whether the nominated targets are inadequate for these types.

Minimum viable patch size

The panel considered a purely structural approach to this issue. Studies have shown (see attached comments from expert panel) that changes in micro climate etc become negligible 1.5 tree lengths from the edge of the forest. (Tree height being the average tree height of highest canopy species) Given this the expert panel felt that patches of forest >1-2ha should be considered viable depending on patch shape. Because mapping units have not gone down to this resolution the general rule should be that no patches should be cut out based on viability but priority should be given to the larger patches. Smaller patches may be advantageous in avoiding fire events so a mix of large and small patches of old growth should be considered as an alternative.

Minimum area issue: Reliability of API data discussed polygons of 10 hectares and down to 2 hectares for rainforest. Suggested that ground checking of smaller areas be carried out before the final cut approved.

Selection of other 'growth stages'

The guidelines suggested that the expert panel consider which other growth stages should be selected when the forest ecosystem target exceeds the old growth target so as to ensure temporal viability.

Suggestions from the panel were:

- Bob Bridges - select old growth and the rest should be a balance through age groups
- Jane Coram & Tony Norton - should select the oldest stands because it is impossible to protect areas completely from disturbance. It is then highly likely that we will end up with a range of successional ages without trying to preserve them.
- Jane Coram - an alternative to old growth could be disturbed old forest or undisturbed mature.
- Tony Norton - could look at each on a case by case basis
- Jane Coram - Because not a lot of disturbed old forest, undisturbed mature forest is more likely to be intact from disturbance (weeds, ferals etc).

The panel agreed that preference of selection should be old growth, then undisturbed mature, then disturbed old forest, and then to disturbed mature forest.

Sensitivity to threatening processes

It was agreed by the panel that the vulnerability rankings for each forest ecosystem, derived during the forest ecosystem workshop, be applied to old growth in those forest ecosystem types. It was highlighted that old growth would incur a greater vulnerability to these processes but lack of information prevents its separation from other growth stages. Appropriate buffering for protection of old growth patches was not considered in the workshop. Experts felt that this needed to be dealt with in the RFA's. Tony Norton will supply information re: buffering requirements for plans of management.

(See Minutes of Forest Ecosystem Expert Workshop Appendix 4.2 for explanation of vulnerability rankings)

Spatial considerations

Suggestions:

- Select old growth throughout its range if 100% target is not achieved;
- look at in a contiguous context, i.e. preferentially select old growth in undisturbed catchments;
- keep contiguity with undisturbed mature forests;
- selecting intact old growth areas irrespective of forest ecosystem types;
- pick up largest sections of old growth rather than individual forest ecosystem approach. May need to give and take a little on targets in order to achieve this;
- maximise contiguity and minimise fragmentation in consideration of tenure.

High quality habitat old growth

On the day of the workshop the high quality habitat layer for fauna species was not complete (we only had 12 species) so the intersection of this layer with the old growth was not possible. The expert panel noted the Environment & Heritage Technical Committee minutes from 12/9/97 to identify areas of high quality habitat old growth for a 100% conservation target & preferentially select these areas. NPWS advised that scaling targets according to the draft would not be possible due to the lack of the layer, however, selection of these areas was probably best achieved by having a high quality habitat old growth layer within C-Plan with the above target.

Aesthetic old growth

NPWS advised the workshop that an aesthetic layer had been generated (Commonwealth responsible for this) and that it had been intersected with the old growth layer. This identified 103 hectares of aesthetic old

growth within the Eden CRA region. The panel noted the suggestion that these areas receive a 100% target from the Environment & Heritage Technical Committee minutes 12/9/97.

Comments from Brian Brooker (FPA)

Brian Brooker's comments received during the meeting were circulated to the workshop. The expert panel thought the above discussion and associated documentation would deal with the FPA's concerns.

Appendix 3.2(b) Old growth forest conservation options - Eden region, NSW

Introduction

An expert panel comprising Ms Jane Coram (AGSO, Canberra) and Professor Tony Norton (CSU, Canberra) was established to comment on conservation options for old growth forest in the Eden region of NSW as part of the CRA process. The experts met for one day in Canberra on 26 September 1997 in the presence of Mr Paul O'Connor, Ms Helen Achurch, and Mr Max Beukers (NSW NPWS), Mr Bob Bridges (State Forests of NSW), and Ms Sarah May and Mr Karl Bossard (Environment Australia).

The primary aims of the expert panel were to:

- evaluate the provisional old growth targets for each forest ecosystem;
- rank old growth types for each forest ecosystem from those most vulnerable and likely to be impacted to those least vulnerable and least likely to be impacted;
- identify the largest and least fragmented areas of old growth forest;
- evaluate the potential for representation of old growth forest across the geographic range of each forest ecosystem; and
- evaluate/develop conservation mechanisms to ensure the long term protection of old growth forest.

Each of the above aims were considered by the experts in consultation with all other participants of the meeting.

Provisional old growth targets for each forest ecosystem

The expert panel was asked to review the suitability of two proposed (and three modified) definitions of landscape disturbance and fragmentation for determining conservation targets (as detailed in the revised old growth conservation requirements version 25/9/97).

The expert panel considered that the figures used in the proposed definitions were quite arbitrary, and that the definitions of fragmentation and contiguity needed to be considered on an ecosystem basis, which was impossible within the time constraints of this exercise. These tabled approaches (and proposed modifications) to assigning reservation targets for old growth forest ecosystems were therefore put aside in favour of a more straight forward approach that required only one assumption.

The JANIS Conservation and Natural National Estate requirements for ecosystem protection established targets of 100% reservation levels where less than 10% of the pre-1750 distribution of a forest ecosystem remains. Assuming that 30% of any pre-1750 forest ecosystem comprised old growth forest (discussed below), this translates to a target of 100% reservation levels where less than 3% of the pre-1750 distribution of a forest ecosystem is old growth forest. Furthermore, the JANIS requirement for protection of old growth forest established a minimum level of 60% of extant old growth forest of each ecosystem. This level should be applied where the extent of old growth forest is equivalent to pre-1750 levels (that is, 30% of the pre-1750 extent of each ecosystem). Using these JANIS targets as fixed points defining the ends of a sliding scale, the experts recommended that:

1. the old growth conservation target for each forest ecosystem be calculated using the function:

$O = 100-((I-3)/27)x40$, **where**

O = the proportion of extant old growth forest which should be protected, and

I = the area of extant candidate old growth forest expressed as a percentage of the calculated pre-1750 distribution of each forest ecosystem.

except

when I<3% where the target automatically becomes 100% (ie. to fulfil the JANIS requirement for 100% reservation when <10% remains of the pre-1750 extent of a forest ecosystem);

and I>30 where the target is fixed at a minimum of 60% (ie. to fulfil the JANIS requirement for 60% minimum reservation).

The assumption that 30% of a forest ecosystem may support old growth forest is based on a limited, but scientifically-based range of observations from Australia, USA, Canada and Chile (eg. BC Forest Practice Guidelines 1995, Spies 1997, JF. Franklin and M. Arroyo, personal communications 1997). These studies suggest that in the order of one third of a forest estate can be expected to support truly old forest under natural conditions (ie. within the calculated natural disturbance regime of the system). The experts believe this threshold to be a conservative estimate, as applied here, since it assumes that a proportional reduction from the pre-1750 situation in the total area of old growth is adequate to sustain the functional requirements of a forest ecosystem such that it will persist indefinitely. This is unlikely to be true as a minimum area of old growth within each forest ecosystem is expected to be necessary to ensure a high probability of persistence of the key structural, functional and biotic features of the ecosystem. The experts hope that this concern can be accommodated during future phases of data integration.

Rank old growth types for each forest ecosystem in terms of vulnerability

Given the limited data available, the expert panel recommended that the same assignment of vulnerability identified for the ecosystem level assessment be adopted for candidate old growth.

Identify the largest and least fragmented areas of old growth forest

Given that most of the available data concern disturbance, the experts recommended that "fragmentation" be considered as least disturbed. Given also that few undisturbed forested catchments remain in south eastern Australia (Norton 1996), it was recommended that emphasis be given to identifying large contiguous or reasonably contiguous blocks of forest that supports candidate old growth and/or undisturbed mature forest (see below) in the study region. Issues like the ratio of perimeter to surface area of each patch also need consideration. This would require consideration of the spatial configuration of the candidate old growth (and other relevant growth stages) of each forest ecosystem with respect to reservation targets, a task that the experts did not have the time nor the data to undertake on the day.

Minimum patch size for viability

The current assessments of candidate old growth are based exclusively on floristic and stand structural features and key disturbances that can be characterised, derived and modelled at the landscape level. The minimum reliable horizontal (spatial) resolution for these analyses is certainly in the order of 3-5 hectares. Since the available published data on the minimum area of old growth forest necessary to sustain basic functional features such as micro-climate (eg. ambient temperature, humidity, precipitation, wind speed) and structure is less than this area in non-linear patches (eg. USDA-FS 1995, Gregory 1997), the experts recommended that all mapped areas of candidate old growth be considered as "viable" for the purposes of any subsequent conservation options analyses. That is, no mapped areas of candidate old growth should be disregarded or considered unimportant.

Representation of old growth forest across the geographic range of each forest ecosystem

Since extant old growth forest is now a rare commodity in the region compared to the likely pre-1750 condition and requires the longest period outside of extreme disturbance to recover (assuming this is now possible), the experts recommended that priority be given to the protection of “undisturbed mature forest” where the remaining extent of “candidate old growth forest” within each forest ecosystem was inadequate to meet specified targets. Despite the undisputed habitat and other values of “disturbed old forest”, it is considered likely to have a higher proportion of weeds and feral animals as the result of past disturbances, and hence is considered a lower priority for protection than “undisturbed mature forest”. The order of selection is therefore recommended to be: candidate old growth forest, undisturbed mature forest, disturbed old forest.

Conservation mechanisms to ensure the long term protection of old growth forest

Adequate consideration of this aim was beyond the scope of the present expert panel due to severe time constraints. It was recommended that this issue be reconsidered at a subsequent date when more time is available.

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Jane Coram

Tony Norton

29 September 1997

Appendix 3.3 - Supporting documentation for the old growth target table

Appendix 4.7 details the areas that were addressed to fulfil the JANIS criteria for old growth forests. A full listing of the fields contained in the spreadsheet is outlined below.

1. Not applicable;

2. Forest ecosystem identification number;

3. Forest is Eucalypt or non-Eucalypt forest;

4. Forest ecosystem name;

5. Pre-1750 forest ecosystem coverage in hectares;

6. Extant forest ecosystem coverage in hectares;

7. Conservation targets for forest ecosystem in %;

8. Conservation targets for forest ecosystem in hectares;

9. Area in hectares in each forest ecosystem which is old growth;

10. % old growth/forest ecosystem pre-1750 coverage;

11. % old growth/forest ecosystem 1997 extant coverage;

12. Provisional old growth target %

IF % old growth/forest ecosystem 1997 extant coverage is < 10% then the conservation target = 100%

IF % old growth/forest ecosystem 1997 extant coverage is >= 10% then the conservation target = 60%;

13. Assessment of rarity and depletion of old growth forests was done with advice from David Keith (NPWS). It was done in a way consistent with assessment of rarity for derivation of forest ecosystem targets. JANIS identified forest ecosystems as rare if their extant area was <1000 hectares. An analogous threshold for extant area of old growth in each forest ecosystem would be 250 hectares. The old growth forest ecosystems requiring adjustment for rarity are 2, 11, 25, 27, 28, 29, 30, 36 and 58. A number of these have 100% forest ecosystem targets. Old growth received (c) if they just fell out of the rare category and (hd) if the forest ecosystem's original extent is highly depleted.

r=rare, hd=highly depleted, c=worthy of consideration;

14. Adjusted Landscape disturbance target (%)

= IF(provisional OG% targ>100% =100% and if

(provisional OG%target<100% then (100-((OG%Orig Target-3)/27)*40) A base level target of 60 % was used for old growth as per JANIS;

15. Final agreed target in %;

16. Final agreed target in hectares;

17. Refer to report by expert panel, Minimum Viable Patch Size column is redundant and hence not necessary to keep in the target table;

18. Vulnerability and the likelihood of threatening process:

Ranked 1(most vulnerable - 5 least vulnerable).

F=fire, L=logging, C=clearing, G=grazing, P=feral pigs, W=weeds and D=degradation;

19. Sensitivity to threatening processes. Final rank 1(most sensitive) - 5(least sensitive)

1=ratio of old growth to young and recently disturbed forest is less than 0.25

2= ratio of old growth to young and recently disturbed forest is between 0.25 and 0.50

3= ratio of old growth to young and recently disturbed forest is less than 0.50 and 1.00

4= ratio of old growth to young and recently disturbed forest is less than 1.00 and 2.00

5= ratio of old growth to young and recently disturbed forest is greater than 2.00;

20. Justification of target adjustment.

Appendix 4.1 Target table for forest ecosystems in the Eden CRA area

	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Forest Ecosystem	Pre 1750 (ha)	Extant 1997 (ha)	% cleared	Total Area (HPT1) %	Total Distribution (HPT2) %	Patch Size (HPT3) %	Maximum value in % obtained in 5, 6, or 7.	Nominal habitat protection target (ha) based on NHPA	Vulnerability to and likelihood of a threatening processes occurring ranked 1(VH)-5(VL)	Sensitivity to threatening processes Final Rank (1-5) highest ranking obtained in column 11	Spatial considerations - geographic range	Spatial consideration - biological variation	National Estate	A Maximum value in % obtained in 6, 7, or 8.	Final Agreed Targets - 15(%)	Final Agreed Targets - 60 & !00 (%)	15% of pre1750 extent (ha)	60% and 100%extant	Final Agreed Targets (ha)	Likely management practices to ameliorate threatening processes
1 Dry Rainfrst	47	42	11	100	0	100	100%	47	F1,C1,L5	1	Fragmented	Fragmented	Warrigal Range, Candelo	100%		100%	7	42	42	unknown
2 Myanba Euc/Fig Frst	333	333	0	100	100	100	100%	333	F3,L5	3				100%		100%	50	333	333	unknown
3 Rocky Top Dry Shrb Frst	1188	1188	0	15	0	0	15%	178	F3,C5, L5	3			Big Jack	15%	15%		178	0	178	unknown
4 A silve/P Brogo Shrb Rainfrst	6673	6288	6	15	0	0	15%	1001	F5,C5, L5	5			Wadbilliga (southern catchment)	15%	15%		1001	0	1001	unknown
5 Bunga Head RF	9	9	0	100	100	100	100%	9	F1, C5, L5	1				100%		100%	1	9	9	unknown
6 Coastal Warm Temp Rainfrst	6469	6393	1	15	0	0	15%	970	F1, C5, L5	1	lat variation Nth and Sth of Bega river	lat variation Nth and Sth of Bega river	Maxwells crk, Murrah River, Bermagui NR, Chalkhills rd, Cuttagee	15%		60%	970	3836	3836	unknown
7 Hinterland Warm Temp Rainfrst	3053	3027	0	15	0	0	15%	458	F1, C5, L5	1			Mt. Waalimma, Ilawambra FR	15%		60%	458	1816	1816	unknown
8 Cool Temp Rainfrst	1053	1053	0	15	0	100	100%	1053	F1, L5, C5	1			Mt Imlay, Burragate Peak, Werrinook FR, Brown Mtn,	100%		100%	158	1053	1053	unknown
9 Mtn Wet Layered Frst (E. nitens)	2267	1813	20	15	0	0	15%	340	F5'L3,C5	3				15%	15%		340	0	340	unknown
10 Mtn Wet Layered Frst (E fasti)	20033	17940	10	15	0	0	15%	3005	F5'L3,C5	3				15%	15%		3005	0	3005	unknown
11 Tantawangalo Wet Shrb Frst	792	790	0	100	100	0	100%	792	C5, F5, L4	4				100%		100%	119	790	790	unknown
12 Mtn Wet Fern Frst	2302	2259	2	15	0	0	15%	345	C5, F5, L4	4				15%	15%		345	0	345	unknown
13 Hinterland Wet Fern Frst	48321	44040	9	15	0	0	15%	7248	C5, F5, L4	4				15%	15%		7248	0	7248	Rel homogenous, extensive, <10% cleared
14 Hinterland Wet Shrb Frst	27004	25882	4	15	0	0	15%	4051	C5, F5, L4	4				15%	15%		4051	0	4051	Rel homogenous, extensive, <10% cleared
15 Mtn Wet Herb Frst	41581	30875	26	15	0	0	15%	6237	C5, F5, L4	4				15%	15%		6237	0	6237	Rel homogenous
16 Basalt Wet Herb Frst	14904	12209	18	15	0	0	15%	2236	C3, G3, W3, L4, F5	3			Cow Bail Ck (Towamba Valley)	15%	15%		2236	0	2236	unknown
17 Flats Wet Herb Frst	3553	2931	18	15	0	0	15%	533	C3,G3, P3, L4, F5 W4	3				15%		60%	533	1759	1759	Feral Pig management
18 Brogo Wet Vine Frst	7850	4306	45	15	0	0	15%	1178	C2, W2, G3, F5,L5	2	Fragmented , Bega and Towamba valleys	Fragmented , Bega and Towamba valleys	Warrigal Range, Towamba Valley - Snake	15%		60%	1178	2584	2584	unknown

	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Forest Ecosystem	Pre 1750 (ha)	Extant 1997 (ha)	% cleared	Total Area (HPT1) %	Total Distribution (HPT2) %	Patch Size (HPT3) %	Maximum value in % obtained in 5, 6, or 7.	Nominal habitat protection target (ha) based on NHPA	Vulnerability to and likelihood of a threatening processes occurring ranked 1(VH)-5(VL)	Sensitivity to threatening processes Final Rank (1-5) highest ranking obtained in column 11	Spatial considerations - geographic range	Spatial consideration - biological variation	National Estate	A Maximum value in % obtained in 6, 7, or 8.	Final Agreed Targets - 15(%)	Final Agreed Targets - 60 & !00 (%)	15% of pre1750 extent (ha)	60% and 100%extant	Final Agreed Targets (ha)	Likely management practices to ameliorate threatening processes
													Trail							
19 Bega Wet Shrb Frst	47749	16908	65	15	0	0	15%	7162	C2, W2, G3, F5, L5	2	Fragmented , Bega and Towamba valleys	Fragmented , Bega and Towamba valleys	Yellow pinch dam (lowland basalt) Towamba Valley - Snake Trail	15%		60%	7162	10145	10145	unknown
20 Bega Dry Grass Frst	31952	3809	88	60	0	100	100%	31952	C1,F5,G1,L5	1	Fragmented , Bega and Towamba valleys	Fragmented , Bega and Towamba valleys		100%		100%	4793	3809	4793	Rel homogenous
21 Candelo Dry Grass Frst	17873	1463	92	100	0	100	100%	17873	C1, G1, W2, L5, F5	1	Fragmented , Bega and Towamba valleys	Fragmented , Bega and Towamba valleys	Sandy Creek	100%		100%	2681	1463	2681	Rel homogenous
22A Monaro Dry Grass Frst	5427	3625	33	15	0	0	15%	814	C2, G2, W2, L5, F5	2			Numurella	15%		60%	814	2175	2175	Rel homogenous, cross regional issue
22B Numeralla Dry Shrb Woodland	11893	8248	31	15	0	0	15%	1784	C1, W1, G1, L5, F5	1			Numurella	15%		60%	1784	4949	4949	Rel homogenous
*23A Monaro Grassland	6481	334	95	100	0	100	100%	6481	C1, W1, G1, L5, F5	1				100%		100%	972	334	972	Rel homogenous
23B Monaro Basalt Grass Woodland	23567	3406	86	60	0	0	60%	14140	C1, G1, W1, F5, L4	1			Nimitibell VCL, Cathcart tip	60%		60%	3535	2044	3535	Rel homogenous
24 Subalpine Dry Shrb Frst	95154	26604	72	60	0	0	60%	57092	C4, G4, L4, F5, L4 W5	3				60%		60%	14273	15962	15962	Rel homogenous, cross regional issue
25 Sandstone Dry Shrb Frst	1142	822	28	100	0	0	100%	1142	C5, G5, F5, L4 W5	4				100%		100%	171	822	822	unknown
26 Tableland Dry Shrb Frst	28047	16115	43	15	0	0	15%	4207	C5, F5, L4,	4				15%	15%		4207	0	4207	unknown
27 Waalimma Dry Grass Frst	1324	1324	0	15	100	0	100%	1324	C5, F5, L4,	4				100%		100%	199	1324	1324	cross regional issue
28 Wog Wog Dry Grass Frst	1304	922	29	100	100	0	100%	1304	C5, F5, L4,	4				100%		100%	196	922	922	unknown
29 Nalbaugh Dry Grass Frst	2597	1936	25	15	0	0	15%	390	C5, F5, L4,	4				15%	15%		390	0	390	unknown
30 Wallagaraugh Dry Grass Frst	1663	914	45	100	0	0	100%	1663	C5, F5, L4, P3, W3	3				100%		100%	249	914	914	Feral Pig management
31 Hinterland Dry Grass Frst	32925	27586	16	15	0	0	15%	4939	C5, G5, L4 F5,W5	4				15%	15%		4939	0	4939	unknown
32 Coastal Dry Shrb Frst (E.longi)	24521	23401	5	15	0	0	15%	3678	L4, F5,W5,C5,G5	4				15%	15%		3678	0	3678	unknown
33 Coastal Dry Shrb Frst (E.muell)	16298	16136	0	15	0	0	15%	2445	L4,F5,W5,G5,C5	4				15%	15%		2445	0	2445	unknown
34 Brogo Dry Shrb Frst	16155	14155	12	15	0	0	15%	2423	L4,F5,W5,G5,C5	4				15%	15%		2423	0	2423	unknown
35 Escarpment Dry Grass Frst	34577	22007	36	15	0	0	15%	5187	L4,F5,W5,G5,C5	4			lowland forests on basalt	15%	15%		5187	0	5187	unknown
36 Dune Dry Shrb Frst	1023	604	41	100	0	100	100%	1023	C2, W2, D1 L4,F5,G4	1		Fragmented		100%		100%	153	604	604	unknown

	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Forest Ecosystem	Pre 1750 (ha)	Extant 1997 (ha)	% cleared	Total Area (HPT1) %	Total Distribution (HPT2) %	Patch Size (HPT3) %	Maximum value in % obtained in 5, 6, or 7.	Nominal habitat protection target (ha) based on NHPA	Vulnerability to and likelihood of a threatening processes occurring ranked 1(VH)-5(VL)	Sensitivity to threatening processes Final Rank (1-5) highest ranking obtained in column 11	Spatial considerations - geographic range	Spatial consideration - biological variation	National Estate	A Maximum value in % obtained in 6, 7, or 8.	Final Agreed Targets - 15(%)	Final Agreed Targets - 60 & !00 (%)	15% of pre1750 extent (ha)	60% and 100%extant	Final Agreed Targets (ha)	Likely management practices to ameliorate threatening processes
37 Coastal Dry Shrb Frst (An.flor)	16153	15147	6	15	0	0	15%	2423	L4,F5,W5,G5,C5	4			Boydtown flat	15%	15%		2423	0	2423	unknown
38 Southern Riparian Scrub	611	516	16	100	0	0	100%	611	C5, W4,L5,F5	4				100%		100%	92	516	516	unknown
39 Northern Riparian Scrub	761	485	36	100	0	100	100%	761	C2, W2, G2,L5,F5	2				100%		100%	114	485	485	unknown
40 Riverine Frst	81	65	19	100	100	100	100%	81	C1,W1,G1,L5,F5	1				100%		100%	12	65	65	cross regional issue
41 Mountain Dry Shrb Frst (E.fraxi)	1865	1864	0	15	0	0	15%	280	F5, L4,C5	4	Fragmented			15%	15%		280	0	280	unknown
42 Coastal Dry Shrb Frst (E.obliq)	22044	21556	2	15	0	0	15%	3307	F5, L4,C5	4				15%	15%		3307	0	3307	unknown
43 Mountain Dry Shrb Frst (E.cypel)	2492	2479	0	15	0	0	15%	374	F5, L4,C5	4				15%	15%		374	0	374	unknown
44 Foothills Dry Shrb Frst	3326	3142	6	15	0	0	15%	499	F5, L4,C5	4				15%	15%		499	0	499	unknown
45 Mountain Dry Shrb Frst (E.siebe)	2024	1915	5	15	0	0	15%	304	F5, L4,C5	4				15%	15%		304	0	304	unknown
46A Timbillica Dry Shrb Frst	22917	22792	0	15	0	0	15%	3438	F5, L4,C5	4				15%	15%		3438	0	3438	unknown
46B Lowland Dry Shrb Frst	15978	15121	5	15	0	0	15%	2397	F5, L4,C5	4				15%	15%		2397	0	2397	Rel homogenous, extensive, <10% cleared
47 Eden Dry Shrb Frst	17797	17141	4	15	0	0	15%	2670	F5, L4,C5	4				15%	15%		2670	0	2670	unknown
48 Bega Dry Shrb Frst	4497	4455	0	15	0	0	15%	674	F5, L4,C5	4				15%	15%		674	0	674	unknown
49 Coastal Dry Shrb Frst (E.agglo)	32334	31837	2	15	0	0	15%	4850	F5, L4,C5	4				15%	15%		4850	0	4850	Rel homogenous, extensive, <10% cleared
50 Genoa Dry Shrb Frst	3702	3026	18	15	0	0	15%	555	F5, L4,C5	4				15%	15%		555	0	555	unknown
51 Rock Shrb (K.ambig)	51	51	0	100	100	100	100%	51	G4, F3,C5,L5	3	Geographic split		Narrababa hill FR	100%		100%	8	51	51	unknown
52 Mtn Rock Scrub	202	202	0	100	0	100	100%	202	G4, F3,L5,C5	3				100%		100%	30	202	202	unknown
53 Montane Heath	1751	1350	23	15	0	0	15%	263	C3, G4, W4, F5, L5	3	Fragmented / disjunct Nth and Sth	Fragmented / disjunct Nth and Sth		15%		60%	263	810	810	unknown
54 Mtn Nadgee Heath	371	371	0	100	100	0	100%	371	F5,L5,G5,C5	5				100%		100%	56	371	371	unknown
55 Coastal Lowland Heath	1676	1630	3	15	0	0	15%	251	F5,L5,G5,C5	5				15%	15%		251	0	251	cross regional issue
56 Swamp Heath	385	385	0	100	0	0	100%	385	F5,L5,G5,C5	5				100%		100%	58	385	385	unknown
57 Lowland Swamp	2010	1892	6	15	0	0	15%	302	F5,L5,G5,C5	5			Nadgee lake	15%	15%		302	0	302	unknown
58 Swamp Frst	1080	953	12	100	0	100	100%	1080	W3, P3, L5, C4, G5, F5	3			Snob and Sheepstations	100%		100%	162	953	953	Feral Pig management

	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Forest Ecosystem	Pre 1750 (ha)	Extant 1997 (ha)	% cleared	Total Area (HPT1) %	Total Distribution (HPT2) %	Patch Size (HPT3) %	Maximum value in % obtained in 5, 6, or 7.	Nominal habitat protection target (ha) based on NHPA	Vulnerability to and likelihood of a threatening processes occurring ranked 1(VH)-5(VL)	Sensitivity to threatening processes Final Rank (1-5) highest ranking obtained in column 11	Spatial considerations - geographic range	Spatial consideration - biological variation	National Estate	A Maximum value in % obtained in 6, 7, or 8.	Final Agreed Targets - 15(%)	Final Agreed Targets - 60 & !00 (%)	15% of pre1750 extent (ha)	60% and 100%extant	Final Agreed Targets (ha)	Likely management practices to ameliorate threatening processes
59 Sub-Alpine Bog	6636	1869	72	60	0	100	100%	6636	C2, G2, PM2, W3, L5, F3	2			Nunnock + Bega swamps	100%		100%	995	1869	1869	unknown
60 Floodplain Wetlands	9421	3281	65	15	0	0	15%	1413	D1,F5,C5,L5	1			Whalens swamp, lower Bega river, Jellat Jellat swamp	15%		60%	1413	1969	1969	unknown
61 Coastal Scrub	2273	1505	34	15	0	0	15%	341	C3, D 3, W3, L5,F5	3				15%		60%	341	903	903	unknown
63 Estuarine Wetland (M.erici)	3028	932	69	100	0	100	100%	3028	C2, D3,F5,L5,	2				100%		100%	454	932	932	unknown
64 Saltmarsh	370	296	20	100	0	100	100%	370	C2, D3,F5,L5,	2				100%		100%	55	296	296	unknown
*66 Estuarine Wetland (Av.marin)	56	38	31	100	0	100	100%	56	C2, D3,F5,L5,	2				100%		100%	8	38	38	unknown
W1 Wadbilliga Dry Shrb Frst	27352	27341	0	15	0	0	15%	4103	F5, L4,	4				15%	15%		4103	0	4103	Rel homogenous, extensive, <10% cleared, cross regional issue
W2 Wadbilliga Range Ash Frst	1007	1007	0	15	100	0	100%	1007	F5, L4,	4		Fragmented		100%		100%	151	1007	1007	unknown
W3 Wadbilliga Mallee Heath	3085	3085	0	15	100	0	100%	3085	F5, L4,	4				100%		100%	463	3085	3085	unknown
W4 Wadbilliga Range Wet Frst	3501	3214	8	15	0	0	15%	525	F5, L4,	4				15%	15%		525	0	525	cross regional issue
W5 Wadbilliga Gorge Dry Frst	7748	7239	7	15	0	0	15%	1162	F5, L4,	4				15%	15%		1162	0	1162	cross regional issue
W6 Wadbilliga River Valley Frst	1902	1897	0	15	0	0	15%	285	W3,F5,L4	3				15%	15%		285	0	285	unknown
Total	809585	551772															121438		152261	unknown

Appendix 4. 2 - Minutes of the forest ecosystem workshop on target setting for conservation requirements

Friday 19/9/97

Head Office NPWS

Those in Attendance: Doug Binns (SF), David Keith (NPWS), Phil Gilmore (Independent), Karl Bossard (EA), Geoff Moore (NPWS Convenor), Helen Neave (EA observer), Bronwyn Goody (EA observer) and Helen Achurch (NPWS Minutes).

1. Introduction and addition to agenda items

Suggested changes to forest ecosystem guiding principles document

- clarification of table in task 6 of 3.1.3 of the supporting documentation for forest ecosystems so that it reads: 'Endangered is when total area has contracted to less than 10% of its former range; vulnerable ecosystems are those where total area is reduced to 11-30% of their former area; and 'other' are ecosystems which cover greater than 30% of their former area';
- Formula in task 10 of 3.1.3 be amended to read:

  NHPA1(ha)= Pre-1750 FE*maximum(HPT1, HPT2 or HPT3)/100.

Addition of cross-regional considerations to the Agenda.

2. Review of targets based on total area, and setting of targets, based on distribution and patch size

Experts reviewed each vegetation type and checked HPT1 target that was derived prior to the workshop.

Expert knowledge was used to assign targets (HPT2 and HPT3). Each forest ecosystem type was considered in terms of distribution and patch size. Using the rule set contained in the supporting documentation, targets HPT2 and HPT3 were assigned where appropriate. (The expert panel considered all vegetation types and assigned targets of 100% to those vegetation types meeting the categories set out in the rule set)

Discussion of each vegetation type is summarised in Table 1.

It was noted that SFNSW had not yet supported the use of vegetation types as 'forest ecosystems' to assess JANIS targets. The workshop recommended that if decisions were taken to reduce the number of forest ecosystems by merging vegetation types, targets should be assessed as demonstrated in the following example.

In the case of vegetation types 28 and 31 which are floristically similar but have differing targets. If these are to be merged, the expert panel recommended that the target assigned to the more extensive type also be assigned to the less extensive type. This would then ensure that the less extensive vegetation type is still reserved at least to the level of 15%, thereby also ensuring that heterogeneity within broader merged units is represented in reserves (JANIS).

3. Ranking of forest ecosystem vulnerability 1(highest)-5(lowest)

Determination of a vulnerability ranking was broken down in the following way:

- determine major threatening processes likely to affect the forest ecosystem in the study area;
- group forest ecosystem types which experience a similar level of vulnerability to a threatening process;
- apply a ranking of vulnerability to each of the major threatening processes for each forest ecosystem;
- determine overall vulnerability ranking by taking the highest ranking from any of the threatening processes.

The main threatening processes were: inappropriate fire regimes (F), logging (L), clearing (C), grazing (G), weeds (W), feral pigs (P) and habitat degradation (D). (Disease was not considered a likely threat in the study area).

Generalities that were agreed to so that forest ecosystems with similar vulnerabilities to certain threatening processes could be grouped:

Fire:

- Eucalyptus dominated ecosystems were given a ranking of 1 for vulnerability to fire. Rainforest forest ecosystem types 1,5,6,7 and 8 were given a ranking of 5 due to the higher vulnerability due to rainforest species. Forest ecosystems 2 and 3 were given a ranking of 3 due to the vulnerability of some rainforest species in their ecosystem;
- Heath ecosystems were given a ranking of 3 - the panel felt that fire could be a problem when combined with variable weather conditions;
- Swamps and bogs were given a ranking of 3 - rare, but extreme fire events would lead to habitat degradation through peat consumption.

Logging:

- Non-eucalypt species given a ranking of 1 because of low logging pressures;
- Dry Euc forests receive a ranking of 2;
- Wet Euc. forests receive a ranking of 3 (because of the adverse competitive effect of a dense fern understorey on regenerating seedlings of trees and shrubs > vulnerability);
- Exceptions to this; forest ecosystem types 11,12,14, 15, and 16, were ranked as 2 because they do not have dense fern understorey.

Clearing:

The panel decided that clearing was a threatening process occurring mainly on private land. Therefore land tenure was important when considering the vulnerability of FE's to this threatening process. Ranking for clearing was assigned on an ecosystem by ecosystem basis.

Weeds:

Considered on an ecosystem by ecosystem basis.

Grazing:

Considered on an ecosystem by ecosystem basis.

Degradation:

Considered on an ecosystem by ecosystem basis.

Feral Pigs:

Considered on an ecosystem by ecosystem basis with emphasis on ecosystems occurring on flats assumed to be the most vulnerable.

Each forest ecosystem type was then assigned a final ranking based on the highest ranking received for any of the threatening processes. For the vulnerable grouping of forest ecosystems (ie those whose pre-1750 extent has been depleted to 11-30%, HBT1 = 60%) where they received an overall vulnerable ranking of 1 or 2, the target was adjusted up to 80% or 100% respectively. (This only occurred in one case).

4. Spatial considerations

The panel determined spatial considerations enabling forest ecosystems to be adequately replicated across their geographic range and for the full range of biological variation to be sampled.

Forest ecosystem types 1, 18 -21 need to be sampled from both the Bega and Towamba valleys. Forest ecosystem types in these two areas have been fragmented so some proportion of the target should be met from each of the remaining fragments. It was suggested that original hectares of each forest type in each of the two areas be calculated and then target sought proportionally. The outcome then is reviewed by the expert panel.

Forest ecosystem type 53 is also fragmented into north and south segments. As above, target should be sought proportionally from each area.

Forest ecosystem type 6 has some latitudinal variations so, as above, target should be sought from north and south of the Bega River.

Forest ecosystem type 51 has a geographic split in its range. Narabarba and Nullica. As above, seek target in all areas.

If amalgamated veg types are to be used in negotiation then further spatial considerations should be considered.

5. National Estate

Some general rules for identifying the best (national estate) examples of forest ecosystems were outlined:

- all areas of rainforest > 20 hectares;
- all areas on rhyolite; and
- all areas on lowland basalt (Lochiel group).

The expert panel then recommended areas of various forest ecosystem types where national estate values would be high:

FE 1 - Warrigal Range, Candelo

FE 3 - Big Jack Mountain

FE 4 - Wadbilliga (southern catchments)

FE 5 - Bunga Head

FE 6 - Maxwells creek, Murrah River, Bermagui Nature Reserve and Chalk Hills Rd in Yurammie.

FE 7 - Waalmma Mt and Illawambra Forest Reserve

FE 8 - Mt Imlay, Brown Mt, Burragate Peak and Werrinook Forest Reserve

FE 16 - Cow Bail creek (head of Towamba valley)

FE 18 - Warrigal Range and Snake Trail (Towamba Valley)

FE 19 - Yellow Pinch Dam with E.teriticornis and Snake Trail (Towamba Valley)

FE 21 - Sandy Creek

FE 22B - Numeralla Crown Land

FE 23A - Nimitabel Vacant Crown Land and Cathcart Tip

FE 35 - Any lowland forests on basalt

FE 51 - Narabarba hill and surrounds

FE 57 - Nadgee Lake

FE 58 - Sheep Station Creek and Snob Creek

FE 59 - Nunnock Swamp and Bega Swamp (research site)

FE 60 - Whalens Swamp, lower Bega river wetlands and Jellat Jellat, Boyd Town Flats Vacant Crown Land

Nalbaugh Plateau would conserve a range of forest ecosystem types.

The panel also advised that in addition to the above areas, the examples of each ecosystem type incorporated into the CAR reserve system would meet the national estate criteria relating to rare and representative ecosystems and plant communities.

6. Management practices to ameliorate threatening process.

Each forest ecosystem type was previously given a ranking for their vulnerability to various threatening processes. The panel suggested that this would be a good guide for determining management strategies. Detailed management prescriptions should be determined in the course of management planning with regard to strategies identified by workshop experts.

Forest ecosystem types 17, 30 and 58 - feral pig control was a necessary management practice.

7. Recommendations for prioritising targets

The panel suggested that the following criteria were appropriate for selecting forest ecosystem types, that could be identified as lower priority for meeting targets where conflicts preclude all targets being met:

- vegetation type is extensive and relatively homogeneous throughout its range and incurs low resource use and is resilient;
- vegetation type given a final ranking or 1 or 2 for vulnerability to threatening process (in previous tasks);
- vegetation type covers greater than 20000 hectares;
- vegetation type has been cleared less than 10% from pre-1750 coverage.

Based on these criteria, vegetation types 13, 14, 46A, 49 and 81 were flagged as lower priority targets.

8. Cross-regional issues

The panel noted that an extensive cross-regional analysis was required to identify with a high level of certainty, vegetation types with distributions extending over large areas outside the Eden CRA. Nonetheless, the panel flagged some forest ecosystems that occurred outside the Eden CRA region, with some degree of certainty that they are floristically similar to examples found within the Eden region. They were: 22A, 24, 27, 40, 55, 65, 81, 84, and 85. These forest ecosystems require a closer examination of their extent and reservation status over the border before any adjustments are made to Eden targets. This could be important for forest ecosystems for which 100% targets were assigned. Subsequent investigation of vegetation studies carried out in East Gippsland revealed that forest ecosystem 27 is likely to be very restricted there. The most similar Ecological Vegetation Class (No.24) in East Gippsland has a structurally and floristically different understorey and has a more restricted distribution than forest ecosystem 27 in NSW.

Appendix 4.3: Details of maps created for species with area targets

Functional Group	Common Name	Model Type (i.e. full model, modified vegetation map or buffered point locations)	Workshop recommended layers for masking habitat	Model Type (PA=Presence-absence, P=Presence only, GAM= , GLM =)	Core Habitat Quality	Intermediate Habitat Quality	Marginal Habitat Quality	Comments
Arboreal Mammal	Greater Glider	Full Model	Logging and Cleared Land	PA-GAM	50-99%	40-49%	30-39%	
Arboreal Mammal	Koala	Modified Vegetation Map	Logging <10 years, Slope>23 degrees	N/A	Mature/ Old Growth on sites of moderate quality.	Young Forest on sites of moderate quality.	Mature/ Old Growth on sites of low quality.	Agreement on this model was not reached until after the workshop. Vegetation types defined by the "Keith & Bedward" Eden Vegetation Map (see associated report). Moderate habitat quality = Veg types: 14, 32, 34, 42, 20, 21. Low habitat quality = Veg types: 29. 30, 31, 35, 43, 18.
Arboreal Mammal	Yellow-bellied Glider	Full Model	Logging and Cleared Land	PA-GAM	55-100%	44-54%	33-43%	
Nocturnal Bird	Barking Owl	Point Location Buffers			All point locations buffers.			2000ha buffer is to be placed around verified locations.
Nocturnal Bird	Masked Owl	Full Model and Point Location Buffers	Cleared	PA-GAM	17-100 % and point location buffers.	12-16%	7-11%	As the model inadequate in subregions 1 and 8, a 2000ha buffer is to be placed around verified

Functional Group	Common Name	Model Type (i.e. full model, modified vegetation map or buffered point locations)	Workshop recommended layers for masking habitat	Model Type (PA=Presence-absence, P=Presence only, GAM= , GLM =)	Core Habitat Quality	Intermediate Habitat Quality	Marginal Habitat Quality	Comments
								locations.
Nocturnal Bird	Powerful Owl	Full Model	Cleared	PA-GLM	25-100%	16-24%	11-15%	
Nocturnal Bird	Sooty Owl	Full Model	Cleared	PA-GAM	30-100%	20-29%	14-19%	
Ground Mammal	Long-footed Potoroo	Current Exclusion Zone			Exclusion Zone			
Ground Mammal	Long-nosed Bandicoot	Full Model	Logging and Cleared Land	P-GAM	90-99%	80-89%	70-79%	
Ground Mammal	Long-nosed Potoroo	Full Model	Logging and Cleared Land	P-GAM	96%	94-95%	90-93%	
Ground Mammal	Smoky Mouse	Point Location Buffers	Logging and Cleared Land		Point Location Buffers			Logging history not used to mask habitat as target area of 4800ha = total available habitat in Eden. Thus, masking habitat with logging will reduce the target area below that specified in the workshop. This issue will be dealt with in negotiations.
Ground Mammal	Southern Brown Bandicoot	Full Model with modification (see comments)	Logging and Cleared Land	P-GLM	95-99%	80-9%4	70-79%	Workshop recommended that low quality habitat in subregion 6 be manually altered to core habitat.

Functional Group	Common Name	Model Type (i.e. full model, modified vegetation map or buffered point locations)	Workshop recommended layers for masking habitat	Model Type (PA=Presence-absence, P=Presence only, GAM= , GLM =)	Core Habitat Quality	Intermediate Habitat Quality	Marginal Habitat Quality	Comments
Ground Mammal	Tiger Quoll	Modified Vegetation Map	Logging and Cleared Land		Veg types: 6-12, 15-17	Veg types: 2-4,13,18,19, 30,37-39,46	Veg types:1, 14,24,29,32 33,34,42,43 ,51,52,58,6 1	
Ground Mammal	White-footed Dunnart	Full Model	Cleared	P-GAM	95-99%	75-94%	45-74%	
Bird	Crested Shrike-tit	Modified Vegetation Map	Cleared		Veg types: 17, 21, 27, 28, 37, 58	Veg types: 9-12, 14-16, 20, 29, 30, 32-35, 39, 46, 71	Veg types: 13, 19, 24, 26, 31, 36, 38, 40-45, 47-50, 54, 64	
Bird	Glossy Black Cockatoo	Full Model	Cleared	P-GLM	80-92%	75-79%	70-74%	
Bird	Olive Whistler	Full Model	Cleared	P-GLM	95-99%	85-94%	75-84%	
Bird	Pink Robin	Modified Vegetation Map	Cleared		Veg types: 7, 8, 9, 10, 12			

Functional Group	Common Name	Model Type (i.e. full model, modified vegetation map or buffered point locations)	Workshop recommended layers for masking habitat	Model Type (PA=Presence-absence, P=Presence only, GAM= , GLM =)	Core Habitat Quality	Intermediate Habitat Quality	Marginal Habitat Quality	Comments
Bird	Red-browed Treecreeper	Modified Vegetation Map	Cleared		Veg types: 9, 10, 11, 12, 15, 16, 17, 24, 28, 29	Veg types: 21, 25, 26, 27, 35, 41, 43, 58, 71	Veg types: 14, 19, 20, 30, 32, 33, 34, 36-40, 42, 44-50, 64	
Bird	Varied Sittella	Full Model	Logging and Cleared Land	P-GAM	80-100%	65-79%	50-64%	
Bird	Yellow-tailed Black Cockatoo	Full Model	Cleared	P-GLM	80-99%	70-79%	60-69%	
Frog	Giant Burrowing Frog	Full Model	Cleared	P-GLM	83-93%	73-82%	63-72%	
Frog	Stuttering Barred Frog	Full Model		P-GAM	83-93%	73-82%	63-72%	
Reptile	Common Death Adder	Full Model	Cleared	P-GAM	98-99%	90-97%	67-89%	
Bat	Common Bentwing Bat	Point Location Buffers			Point Location Buffers			Workshop requested that NPWS provide locations of major roost sites which require 1000m exclusion zones around them.
Bat	Eastern Horseshoe-bat	Point Location Buffers			Point Location Buffers			Workshop requested that NPWS provide locations of major roost sites which require 1000m exclusion zones around them.

Functional Group	Common Name	Model Type (i.e. full model, modified vegetation map or buffered point locations)	Workshop recommended layers for masking habitat	Model Type (PA=Presence-absence, P=Presence only, GAM= , GLM =)	Core Habitat Quality	Intermediate Habitat Quality	Marginal Habitat Quality	Comments
Bat	Grey-headed Flying Fox	Modified Vegetation Map	Logging and Cleared Land		Veg types: 18, 20, 21, 32, 46, 47			Doug Mills, Brad Law and Harry Parnaby discussed the veg based model after the workshop and suggested developing a model based on E. tereticonis, E.gummnifera and E.longifolia instead. It was agreed that a target of 4* 300ha patches per sub-region be set.

Appendix 4.4: A Summary of the final agreed target areas and associated information.

SPECIES	Target Area (hectares)	Minimum Patch Size (hectares)	No. of Subregions, No. of Patches allocated.	Comments
Greater Glider	3,000	500	4, 6	Target was increased to from 2,600 to meet the sum of patches allocated in the workshop.
Koala	53,000	5,300	9, 10	No patch allocated in subregion 9.
Yellow-bellied Glider	53,000	5,300	8,10	Subregion 6 has no target. Subregions identified for management only and did not have targets were not considered for C-Plan.
Barking Owl	26,000*	2000 buffers around species records.	N/A	*Workshop defined target area as the sum of buffers around locations.
Masked Owl	308,000	3,000	8,11	Target area not allocated using the patches and subregions was...
Powerful Owl	260,000	5,000	8, 12	
Sooty Owl	204,000	5,000	7, 7	
Long-footed Potoroo	Exclusion Zone	N/A	1	
Long-nosed Bandicoot	3,412	341	8, 9	Subregions identified for further survey were not considered for C-Plan.
Long-nosed Potoroo	3,750	375	7, 8	Subregions identified for further survey were not considered for C-Plan.
Smoky Mouse	4,800	Total area divide 60:40 between two known locations.	2	
Southern Brown Bandicoot	5,000	500	8, 10	Workshop recommended that low quality habitat in region 6 be changed to core habitat. Areas identified for further survey in the workshop did not have area targets so weren't considered for C-Plan.
Tiger Quoll	*375,000*	*37,500*	*5, 5*	*Balance of allocated area should be divided proportionally between sub-*

				regions.
White Footed Dunnart	*1,429*	*140*	*7. 8*	
Crested Shrike-tit	*9,333*	*200*	*9, 46*	
Glossy Black Cockatoo	*126,491*	*1,000*	*6, 9*	
Olive Whistler	*4,667*	*100*	*11, 15*	
Pink Robin	*1,167*	*50*	*8, 22*	
Red-browed Tree-creeper	2,600	200	12, 13	
Varied Sitella	*13,333*	*200*	*8, 16*	
Yellow-tailed Black Cockatoo	*114,416*	*1,000*	*7, 13*	
Giant Burrowing Frog	7,000	1,000	8, 7	
Stuttering Barred Frog	6,000	1,000	8, 6	
Common Death Adder	*6,000*	*100*	*7, 7*	
Common Bentwing Bat	Target area was the sum of buffers around verified locations.	1000m radius exclusion zone.	N/A	
Eastern Horseshoe Bat	Target area was the sum of buffers around verified locations.	1000m radius exclusion zone.	N/A	
Grey-headed Flying Fox	4800	1200	4	Target area and patch size finalised after the workshop.

Appendix 4.5 - Habitat models and sub-region maps

Appendix 4.6 - Flora species target table

Species	Vulnerability Class	Target sought (outside reserves)	Order in C-Plan
*Genoplesium rhyoliticum	1	5	1
Grevillea acanthifolia ssp. paludosa	1	4	2
Zieria formosa	1	5	3
Acacia constablei	2	5	4
*Correa baeuerlenii	2	10	5
Cryptostylis hunteriana	2	3	6
Eucalyptus parvula	2	10	7
Lepidium hyssopifolium	2	4	8
Phebalium ralstonii	2	2	9
Pomaderris cotoneaster	2	5	10
*Westringia davidii	2	7	11
Zieria buxijugum	2	5	12
Zieria parrisiae	2	5	13
Acacia georgensis	3	4	14
Boronia deanei	3	4	15
Burnettia cuneata	3	4	16
Deyeuxia accedens	3	5	17
Eucalyptus imlayensis	3	4	18
Eucalyptus paliformis	3	4	19
Jacksonia scoparia	3	5	20
Phebalium rhytidophyllum	3	2	21
Pimelea curviflora spp. gracilis var. sericea	3	9	22
*Pomaderris costata	3	3	23
Pomaderris parrisiae	3	1	24
*Psoralea adscendens	3	4	25
Pultenaea hispidula	3	4	26
*Pultenaea villifera	3	3	27
Rulingia hermannifolia	3	10	28
Sicyos australis	3	7	29
Zornia dyctyocarpa var. dyctyocarpa	3	10	30

Acacia blayana	4	2	31
Acacia costiniana	4	2	32
Acacia lucasii	4	2	33
Acacia subtilinervis	4	3	34
Adriana glabrata	4	5	35
Allocasuarina diminuta ssp. annectens	4	5	36
Allocasuarina distyla	4	4	37
Asplenium australasicum	4	4	38
Asterolasia astericophora	4	4	39
*Astroloma pinifolum	4	5	40
Baeckea denticulata	4	3	41
*Banksia spinulosa var. cunninghamii	4	4	42
*Boronia nana var. hyssopfolia	4	2	43
*Botrychium australe	4	5	44
*Bracteantha viscosa	4	4	45
Callitris muelleri	4	5	46
Calotis glandulosa	4	4	47
Cassinia aureonitens	4	5	48
Cassinia uncata	4	3	49
*Caustis recurvata	4	3	50
*Cymbidium suave	4	0	51
Davalllia pyxidata	4	8	52
Daviesia suaveolens	4	0	53
Desmodium brachypodium	4	8	54
Deyeuxia talariata	4	4	55
Dodonaea rhombifolia	4	2	56
Epilobium pallidiflorum	4	4	57
*Eucalyptus badjensis	4	0	58
Eucalyptus baueriana	4	0	59
*Eucalyptus ignorabilis	4	5	60
Eucalyptus latiuscula	4	0	61
Eucalyptus melliodora	4	9	62
Eucalyptus olsenii	4	2	63

Eucalyptus spectatrix	4	0	64
Eucalyptus stenostoma	4	2	65
*Eucalyptus tereticornis	4	8	66
Eucalyptus wilcoxii	4	1	67
*Festuca asperula	4	5	68
*Festuca hookeriana	4	5	69
Gaultheria appressa	4	0	70
*Grevillea miqueliana	4	0	71
Hakea macreana	4	0	72
Haloragodendron baeuerlenii	4	3	73
Haloragodendron monospermum	4	1	74
Helichrysum collinum	4	4	75
*Hibbertia hermanniifolia	4	3	76
Hibbertia sp. nov. aff. hermanniifolia	4	3	77
*Korthalsella rubra	4	9	78
*Lasiopetalum parvifolium	4	5	79
Leptorhynchos nitidulus	4	2	80
Leptospermum scoparium	4	0	81
*Leucopogon setiger	4	1	82
*Logania pusilla	4	1	83
Lycopodium myrtifolium	4	3	84
*Mazus pumilio	4	3	85
*Monotoca albens	4	0	86
Myoporum bateae	4	3	87
Notothixos subaurens	4	8	88
Ozothamnus conditus	4	3	89
Pentapogon quadrifidus	4	4	90
*Persoonia brevifolia	4	0	91
Phebalium carruthersii	4	3	92
Phebalium ellipticum	4	3	93
*Pittosporum bicolor	4	0	94
Platycerium bifurcatum ssp. bifurcatum	4	10	95
Poa cheelii	4	3	96

Poa costiniana	4	4	97
*Pomaderris brogoensis	4	0	98
Pomaderris pauciflora	4	4	99
Pomaderris virgata	4	4	100
Prostanthera walteri	4	3	101
Pseudanthus divaricatissimus	4	2	102
*Rhagodia candolleana	4	0	103
Santalum obtusifolium	4	1	104
*Sarochilus australis	4	8	105
Sarochilus olivaceus	4	7	106
Spyridium cinereum	4	4	107
*Styphelia psiloclada	4	5	108
*Symplocos thwaitesii	4	5	109
Thysanotus patersonii	4	4	110
Tmesipteris ovata	4	5	111
Tmesipteris truncata	4	2	112
*Trachymene humilis ssp. humilis	4	4	113
Trisetum spicatum	4	4	114
Viola caleyana	4	0	115
Viola cleistogamoides	4	4	116
Acacia oxycedrus	5	1	117
*Acacia pyncantha	5	5	118
*Acacia subporosa	5	0	119
*Acronychia oblongifolia	5	0	120
*Alectryon subcinereus	5	0	121
*Clematis microphylla var. leptophylla	5	4	122
Cyathea leichhardtiana	5	2	123
*Daviesia acicularis	5	4	124
*Dillwynia juniperina	5	2	125
Dodonaea multijuga	5	1	126
Ehretia acuminata	5	2	127
Epacris robusta	5	2	128
Eriostemon myoporoides spp. myoporoides	5	2	129

*Eriostemon virgatus	5	5	130
Eucalyptus conspicua	5	4	131
*Eucalyptus croajingolensis	5	5	132
Eucalyptus pseudoglobulus	5	4	133
*Eucalyptus stellulata	5	2	134
Eucryphia moorei	5	0	135
Grevillea mucronulata	5	1	136
Hibbertia saligna	5	4	137
Hovea longifolia	5	4	138
Kunzea sp. C (aff.capitata)	5	0	139
Lepidium pseudotasmanicum	5	5	140
Leucopogon attenuatus	5	0	141
Leucopogon suaveolens	5	4	142
Livistona australis	5	4	143
*Macrozamia communis	5	0	144
Mirbelia pungens	5	4	145
Persoonia asperula	5	0	146
Pomaderris angustifolia	5	4	147
*Pomaderris betulina	5	4	148
Pomaderris elachophylla	5	4	149
Pomaderris eriocephala	5	3	150
*Pschotria loniceroides	5	0	151
Pultenaea blakelyi	5	4	152
Sarcomelicope simplicifolia	5	4	153
*Schizomeria ovata	5	5	154
Styphelia adscendens	5	4	155
Tetratheca subaphylla	5	4	156
*Wahlenbergia gloriosa	5	4	157
*Xanthorrhoea concava	5	0	158
Zieria fraseri ssp. compacta	5	5	159

* = targets that could not be met on public lands only

Appendix 4.7 Old growth target tables

Forest Ecosystem	FE Pre 1750 (ha)	FE Extant 1997 (ha)	FE target (%)	FE target (ha)	OG Extant 1997 (ha)	% OG / FE Pre 1750	% OG / FE 1997 Extant	Provisional OG Target (%)	Rare & Depleted [1]	Adjusted Landscape disturbance target % [2]	Final Agreed Target %	Final Agreed Target (ha)	Minimum Viable Patch size	Vulnerability to and likelihood of a threatening processes occurring ranked 1(VH)-5(VL)	Euc Frst vs Non-Euc Frst	Sensitivity to threatening processes Final Rank (1-5). Most sensitive 1, least 5 [3]	Comments: Justified Fields
OG 9 Mtn Wet Layered Frst (E. nit	2267	1813	0.15	340	436	19.23	24.05	60%		75.96	60	262	N/A	F5'L3,C5	euc frst	4	provisional target increased due to fragmentation and other landscape disturbances
OG 10 Mtn Wet Layered Frst (E fas	20033	17940	0.15	3005	4139	20.66	23.07	60%		73.84	60	2483	N/A	F5'L3,C5	euc frst	3	provisional target increased due to fragmentation and other landscape disturbances
OG 11 Tantawangalo Wet Shrb Frst	792	790	1.00	790	200	25.26	25.32	60%	r	67.02	100	200	N/A	C5, F5, L4	euc frst	4	provisional target increased due to fragmentation and other landscape disturbances and rarity of forest ecosystem
OG 12 Mtn Wet Fern Frst	2302	2259	0.15	345	609	26.46	26.96	60%		65.24	60	365	N/A	C5, F5, L4	euc frst	4	provisional target increased due to fragmentation and other landscape disturbances
OG 13 Hinterland Wet Fern Frst	48321	44040	0.15	7248	9476	19.61	21.52	60%		75.39	60	5686	N/A	C5, F5, L4	euc frst	3	provisional target increased due to fragmentation and other landscape disturbances
OG 14 Hinterland Wet Shrb Frst	27004	25882	0.15	4051	4020	14.89	15.53	60%		82.39	60	2412	N/A	C5, F5, L4	euc frst	2	provisional target increased due to fragmentation and other landscape disturbances
OG 15 Mtn Wet Herb Frst	41581	30875	0.15	6237	5756	13.84	18.64	60%		83.94	60	3454	N/A	C5, F5, L4	euc frst	3	provisional target increased due to fragmentation and other landscape disturbances
OG 16 Basalt Wet Herb Frst	14904	12209	0.15	2236	1695	11.37	13.88	60%		87.60	60	1017	N/A	C3, G3, W3, L4, F5	euc frst	2	provisional target increased due to fragmentation and other landscape disturbances
OG 17 Flats Wet Herb Frst	3553	2931	0.15	533	270	7.60	9.21	100%	c	100	100	270	N/A	C3,G3, P3, L4, F5 W4	euc frst	2	
OG 18 Brogo Wet Vine Frst	7850	4306	0.15	1178	402	5.12	9.34	100%		100	100	402	N/A	C2, W2, G3, F5,L5	euc frst	2	
OG 19 Bega Wet Shrb Frst	47749	16908	0.15	7162	3038	6.36	17.97	60%		95.02	60	1823	N/A	C2, W2, G3, F5, L5	euc frst	3	provisional target increased due to fragmentation and other landscape disturbances
OG 20 Bega Dry Grass Frst	31952	3809	1.00	4793	317	0.99	8.32	100%	hd	100	100	317	N/A	C1,F5,G1,L5	euc frst	2	
OG 21 Candelo Dry Grass Frst	17873	1463	1.00	2681	498	2.79	34.04	60%	hd	100.00	100	498	N/A	C1, G1, W2, L5, F5	euc frst	3	provisional target increased due to fragmentation and other landscape disturbances and high depletion
*OG 22A Monaro Dry Grass Frst	5427	3625	0.15	814	811	14.94	22.37	60%		82.31	60	487	N/A	C2, G2, W2, L5, F5	euc frst	3	provisional target increased due to fragmentation and other landscape disturbances
OG 22B Numeralla Dry Shrb Woodlan	11893	8248	0.15	1784	2431	20.44	29.48	60%		74.16	60	1459	N/A	C1, W1, G1, L5, F5	euc frst	1	provisional target increased due to fragmentation and other landscape disturbances

Forest Ecosystem	FE Pre 1750 (ha)	FE Extant 1997 (ha)	FE target (%)	FE target (ha)	OG Extant 1997 (ha)	% OG / FE Pre 1750	% OG / FE 1997 Extant	Provisional OG Target (%)	Rare & Depleted [1]	Adjusted Landscape disturbance target % [2]	Final Agreed Target %	Final Agreed Target (ha)	Minimum Viable Patch size	Vulnerability to and likelihood of a threatening processes occurring ranked 1(VH)-5(VL)	Euc Frst vs Non-Euc Frst	Sensitivity to threatening processes Final Rank (1-5). Most sensitive 1, least 5 [3]	Comments: Justified Fields
OG 23B Monaro Basalt Grass Woodla	23567	3406	1.00	3535	578	2.45	16.97	60%	hd	100.00	100	578	N/A	C1, G1, W1, F5, L4	euc frst	4	provisional target increased due to fragmentation and other landscape disturbances and high depletion
OG 24 Subalpine Dry Shrb Frst	95154	26604	0.60	15962	8687	9.13	32.65	60%	hd	90.92	100	8687	N/A	C4, G4, L4, F5, L4 W5	euc frst	4	provisional target increased due to fragmentation and other landscape disturbances and high depletion
OG 25 Sandstone Dry Shrb Frst	1142	822	1.00	822	187	16.38	22.74	60%	r	80.18	100	187	N/A	C5, G5, F5, L4 W5	euc frst	3	provisional target increased due to fragmentation and other landscape disturbances and rarity of forest ecosystem
OG 26 Tableland Dry Shrb Frst	28047	16115	0.60	9669	1524	5.43	9.46	100%		100	100	1524	N/A	C5, F5, L4,	euc frst	5	
OG 27 Waalimma Dry Grass Frst	1324	1324	1.00	1324	76	5.74	5.74	100%	r	100	100	76	N/A	C5, F5, L4,	euc frst	5	
OG 28 Wog Wog Dry Grass Frst	1304	922	1.00	922	119	9.13	12.91	60%	r	90.92	100	119	N/A	C5, F5, L4,	euc frst	4	provisional target increased due to fragmentation and other landscape disturbances and rarity of forest ecosystem
OG 29 Nalbaugh Dry Grass Frst	2597	1936	0.15	390	199	7.66	10.28	60%	r	93.10	100	199	N/A	C5, F5, L4,	euc frst	4	provisional target increased due to fragmentation and other landscape disturbances and rarity of forest ecosystem
OG 30 Wallagaraugh Dry Grass Frst	1663	914	1.00	914	82	4.93	8.97	100%	r	100	100	82	N/A	C5, F5, L4, P3, W3	euc frst	5	
OG 32 Coastal Dry Shrb Frst (E.lo	24521	23401	0.15	3678	2293	9.35	9.80	100%		100	100	2293	N/A	L4, F5,W5,C5,G5	euc frst	1	
OG 33 Coastal Dry Shrb Frst (E.mu	16298	16136	0.15	2445	2803	17.20	17.37	60%		78.96	60	1682	N/A	L4,F5,W5,G5,C5	euc frst	1	provisional target increased due to fragmentation and other landscape disturbances
OG 34 Brogo Dry Shrb Frst	16155	14155	0.15	2423	3237	20.04	22.87	60%		74.76	60	1942	N/A	L4,F5,W5,G5,C5	euc frst	1	provisional target increased due to fragmentation and other landscape disturbances
OG 35 Escarpment Dry Grass Frst	34577	22007	0.15	5187	5041	14.58	22.91	60%		82.84	60	3025	N/A	L4,F5,W5,G5,C5	euc frst	2	provisional target increased due to fragmentation and other landscape disturbances
OG 36 Dune Dry Shrb Frst	1023	604	1.00	604	130	12.71	21.53	60%	r	85.61	100	130	N/A	C2, W2, D1 L4,F5,G4	euc frst	2	provisional target increased due to fragmentation and other landscape disturbances and rarity of forest ecosystem
OG 37 Coastal Dry Shrb Frst (An.f	16153	15147	0.15	2423	2929	18.13	19.34	60%		77.59	60	1757	N/A	L4,F5,W5,G5,C5	euc frst	3	provisional target increased due to fragmentation and other landscape disturbances
OG 41 Mountain Dry Shrb Frst (E.f	1865	1864	0.15	280	372	19.95	19.96	60%		74.89	60	223	N/A	F5, L4,C5	euc frst	4	provisional target increased due to fragmentation and other landscape disturbances
OG 42 Coastal Dry Shrb Frst (E.ob	22044	21556	0.15	3307	1746	7.92	8.10	100%		100	100	1746	N/A	F5, L4,C5	euc frst	5	

Forest Ecosystem	FE Pre 1750 (ha)	FE Extant 1997 (ha)	FE target (%)	FE target (ha)	OG Extant 1997 (ha)	% OG / FE Pre 1750	% OG / FE 1997 Extant	Provisional OG Target (%)	Rare & Depleted [1]	Adjusted Landscape disturbance target % [2]	Final Agreed Target %	Final Agreed Target (ha)	Minimum Viable Patch size	Vulnerability to and likelihood of a threatening processes occurring ranked 1(VH)-5(VL)	Euc Frst vs Non-Euc Frst	Sensitivity to threatening processes Final Rank (1-5). Most sensitive 1, least 5 [3]	Comments: Justified Fields
OG 43 Mountain Dry Shrb Frst (E.c	2492	2479	0.15	374	512	20.54	20.65	60%		74.01	60	307	N/A	F5, L4,C5	euc frst	3	provisional target increased due to fragmentation and other landscape disturbances
OG 44 Foothills Dry Shrb Frst	3326	3142	0.15	499	752	22.61	23.94	60%		70.95	60	451	N/A	F5, L4,C5	euc frst	3	provisional target increased due to fragmentation and other landscape disturbances
OG 45 Mountain Dry Shrb Frst (E.s	2024	1915	0.15	304	369	18.23	19.27	60%		77.44	60	221	N/A	F5, L4,C5	euc frst	4	provisional target increased due to fragmentation and other landscape disturbances
OG 46A Timbillica Dry Shrb Frst	22917	22792	0.15	3438	1579	6.89	6.93	100%		100	100	1579	N/A	F5, L4,C5	euc frst	3	
OG 46B Lowland Dry Shrb Frst	15978	15121	0.15	2397	4789	29.97	31.67	60%		60.04	60	2873	N/A	F5, L4,C5	euc frst	3	provisional target increased due to fragmentation and other landscape disturbances
OG 47 Eden Dry Shrb Frst	17797	17141	0.15	2670	4453	25.02	25.98	60%		67.38	60	2672	N/A	F5, L4,C5	euc frst	1	provisional target increased due to fragmentation and other landscape disturbances
OG 48 Bega Dry Shrb Frst	4497	4455	0.15	674	826	18.37	18.54	60%		77.23	60	496	N/A	F5, L4,C5	euc frst	4	provisional target increased due to fragmentation and other landscape disturbances
OG 49 Coastal Dry Shrb Frst (E.ag	32334	31837	0.15	4850	3385	10.47	10.63	60%		88.93	60	2031	N/A	F5, L4,C5	euc frst	3	provisional target increased due to fragmentation and other landscape disturbances
OG 50 Genoa Dry Shrb Frst	3702	3026	0.15	555	903	24.39	29.84	60%		68.31	60	542	N/A	F5, L4,C5	euc frst	2	provisional target increased due to fragmentation and other landscape disturbances
OG 58 Swamp Frst	1080	953	1.00	953	109	10.10	11.44	60%	r	89.48	100	109	N/A	W3, P3, L5, C4, G5, F5	euc_frst	1	provisional target increased due to fragmentation and other landscape disturbances and rarity of forest ecosystem
OG W1 Wadbilliga Dry Shrb Frst	27352	27341	0.15	4103	11109	40.62	40.63	60%		60.00	60	6665	N/A	F5, L4,	euc frst	5	
OG W2 Wadbilliga Range Ash Frst	1007	1007	1.00	1007	394	39.13	39.13	60%		60.00	60	236	N/A	F5, L4,	euc frst	2	
OG W4 Wadbilliga Range Wet Frst	3501	3214	0.15	525	1226	35.01	38.15	60%		60.00	60	736	N/A	F5, L4,	euc frst	5	
OG W5 Wadbilliga Gorge Dry Frst	7748	7239	0.15	1162	2110	27.23	29.15	60%		64.10	60	1266	N/A	F5, L4,	euc frst	5	provisional target increased due to fragmentation and other landscape disturbances
OG W6 Wadbilliga River Valley Frst	1902	1897	0.15	285	563	29.60	29.68	60%		60.59	60	338	N/A	W3,F5,L4	euc frst	4	
TOTAL	**751513**	**515152**		**125814**	**102453**							**69070**					

Rare & Depleted [1]
r = rare
hd = highly depleted
c = worthy of consideration

Adjusted Landscape disturbance target % [2]
(equals IF (provo % targ >100% =100) AND IF (provo % targ <100% THEN (100-((OG % Orig Targ -3)/27)*40). Where formula equals < 60% then 60% held and formula ignored)
104.44

Sensitivity to threatening processes. Final Rank (1-5). Highest sensitivity 1, least 5 [3]
1 = ratio of oldgrowth the young and recently disturbed forest is less than 0.25
2 = ratio of oldgrowth the young and recently disturbed forest is between 0.25 and 0.50
3 = ratio of oldgrowth the young and recently disturbed forest is between 0.50 and 1.00
4 = ratio of oldgrowth the young and recently disturbed forest is between 1.00 and 2.00
5 = ratio of oldgrowth the young and recently disturbed forest is greater than 2.00

Appendix 4.8 - Endemic flora species

No.	Species	ROTAP	Comm. legislation	NPWS legislation	Significance Endemic
63	Acacia constablei	2V	V	V	endemic (Class A, Level 4)
168	Eucalyptus imlayensis	2VCit	V	E	endemic (Class A, Level 4)
144	Genoplesium rhyoliticum	2E	E	E	endemic (Class A, Level 4)
76	Grevillea acanthifolia ssp. paludosa	2ECit		E	endemic (Class A, Level 4)
123	Hibbertia sp. nov. aff. hermanniifolia				endemic (Class A, Level 4)
139	Phebalium rhytidophyllum	2VCit	V	V	endemic (Class A, Level 4)
108	Westringia kydrensis	2KV-		E	endemic (Class A, Level 4)
109	Zieria buxijugum	2E	E	E	endemic (Class A, Level 4)
111	Zieria formosa	2E	E	E	endemic (Class A, Level 4)
113	Zieria parrisiae	2E	E	E	endemic (Class A, Level 4)
62	Acacia blayana	2RC-			endemic (Class A, Level 3)
115	Acacia georgensis	2VCi	V	V	endemic (Class A, Level 3)
173	Eucalyptus spectatrix	2RVi			endemic (Class A, Level 3)
124	Hibbertia hermanniifolia	3RCa			endemic (Class A, Level 3)
87	Phebalium ralstonii	2VCi	V	V	endemic (Class A, Level 3)
107	Westringia davidii	2V	V	V	endemic (Class A, Level 3)
5	Eucalyptus paliformis	2RCat			endemic (Class A, Level 2)
94	Pomaderris parrisiae	2VC-	V	V	endemic (Class B
71	Correa baeuerlenii	3VCi	V	V	endemic (Class B)
9	Deyeuxia accedens	3RC-			endemic (Class B)
162	Eucalyptus badjensis	2RCi			endemic (Class B)
176	Eucalyptus parvula	2VCi	V	V	endemic (Class B)
127	Persoonia brevifolia	2RCa			endemic (Class B, Level 2)
54	Pomaderris brogoensis	3RC-			endemic (Class B, Level 2)
95	Pomaderris virgata	3RC-			endemic (Class B, Level 2)
101	Pultenaea parrisiae ssp. parrisiae	3VCi	V	V	endemic (Class B, Level 2)
64	Acacia costiniana	3RCa			endemic (Class B, Level 1)
66	Acacia subporosa				endemic (Class B, Level 1)

Appendix 4.9 - Disjunct flora species for Eden CRA

no.	Species	ROTAP	Comm. legislation	NPWS legislation	Significance
64	Acacia costiniana	3RCa			disjunct pop
116	Acacia lucasii	3RCa			disjunct pop
118	Acacia subtilinervis	3RCa			disjunct pop
67	Actinotus gibbonsii				disjunct pop
161	Allocasuarina diminuta ssp. annectens				disjunct pop
60	Boronia deanei	3VCa	V	V	disjunct pop
143	Burnettia cuneata	3RC-			disjunct pop
40	Cassinia aureonitens				disjunct pop
41	Cassinia cunninghamii				disjunct pop
71	Correa baeuerlenii	3VCi	V	V	disjunct pop
73	Dodonaea multijuga				disjunct pop
134	Dodonaea triangularis				disjunct pop
77	Grevillea miqueliana				disjunct pop
43	Helichrysum collinum				disjunct pop
80	Hibbertia saligna				disjunct pop
81	Hovea longifolia				disjunct pop
48	Jacksonia scoparia				disjunct pop
82	Leucopogon setiger				disjunct pop
160	Pterostylis plumosa				disjunct pop
102	Pultenaea villifera	3RC-			disjunct pop
103	Rulingia hermannifolia	3RCa			disjunct pop
44	Trochocarpa laurina				disjunct pop

Appendix 4.10 - National Estate assessment workshop report

Identification of non-targeted JANIS and National Estate natural values CRA/RFA Eden region 20 August 1996

Participants:

Dr Brendan Mackey (Geography, ANU)
Phillip Gilmour (ecologist)
Dr Dan Faith (CSIRO Wildlife & Ecology)
Assoc Prof Craig Moritz (Zoology, UQ)
Dr Bruce Wellington (ecologist),
Bronwen Wicks (Environment Australia)
Philip Hodgson (Environment Australia)
Karl Bossard (Environment Australia)
Geoff Moore (NSW NPWS)
Simon Ferrier (NSW NPWS)
Ian Barnes (State Forests, NSW)

Background:

National estate values are amongst those required to be assessed as part of the Comprehensive Regional Assessment of forested areas in Australia. Assessment of national estate values in a regional context involves a comparative evaluation of the significance of places having one or more attributes or values derived from the national estate criteria.

A place is deemed significant for a particular national estate value when the expression of the value at the place is assessed to be at or above a certain threshold of significance. Thresholds of significance are developed for each value, and are based on the level of current knowledge about the nature and extent of natural values, and their distribution in the landscape at local, regional and national levels.

The assessment of national estate values in a regional context requires:

- identification and mapping of relevant values in the region;
- assessment of the expression of values at particular places against thresholds of significance;
- identification of places with values above appropriate thresholds of significance.

Aim of workshop:

The aim of the workshop was to provide advice concerning the use of currently available data layers for the Eden CRA region for identifying places with national estate values associated with:

1) Centres of endemism;
2) Places of refugia;
3) Areas important for relictual species;
4) Areas important for disjunct species and species at their biogeographic limits;
5) Areas of high diversity and/or richness.

Data:

Data being used for the Eden CRA include new data layers, and improved and extended versions of data layers used for previous assessment work in the region, such as the IAP and DFA processes. Some data layers for Eden, including the forest vegetation and growth stages maps, and distribution models for some fauna species are currently in varying stages of development.

Timelines:

All derived outputs to meet national estate requirements for the Eden RFA are required to be completed by 12 September 1997. The outputs will be used for the integration phase of the RFA in conjunction with decision support systems, including C-Plan.

It is estimated that some of the baseline datasets necessary to derive outputs required for national estate assessment (for example forest type mapping) will not be available before the end of August 1997. As a

result, only a limited amount of time will be available to undertake the necessary derivation work for national estate values.

The Workshop was asked to consider these time constraints when it formulated its advice concerning work to meet national estate, and consequently JANIS, requirements for the Eden CRA region.

National estate assessment

Some national estate values have specific targets that have been set as part of the JANIS criteria. However, there are also national estate values that have no JANIS equivalents, and others for which there are JANIS equivalents, but no specific conservation targets.

Recommendations

The Workshop recommended that:

1) all options identified in relation to values with specific targets are also evaluated for their relative contribution to those values without targets in the application of C-Plan;
2) the integration phase attempt to identify options that maximise the protection of all national estate values, including those values without specific targets set under JANIS.

Such an approach would provide a mechanism of ensuring that the trade-offs for national estate values without specific targets are explicitly considered in the integration phase.

1. Endemism and centres of endemism

Definitions

- **Endemics** were defined to include the following two classes of taxa:

  Class A endemics - species of plants and animals whose natural distribution is wholly confined to the Eden region; and

  Class B endemics - species of plants and animals whose natural distribution is mainly (>50%) in the Eden region, and with additional populations confined to adjacent regions

- **Centres of Endemism** were defined as places which include a number of endemic species:

Endemic Flora

Distribution

- Rhyolite outcrops were identified as an important factor associated with endemic flora in the Eden region. Many of the endemic plant species in the region are confined to rhyolite outcrops. Some species (eg *Zieria* sp.) have distributions confined to one or a few outcrops, whereas other taxa (eg *Westringia* sp.) may be distributed widely on rhyolite outcrops throughout the region.
- It was noted that there is sometimes a good correlation between the distributions of endemic plant species in the region, with several taxa likely to be found at the same locality.
- In contrast, there is likely to be little or no correlation between the distributions of endemic plant and animal taxa.
  Endemic plant taxa are often found in extreme habitats (eg the acid volcanic soils associated with rhyolite outcrops) whereas faunal diversity and the incidence of endemic animal taxa are more likely to be associated with other factors such as areas of higher soil nutrient availability.

Class A endemics

- The distribution of Class A plant endemics in the region is reasonably well defined based on available site records and expert knowledge.
- The distribution of Class A plant endemics tends to be restricted and, for many species including those associated with rhyolite outcrops, is reasonably well known.
- Modelling is unlikely to be of much use for predicting the distribution of Class A species.

- The distribution of some Class A plant endemics has been mapped (likely accuracy - ca 100m +).

Class B endemics

- The distribution of Class B plant endemics in the region is broader and more difficult to define.
- Most Class B plant endemics are likely to have a restricted distribution, but there are also some species (eg *Acacia porosa*) which are widely distributed in the Eden region and these endemics are therefore locally common.
- Many Class B endemics are likely to be associated with the escarpment, and many species will therefore be represented in the reserve system.

Centres of endemism

- The co-occurrence of endemic species is an important criterion for a centre of endemism.
- Centres of endemism may be associated with particular processes leading to endemicity; they therefore can be important in predicting endemicity amongst other species.
- Identification of places that support more than one endemic species is important for identifying possible centres of endemism.

Thresholds

- In discussing thresholds for endemism, the Workshop identified the following levels:
  - Level 4 - endemic to the region, and occurring at only one locality (Class A endemic)
  - Level 3 - endemic to the region and occurring at more than one locality (Class A endemic)
  - Level 2 - mainly endemic to the region and rare elsewhere (Class B endemic)
  - Level 1 - mainly endemic to the region, but common in adjacent regions (Class B endemic)
- It is important to ensure that all grid cells (or polygons) with expressions of endemism at Level 4 are included.
- It is also important to ensure that all grid cells with expressions of endemism at Level 3 are included where the endemic species is uncommon.
- Grid cells with expressions of endemism at Level 3 for more than 2 species may be associated with centres of endemicity and should also be included.
- Thresholds for Levels 2 and 1 (Class B endemics) will need to be determined based on a consideration of all of the available distribution data for each species.

Actions

It was agreed that Phil Gilmore would identify plant species endemic to the region, and categorise each species according to the classes and levels of endemism outlined above.

Endemic fauna

Distribution

- Distribution models are currently available for 300 fauna species in the region, including those on the list of priority species. The available data concern higher vertebrates, including mammals, birds, reptiles and amphibians.
- Little is currently known of the distribution of aquatic fauna or invertebrates in the region. Invertebrates are thought likely to have a very high diversity in the region, and to include many endemic species, but there is little or no data concerning either the taxa involved or their distribution in the region.

Class A endemics

- There are no Class A endemics amongst the higher vertebrates as currently known for the region, although it should be noted that the distribution of spatially-constrained species (for example frogs) has yet to be considered in detail.
- Too little is currently known of the distribution of lower fauna taxa including invertebrates in the region to determine whether these include any Class A endemics.

Class B endemics

- The Long-footed Potoroo was thought likely to be a Class B endemic for the Eden region on the basis of its distribution which is confined to the south-east IBRA region, including the Eden and adjacent East Gippsland RFA regions.
- It was thought that other likely Class B endemics for the Eden region would include some species of reptiles and amphibians.
- Too little is currently known of the distribution of lower fauna taxa including invertebrates in the region to determine whether these include any Class B endemics.

Thresholds

- The Workshop agreed that a conceptual approach similar to that outlined above for plants should be used to identify fauna species above threshold for national estate value related to endemism. This would involve the following steps:

1) Finalise the list of fauna species for the region;
2) Identify relevant experts for each major taxonomic group;
3) Identify species above threshold in relation to endemism, using relevant experts.

Actions

It was agreed that the list of 300 fauna species for the region would be used and Geoff Moore would approach relevant experts to identify the endemic status of fauna species.

It was agreed that Karl Bossard would approach Penelope Greenslade (CSIRO Entomology) (if time permitted) to provide expert advice regarding the known or possible endemic status of any invertebrates in the region .

Recommendations

- Requirements for the integration phase (C-Plan) should include layers with defined areas that represent values associated with endemism, including centres of endemism.
- Statements indicating the following should be included in any discussion of national estate values associated with endemism and centres of endemism for the Eden CRA/RFA:

  a) little is currently known of the distribution of lower plant taxa including bryophytes and fungi and these taxa may include a number of endemic species;

  b) centres of endemism for plants are unlikely to predict centres of endemism for invertebrates;

  c) high levels of diversity and endemism are known to occur amongst invertebrate fauna for the region, but that there are no data available to characterise the distribution of these taxa;

  d) it is unlikely that the reserve system will necessarily include adequate representation of endemic invertebrate species; and

  e) there is a need to ensure that appropriate data concerning the distribution and status of lower plant and animal taxa are collected for use in future planning processes in the region.

Draft rule set for identifying centres of endemism

Identify endemic species and centres of endemism:

1) Identify all endemic species for the region;
2) Classify endemic species into class and level (see above);
3) Identify appropriate methods and spatial scales for representing species distributions (methods will include grid cells for site data, and polygons for modelled distributions; grid resolution will need to be as fine as possible, but broad enough to avoid false absences);
4) Identify places (grid squares or polygons) with endemic values at Level 4, and Level 3 where the species are uncommon (these areas above threshold);
5) Identify places (grid squares or polygons) with endemic species at Levels 2 and 1 and assess these in the context of the distribution of their endemic species outside the region;
6) Identify any places above threshold in the region for Levels 2 and 1 species;
7) Identify all places which have more than one endemic species and therefore are possible centres of endemism;
8) Rank all possible centres of endemism against their total number of endemic species and their number of species at each level of endemism;
9) Identify thresholds for centres of endemism based on an assessment of all possible places for number of endemics, and levels of endemism in the region,
10) Identify places above threshold for number of endemics as centres of endemism.

Ensure protection of endemic values:

1) Quantify the contribution to protecting endemic values of each land-use option generated to achieve particular targets for other values using C-Plan;
2) Rank the options on the basis of their contribution to endemic values;
3) Ensure that the selection of options attempts to maximise the contribution to protecting endemic values;
4) For land-use options selected, identify places with above threshold value that are not adequately protected by tenure arrangements;
5) Ensure that other arrangements, including prescriptive management arrangements, are agreed to protect all endemic values above threshold.

2. Places of refugia

Definitions

- Refugia are places where species are not eliminated by a threatening process. The impacts of the threatening process are either prevented or buffered, and species are able to persist despite being eliminated from other (non-refugial) areas.
- Refugia include places to which species can move to avoid a threatening process.
- Refugia are places where species can persist and subsequently disperse from following large fluctuations in threatening processes.

Threatening processes

- Threatening processes identified as relevant to refugia in the Eden region, and of high priority for national estate assessment in the CRA/RFA process included:

  - climate change (long-term);

  - drought;

  - fire.

- Threatening processes identified as relevant to refugia in the Eden region, but of low priority for national estate assessment included:

  - introduced species;

  - clearing.

Types of refugia

Summary Table - Threats and refugia

Threat	Priority	Refugial characteristics	Examples	Examples identified
Long-term climate change	High	- environmental gradients (i.e. migratory routes) - sites with long-term stable environmental conditions	Pleistocene refugia (rainforest) Steep altitudinal gradients	Cool temp rainforest For example: - Burragate - Werrinook FR - Brown Mountain - Mt Imlay Warm temp rainforest For example: - Waalimme - Howe Range - Murrabrine parts of the Great Divide escarpment
Drought	High	sites of permanent water availability due to: - local variation in rainfall, mist - landscape redistribution of water	riparian areas wetlands swamps lakes rainforest escarpment sites	
Fire	High	relatively moist areas, sites with topographic features resulting in low fire risk, or low fire intensity	areas of low fire risk rainforest	

Introduced species	Low	sites protected due to: - physical barriers - human access barriers	wilderness areas of restricted human access	
Clearing	Low	artificial remnant areas providing refuge to species	remnant vegetation	Remnants of Eucalyptus tereticornis - Blue Box
Various (may include one or more of the above threats)		geographic isolates	mountain tops rocky outcrops	Nalbaugh Plateau isolated peaks in region Jingera Rock Bunga Head Biamanga Granite Pheasant Creek Perico

Identification

- Rainforest

  Rainforest in the region has been mapped

  (identification: forest type data layer)

- Temperature/rainfall

  Software currently available (ANU) can be used to define signature 'envelopes' of environmental conditions for suites of sites with a demonstrated refugial characteristic by linking their boundaries to grided estimates of environmental data for the region. The data layers can then be searched for other sites that also lie within the particular environmental envelope and are therefore possible refuges in the region.

- Drought refuges

  Drought refuges can be identified based on features associated with wetter areas within forests. These include:

  - topographic features (rivers, swamps, lakes);
  - (identification: DEM, other data layers?)
  - vegetation characteristics (riparian vegetation, rainforest, old growth wet forest)

    (identification: vegetation and forest type data layers)

- Fire refuges

  Fire refuges include:

- relatively wet areas within forests that have a low probability of high intensity fire, including riparian vegetation, rainforest, wet forest (also see under Drought);
- sites of low fire risk (identification: fire risk model available for south coast region);
- sites of low fire intensity (identification: fire history data layer);
- rainforest (identification: forest type data layer).

Note: Refugial areas located within fire boundaries are likely to be important in a national estate context. It should be emphasised that 'within-fire' refuges are likely to be associated with relatively moist areas of forest. However, they are unable to be identified from any currently available data, and they are not adequately represented by any other types of refuge (eg riparian zones, wetlands etc). It is also important to note that rivers, lakes etc do not represent refuges for most animal species.

- Mountain tops

Mountain tops are important in providing refuges in relation to:

- higher temperatures (climate change threat)
- fire (particularly high fire intensities)

- Sharp elevational gradients

Elevational gradients are important in providing refuges and 'escape routes' in the face of long-term climate change. The steepness of the gradient and its altitudinal range are both important refugial characteristics. There is also likely to be a threshold of significance based on characteristics of steepness and altitudinal range; this will need to be determined in each regional context.

Note: Reserve design principles should include the goal of maximising sharp elevational gradients due to their importance for refugia, particularly in the context of climate change.

Action

Phil Gilmore to provide a list of relevant elevational gradients for the Eden region.

Recommendations

- Reserve design should attempt to maximise the contribution of the reserve system to representing the refugial values, for all types of refuges;
- Possible linkages between refugia in the context of rare or threatened species and the context of National Estate should be investigated (including a recent review of refugia undertaken in relation to ROTS);
- Although there is not sufficient time to undertake this work in the context of the Eden CRA/RFA, it is desirable that changes in refugial values within regions should be modelled under a scenario of future climate change associated with a global warming cycle. This could be attempted by modelling changes in a temperature surface based on the estimated distribution of temperature classes for the region. The aim would be to assess the change in distribution of temperature classes, particularly those classes which tended to persist and those which tended to become rarer.

Draft rule set for identifying refugia

Identify refugia to long term climatic change

1. *Identify all areas of Rainforest. Include:*
Bunga Head Rainforest
Coastal Warm Temperate Rainforest
Cool Temperate Rainforest)Dry Rainforest
Hinterland Warm Temperate Rainforest
Myanba Eucalypt - Fig Forest
Rocky Tops
2 *Identify isolated mountain tops. Include:*

Burragate Peak – Jingera Rock (areas above 750 m)
Mount Imlay (areas above 800 m)
Mount Poole (areas above 675 m)
Mumbulla Mountain (areas above 675 m)
Murrabrine (Mountain) (areas above 725 m)
Nadgee Mountain (Mt Nagha) (areas above 450 m)
Nungatta Plateau (areas above 800 m)
Waalimma Peak (areas above 625 m)
Wolumla Peak (areas above 675 m)
Nalbough Plateau (areas above 975 m)
White Rock Mountain
Wog Wog Mountain

Identify Drought Refugia

3. *Use identified rainforest (above)*

4. *Identify riparian vegetation, old growth wet forest and wetlands. Include:*
Southern Riparian Scrub
Northern Riparian Scrub
Riverine Forest
Old Growth
Mountain Wet Layered Forest (Shining Gum)
Mountain Wet Layered Forest (Brown Barrel)
Tantawangalo Wet Shrub Forest
Mountain Wet Fern Forest (Brown Barrel-Gum)
Hinterland Wet Fern Forest (Gum)
Hinterland Wet Shrub Forest (Stringybark)
Mountain Wet Herb Forest (Messmate-Gum)
Basalt Wet Herb Forest (Brown Barrel-Gum)
Flats Wet Herb Forest (Ribbon Gum)
Brogo Wet Vine Forest (Red Gum)
Brogo Wet Shrub Forest (Peppermint-Blue Box)
Wadbilliga Wet Shrub Forest
Swamp Heath
Lowland Swamp
Swamp Forest
Subalpine Bog
Floodplain Wetlands
Estuarine Wetland

Identify Fire refugia

5. Use identified rainforest, wetlands and mountain tops (above)

6. *Identify rocky outcrops. Include:*
Jingera Rock
Bunga Head
Biamanga Granite
Pheasant's Peak
Perico Mountain

7. Identify sites of low fire risk (based on fire risk model)

8. Identify sites that are only known to have burnt with low fire intensity (or not at all) (based on fire history data)

9. *In the context of all places identified, define threshold of refugial significance in relation to each type of refugial value*

10. *Identify those places (grid squares or polygons) with refugial values above threshold for the region*

3. Relicts

Definition

Relicts are disjunct populations that have become isolated due to historical factors (for example environmental change, evolutionary factors) rather than recent factors (for example due to long distance dispersal).

Relicts are likely to have a high level of significance associated with their rarity in the region, or their particular taxonomic status and genetic structure.

Places associated with relicts in the Eden CRA region include:

- mountain tops (high altitude isolates are likely to be relictual)
- heathlands (it is not certain whether these are relictual or recent)

Taxa likely to have national estate significance due to their relictual status in the region include Gondwanic rainforest families. These include:

Monemiaceae

Winteraceae

Eupomateaceae

Eucryphiaceae

Atherospermataceae

Cool temperate rainforest can therefore be used as a surrogate for these relictual values in the Eden region

Other relictual taxa in the region may include:

Prostanthera monticola

Grevillea obtusifolia

Eucalyptus parviflora

primitive taxa (*Macrozamia communis*)

Draft rule set for identifying places important for relictual species

Identify places important for relictual species:

1) Use identified rainforest and mountain tops (above);
2) Identify heathlands (wet heaths, damp sub-alpine heath and subalpine treeless complex (bog communities)) and riparian scrub complex;
3) In the context of all places identified as supporting relictual species, define threshold of significance for relictual values;
4) Identify those places (grid squares or polygons) with relictual values above threshold for the region.

Ensure protection of places important for relictual species:

5) Quantify the contribution to protecting places important for relictual species of each land-use option generated to achieve particular targets for other values using C-Plan;
6) Rank the options on the basis of their contribution to protecting places important for relictual species;
7) Ensure that the selection of options attempts to maximise the contribution to protecting places important for relictual species;
8) For land-use options selected, identify places with above threshold value that are not adequately protected by tenure arrangements;

9) Ensure that other arrangements, including prescriptive management arrangements are agreed to protect all places important for relictual species above threshold.

4. Disjunct populations, biogeographic limits

Definition

Disjunct populations are defined as those that are isolated geographically from other populations of the same species.

Disjunct flora

Action

Species with disjunct populations:

- Geoff Moore to provide relevant species lists (David Keith's report, database) to Phil Gilmore
- Phil Gilmore to use lists to identify:
  1) disjunct species
  2) species at their biogeographic limits in the region
- Geoff Moore to map distribution of relevant species and identify areas important in relation to disjunct populations, and for species at their biogeographic limits in the region

Unusual habitats in the region

(For example, *Eucalyptus tereticornis, E. maidenii* on basalt)

- Phil Gilmore to examine lists provided by Geoff Moore for unusual habitats
- Phil Gilmore to discuss these with David Keith, Doug Binns (Sydney)

Disjunct communities

- Phil Gilmore to check available information re these

Disjunct fauna

Action

(For example, Long-footed Potoroo)

- Geoff Moore to identify relevant species

Draft rule set for identifying places important for disjunct populations and populations at their biogeographical limits

Identify places important for disjunct populations, biogeographical limits

1) Identify species that are disjunct or at their biogeographical limit in the region;
2) Identify unusual habitats and disjunct communities in the region;
3) Identify appropriate methods and spatial scales for representing the distributions of 1 and 2 in the region (methods will include grid cells for site data, and polygons for mapped or modelled distributions; grid resolution will need to be as fine as possible, but broad enough to avoid false absences);
4) Identify places (grid squares or polygons) with disjunct species, species at their biogeographical limits, unusual habitats, disjunct communities;
5) In the context of all places identified in 4. above, define thresholds of significance for these values in a regional context;
6) Identify places above threshold in the region for these values;
7) Ensure protection of values associated with disjunct populations, biogeographical limits;

8) Quantify the contribution, to protecting places important for disjunct populations and for species at their biogeographical limit, of each land-use option generated to achieve particular targets for other values using C-Plan;

9) Rank the options on the basis of their contribution to protecting places important for disjunct populations and for species at their biogeographical limit;

10) Ensure that the selection of options attempts to maximise the contribution to protecting places important for disjunct populations and for species at their biogeographical limit;

11) For land-use options selected, identify places with above threshold value that are not adequately protected by tenure arrangements;

12) Ensure that other arrangements, including prescriptive management arrangements are agreed to protect all places important for disjunct populations and for species at their biogeographical limit above threshold.

5. Areas of high diversity/richness

Diversity can be expressed as alpha diversity (species richness at or within a site), beta diversity (species richness between sites), and gamma diversity (diversity at landscape scale). The Workshop noted that both alpha and gamma diversity are relevant to assessing national estate values for diversity.

Difficulties exist in estimating diversity for the Eden region based on the flora data as these are available only as sample records. There is also a strong sampling bias, with little data available for private forests.

The option exists of developing surrogates for diversity based on the available biotic and abiotic datasets for the region. These can be used to develop indices of heterogeneity at relevant scales. For example, it would be possible to use 2 resolutions of grid cells. Compartment and coupe scales are also currently in use for the region. These can vary depending on management factors such as accessibility, but are roughly in the order of 200 ha (compartments) and 50 ha (coupes).

Recommendations

- Forest types be used as surrogates for diversity at the broader scale in the Eden region.
- At the finer scale, intra-forest type diversity be estimated based on the modelled environmental variation within each forest type.
- Compartments can then be ranked according to their relative richness at the different scales, and areas of higher diversity identified based on the richest compartments.

Draft rule set for identifying areas of high diversity/richness

Identify places important as areas of high ecosystem diversity/richness:

1) Intersect forest ecosystem/forest type layer with planning unit (compartment) layer;

2) Calculate the number of ecosystem types in each compartment and divide by the size of the compartment (ha) to provide an index (ecosystem diversity index) of the number of ecosystem types per unit area for each compartment;

3) Rank the compartments according to their diversity index and in the context of all compartments, define threshold of significance for areas of high diversity/richness;

4) Identify those places (compartments) with high ecosystem diversity/richness above threshold for the region.

Identify places important as areas of high fauna diversity/richness:

1) Intersect fauna models with planning unit (compartment) layer;

2) Calculate the number of fauna types in each compartment and divide by the size of the compartment (ha) to provide an index (fauna diversity index) of the number of fauna types per unit area for each compartment;

3) Rank the compartments according to their diversity index and in the context of all compartments, define threshold of significance for areas of high fauna diversity/richness;
4) Identify those places (compartments) with high fauna diversity/richness above threshold for the region.

Ensure protection of places important as areas of high diversity/richness:

1) Quantify the contribution to protecting places important as areas of high diversity/richness for each land-use option generated to achieve particular targets for other values using C-Plan;
2) Rank the options on the basis of their contribution to protecting places as areas of high diversity/richness
3) Ensure that the selection of options attempts to maximise the contribution to protecting places important as areas of high diversity/richness;
4) For land-use options selected, identify places with above threshold value that are not adequately protected by tenure arrangements;
5) Ensure that other arrangements, including prescriptive management arrangements are agreed to protect all places important as areas of high diversity/richness above threshold.

Appendix 4.11 - Australian heritage commission criteria for the register of the National Estate

Without limiting the generality of sub-section (1) of the *Australian Heritage Commission Act 1975*, a place that is a component of the natural or cultural environment of Australia is to be taken to be a place included in the National Estate if it has significance or other special value for future generations as well as for the present community because of:

Criterion A: Its importance in the course, or pattern, of Australia's natural or cultural history.

A.1 Importance in the evolution of Australian flora, fauna, landscapes or climate;

A.2 Importance in maintaining existing processes or natural systems at the regional or national scale;

A.3 Importance in exhibiting unusual richness or diversity of flora, fauna, landscapes or cultural features;

A.4 Importance for association with events, developments or cultural phases which have had a significant role in the human occupation and evolution of the nation, State, region or community.

Criterion B: Its possession of uncommon, rare or endangered aspects of Australia's natural or cultural history.

B.1 Importance for rare, endangered or uncommon flora, fauna, communities, ecosystems, natural landscapes or phenomena, or as a wilderness;

B.2 Importance in demonstrating a distinctive way of life, custom, process, land-use, function or design no longer practised, in danger of being lost, or of exceptional interest.

Criterion C: Its potential to yield information that will contribute to an understanding of Australia's natural or cultural history.

C.1 Importance for information contributing to a wider understanding of Australian natural history, by virtue of its use as a research site, teaching site, type locality, reference or benchmark site;

C.2 Importance for information contributing to a wider understanding of the history of human occupation of Australia.

Criterion D: Its importance in demonstrating the principal characteristics of:

(i) a class of Australia's natural or cultural places; or

(ii) a class of Australia's natural or cultural environments.

D.1 Importance in demonstrating the principal characteristics of the range of landscapes, environments or ecosystems, the attributes of which identify them as being characteristic of their class;

D.2 Importance in demonstrating the principal characteristics of the range of human activities in the Australian environment (including way of life, custom, process, land-use, function, design or technique).

Criterion E: Its importance in exhibiting particular aesthetic characteristics valued by a community or cultural group.

E.1 Importance for a community for aesthetic characteristics held in high esteem or otherwise valued by the community.

Criterion F: Its importance in demonstrating a high degree of creative or technical achievement at a particular period.

F.1 Importance for its technical, creative, design or artistic excellence, innovation or achievement.

Criterion G: Its strong or special associations with a particular community or cultural group for social, cultural or spiritual reasons.

G.1 Importance as a place highly valued by a community for reasons of religious, spiritual, symbolic, cultural, educational, or social associations.

Criterion H: Its special association with the life or works of a person, or group of persons, of importance in Australia's natural or cultural history.

H.1 Importance for close associations with individuals whose activities have been significant within the history of the nation, State or region.