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National Estate Identification and Assessment in the South West Forest Region of Western Australia

A REGIONAL FOREST AGREEMENT FOR WESTERN AUSTRALIA

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Locked Bag 104
BENTLEY DELIVERY CENTRE WA 6983
Telephone 08 9334 0333

http://www.calm.wa.gov.au

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http://www.rfa.gov.au

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Foreword

This report provides information on the results of the assessment of national estate values for the comprehensive regional assessment of the South-West Forest Region of Western Australia. Places with national estate value are components of the natural or cultural environment that have aesthetic, historic, scientific or social significance, or other special value for future generations, as well as for the present community.

The comprehensive regional assessment of the South-West Forest Region has involved examination of environment and heritage, and social and economic values. Information on the range of these values, with the exception of national estate values, is contained in the report *Comprehensive Regional Assessment* published recently. A report entitled *Assessment of Ecologically Sustainable Forest Management in the South-West Forest Region of Western Australia* (Ferguson *et al.* 1997) has also been produced.

The information gathered in comprehensive regional assessment projects will be used in the development of a Regional Forest Agreement for Western Australia. Further information on approaches to the development of the Regional Forest Agreement is provided in the public consultation paper *Towards a Regional Forest Agreement for the South-West Forest Region of Western Australia.*

Summary

This report presents the outcomes of the national estate component of the comprehensive regional assessment of the South-West Forest Region of Western Australia. It will contribute to the development of a Regional Forest Agreement for Western Australia.

As defined in the *Australian Heritage Commission Act 1975*, the national estate comprises:

> 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 the for the present community.

Areas identified in this report as having potential national estate value are indicative only and are not necessarily the delineated forest areas that will be listed in the Register of the National Estate. The report documents the values that need to be taken into account in determining national estate places; the data in the report will form the basis of that determination by the Australian Heritage Commission. The data layers and indicative areas will remain indicative until they have been considered by the Australian Heritage Commission.

Over 160 areas were identified as indicative national estate areas of Aboriginal, social or aesthetic cultural value. Indicative national estate areas of natural value are identified in value maps covering natural landscapes, old-growth, wilderness, flora, fauna and natural history.

The national estate component of the CRA has greatly enhanced knowledge of the occurrence of national estate values in the forests of Western Australia. Some of the areas identified in this assessment occur within places already listed or interim-listed in the Register of the National Estate, and some places previously listed in the Register have been found not to have retained their national estate values. Places already listed or interim-listed in the Register of the National Estate will be updated in the light of the information gathered during the CRA.

It is expected that the Regional Forest Agreement between the Western Australian and Commonwealth Governments will include specifications for a jointly agreed national estate outcome in terms of both the listing of places, including a review of places currently listed or interim-listed in the Register of the National Estate, and the long-term management of national estate values in forests.

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1 Introduction

There are a number of stages in the development of the Regional Forest Agreement (RFA) between the Western Australian and Commonwealth Governments. The first stage, which follows the signing of the Scoping Agreement, is the comprehensive regional assessment (CRA). Both Governments, in collaboration with experts, have been involved in a wide range of projects designed to provide the information necessary for the analysis and identification of values and the determination of possible approaches for a RFA. Subsequent stages include the integration of environment, heritage, social and economic values in the Region, the development of the public consultation paper, and the drafting of the RFA.

This report presents the results of the assessment of natural and cultural national estate values, carried out as part of the CRA, and identifies indicative areas of national estate value in the Region. The values documented in this report will be taken into account in delineating national estate places. Areas endorsed by the Australian Heritage Commission (AHC) will be interim listed in the Register of the National Estate. The interim listing of areas will then be advertised and subject to the statutory period of three months allowed for objections and public comment. It is anticipated that interim listing of areas identified through this process will occur after the Western Australia-Commonwealth RFA is signed.

Western Australia and the Commonwealth are considering other matters to ensure that national estate values in forests are identified and managed on a long-term basis. This includes an examination by a group of independent experts of current forest management practices through the assessment of ecologically sustainable forest management (copies of the report *Assessment of Ecologically Sustainable Forest Management in the South-West Forest Region of Western Australia* are available on the internet at http://www.rfa.gov.au). Mechanisms for the protection of national estate values and places are also being evaluated and will be considered in the development of the RFA.

1.1 THE 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 protection of national estate places and the potential impact on national estate values of Commonwealth decisions 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 or national level. The identification and assessment of places for listing in the Register is guided by the national estate criteria (see Appendix B).

When making decisions about the use of forests that contain places of national estate significance, e.g., decisions on whether to grant woodchip export licences, the Commonwealth must consider any potential adverse effects on the national estate.

In the past, the lack of detailed information in a regional context about the national estate values of forests has made it difficult for the Australian Heritage Commission to identify and register places of national estate significance and to provide the Commonwealth Government with detailed advice about the protection of those places. The lack of information has also contributed to uncertainty for forest-based industries and for State governments about which places will be listed in the Register of the National Estate, and what advice the Commission would give on the protection of those places.

In recognition of these problems, the Commission has developed a methodology for the regional assessment of national estate values which focuses on systematic survey to identify areas of national estate significance coupled with appropriate management to protect identified values, using a regional framework as the basis for decision-making. A systematic regional approach to the assessment of national estate values ensures that information on the distribution and regional protection of values is available to provide an appropriate context for the Commission to develop its advice to the Commonwealth Government, and all stakeholders and the general community are aware of the places of national estate significance in the Region.

In providing advice on the protection of national estate values identified through CRAs undertaken for the development of RFAs, the Commission has developed a policy which recognises the implementation, through the RFA process, of the nationally agreed criteria for a comprehensive, adequate and representative (CAR) reserve system for forests (the JANIS criteria). In summary, the Commission's current policy on the listing and protection of national estate values in a CAR reserve system is that where a RFA has substantially met the various attributes and expectations of the Commission, then it is appropriate to list all places identified through the RFA as containing national estate values which are protected by reservation, by reserve management prescription, by site exclusion, by consultation processes or other measures appropriate to the value, or which are robust and not affected by timber harvesting or other off-reserve management regime or activity.

Some of the areas identified in this assessment occur within places already listed or interim-listed in the Register of the National Estate (Appendix A and Map 8). In addition to the identification of new indicative areas of national estate significance, this assessment has demonstrated that some places previously listed in the Register have not retained their national estate values. Places already listed or interim-listed in the Register of the National Estate will be updated in the light of the information gathered during the CRA.

1.1.1 The national estate assessment

The RFA process is designed to comply with a range of Commonwealth and State statutory obligations in relation to the management of forests, including the identification of and provision of advice on the protection of national estate values required under the *Australian Heritage Commission Act* 1975. The assessment of national estate values in the South-West Forest Region involved the Australian Heritage Commission, the Commonwealth Department of the Environment, and relevant State agencies including the Department of Conservation and Land Management (CALM), the Western Australian Museum, the Aboriginal Affairs Department and the Heritage Council of Western Australia. A similar assessment for a RFA has been completed by the AHC and Commonwealth and State agencies in Tasmania. Earlier regional assessments of national estate values, such as the AHC/CALM assessment of the Southern Forest Region and studies in East Gippsland and the Central Highlands of Victoria, were conducted by the Australian Heritage Commission in conjunction with State agencies.

Areas identified in this report as having potential national estate value are indicative only, and are not necessarily the delineated forest areas that will be listed in the Register of the National Estate. The report documents the values that need to be taken into account in determining national estate places; the data in the report will form the basis of that determination. The data layers and indicative areas will remain indicative until they have been considered by the Australian Heritage Commission. Places in the South-West Forest Region endorsed by the Commission will initially be interim-listed in the national estate. Interim-listed places will then be advertised and be subject to the statutory period of three months allowed for public comment. It is anticipated that interim-listing of places identified through this process will occur after the Western Australia–Commonwealth RFA is signed.

This assessment builds on the previous joint assessment by the AHC and CALM of national estate values in the Southern Forest Region which is within the Region covered by the RFA. Places in the South-West Forest Region which are already listed in the Register of the National Estate and those already on the interim list will be updated in the context of the information gathered during the CRA. The identification of national estate values in the Region will contribute to the development of the RFA. The RFA will include specifications for a jointly agreed national estate outcome.

Copies of consultancy reports which have contributed to the national estate assessment are available for inspection in Perth and Canberra:

Forest Science Library
Department of Conservation and Land Management
50 Hayman Rd
COMO WA

Department of the Environment
Tobruk House
15 Moore Street
CANBERRA ACT

This report has been prepared by the CRA project team including officers of the Commonwealth Department of the Environment and Western Australian Department of CALM with the assistance of a number of other agencies, organisations and individuals.

2 National Estate Cultural Values

2.1 INTRODUCTION

Cultural places of national estate significance can have aesthetic, historic, scientific or social values. Documentary and community-centred research reveals a wide range of cultural places within or related to the forests of the South-West Forest Region of Western Australia. These places are indicative of the rich and diverse history of human interaction with, and response to, those forests.

The national estate cultural studies component of the comprehensive regional assessment (CRA) has considered forest and forest-related cultural places within the study area across all land tenures. Cultural heritage places have mainly been identified on public lands. In the instances where places of indicative national estate cultural heritage value are located on private land, it is the policy of the Australian Heritage Commission to undertake detailed consultation with all relevant land owners and other parties to verify the significance of the place prior to any action being taken in relation to its listing in the Register of the National Estate. No action towards national estate listing for any places on private land identified in this report will be taken until such consultation has occurred.

Within the CRA process, the following cultural values were considered:

- places of social value (Aboriginal and non-Aboriginal);
- places of aesthetic value, and
- places of historic value.

2.1.1 Assessing the significance of cultural heritage values

Assessing the significance of national estate cultural heritage values in a regional context is a process which begins in the early stages of place identification and documentation and ends with the assessment of places against significance indicators and the application of a threshold of significance. Specific criteria are used in the development of significance indicators and the setting of thresholds. These criteria are specified in the *Australian Heritage Commission Act 1975*. The criteria, together with a series of operational sub-criteria, are listed in Appendix B.

Significance indicators are used to provide an indication as to whether or not a place holds the core components of a particular national estate value. They vary across the national estate values and may include the following:

- strength of community attachment;
- size and/or extent of community demonstrating attachment;
- substantiated strong association with a particular group or groups, and
- longevity of association with a particular group or groups.

Each threshold is set in relation to the significance indicators and is specific to each value. For instance, a place may need to rank highly on three out of five significance indicators to reach the threshold of national estate significance for a particular national estate value,. In other cases, a place may be highly ranked on just one significance indicator and still reach the national estate threshold. The point at which the threshold is set depends on the importance or relevance of the significance indicator to the national estate value.

The relationship between significance indicators and the national estate threshold is established through consideration of the quantity and quality of available information, through expert opinion, and through consideration of previous national estate thresholding and listing decisions.

A national estate threshold is not graded: a place will either meet the threshold or not. Places may be significant against more than one national estate criterion, although a place need only be significant against one criterion to warrant listing in the Register of the National Estate.

A regional perspective provides a much more comprehensive knowledge base for assessing places and for applying the thresholds for national estate significance.

In relation to places of Aboriginal value, it was not considered appropriate for a threshold of significance developed by people outside Aboriginal communities in the manner described above, to be applied to cultural heritage places identified by members of Aboriginal communities in the South-West without further extensive consultation. The process used to identify Aboriginal places of indicative national estate significance in the CRA process is described in Section 2.4.2.

2.1.2 Community consultation

Community consultation provides important information for the assessment of places of social significance (sub-criterion G.1) and aesthetic significance (sub-criterion E.1) (see Appendix B).

To identify and assess social (both Aboriginal and non-Aboriginal) and aesthetic values it is necessary to collect data directly from the community. This is because the criteria used to assess these values in the landscape specify that places of social or aesthetic value must be of significance to a community or cultural group.

The following considerations can provide a measure of the strength and depth of the community's attachment to a place:

- the size and extent of the attached community or group;
- the nature of the community, its history and cultural identity;
- the extent to which community members are prepared to allow the place to change, and
- the pace of change and whether the change is in harmony with the life of the community.

2.2 PLACES OF SOCIAL VALUE (NON-ABORIGINAL)

The identification and assessment of places of national estate significance for social value in the South-West Forest Region was based on national estate sub-criterion G.1, which recognises places that have strong or special association with a community for social, cultural or spiritual reasons (see Appendix B). Following consultation with members of Aboriginal communities from the Region, a parallel project was conducted to specifically identify and assess Aboriginal social values (see Section 2.4).

Many different types of places are important to community groups for many different reasons. Often communities value a particular place very highly because of the way they use the place or the meaning it holds for them. A place significant to the community may be a place where a memorable event has occurred in the past, or a place associated with a significant recent event. It can be a built feature such as a local hall, roadway or track, or it can be a naturally occurring feature such as a rock formation, a lake, an area of forest or a single tree. Such places are considered important because they form a part of the community's identity.

The aim of the national estate social values project was to identify the range and extent of places valued by communities in the South-West Forest Region and to assess those places for national estate significance. Before the CRA, very few places having national estate social significance had been identified in the Region. In these few places, however, this value had not been identified or corroborated through community consultation; rather, it had been determined through assessment by cultural and natural environment heritage experts. The information gathered during the CRA process, which enhances our understanding of the importance of these places, will be amalgamated with existing information on places already in the Register of the National Estate.

Some places of cultural heritage value in the Region have previously been identified in the Municipal Inventory process using community-based research methods similar to that described below. However, the majority of places identified through the Municipal Inventory process are within towns, rather than forested areas. Further, in the Municipal Inventory process, identification and assessment methods varied greatly between shires which, in the context of a regional assessment of social values in the South-West, resulted in data too variable for utilisation in this project.

2.2.1 Data sources

The communities of the South-West Forest Region provided the primary source of data for identifying and assessing places of indicative national estate social value during the CRA. Individuals and representatives of a broad range of organisations came together in community workshops to identify places important to them and to provide information on why those places were important, and on their locations and boundaries. Ten community workshops were held throughout the Region. The workshops were designed, organised and facilitated by consultants (The Training and Development Group in association with Considine and Griffiths Pty Ltd, Gray, Heaver & O'Connor) in collaboration with Commonwealth and State government Regional Forest Agreement (RFA) project officers.

Information obtained through the social values community workshop process was also used as a primary layer of data in the identification and assessment of places of aesthetic value in the Region (see Section 2.3.1).

2.2.2 Methodology

Identifying the range and extent of places of social value in the Region required a group-based social research method that would draw together a wide range of people willing to share their knowledge, opinions and feelings. From the range of community consultation methodologies available, the workshop method was selected as the most efficient because it could achieve a number of goals:

- involve a large number of people and maximise their input;
- cater for a wide range of community interests and perspectives;
- engage participants in identifying and expressing shared values;
- facilitate comparison between the range of places valued by a community;
- be applied in a consistent manner across the Region;
- provide results within the available timeframe;
- allow for the broad dissemination of information about the RFA generally and provide an opportunity for public question time with government officials, and
- consistency with methodologies used in the assessment of social value in RFA regions in other States.

Workshop locations

The choice of locations for workshops was based on a range of demographic, geographic and social information. Factors included the accessibility of workshop locations to major social catchment areas and the distance participants would be required to travel. Ten locations were selected: Armadale, Collie, Denmark, Dwellingup, Manjimup, Margaret River, Mundaring, Nannup, Pemberton and Perth.

Identifying potential workshop participants

To help identify potential workshop participants representative of a range of groups with different interests, values and knowledge about forest places of social value, numerous agencies and groups were consulted. These included those with interests in local government, business, timber industry, mining, primary industries, community service, conservation, history, tourism and recreation. People with long associations with an area were encouraged to participate, as were those with a particular interest in their local forest area.

Local community coordinators, engaged to assist in workshop implementation in each locality, also provided valuable input into this process. Their role was to identify any omissions from invitation lists and try to ensure a broad and balanced community representation at each of the workshops in

terms of interests, age and gender. Local community coordinators also sent out background information on the aims and context of the workshops to potential participants, loaned out videos on the national estate and RFA process and made themselves available to answer questions. Where possible, telephone contact was made with potential participants to further explain the project and encourage participation

Workshop design and process

Each workshop lasted from between two-and-a-half to three hours and included a number of group and individual activities designed to encourage participants to reflect on which places were important to them and to discuss their ideas with other participants. The workshops were structured into four phases.

- The first phase involved all participants in discussion about the RFA process, the aims of the workshop, the meaning of social value and the sorts of places that might have social value to communities.

- The second phase involved smaller groups of participants in compiling lists of places of possible social value through discussion and sharing of ideas.

- In the third phase participants provided detailed information (including a description of the place, its history, location and boundaries, and why it was of social value) by filling in data forms.

- In the fourth phase participants located and marked on 1:100 000 scale map overlays the boundaries of the places they had described, where known.

All workshop participants were sent a summary of their workshop and a list of the places identified. Copies of the complete documentation for the social values project have been deposited in regional centres for community use.

Identifying places of indicative national estate social value

Since not all places are equally valued by the community, places identified through the workshops were sorted and analysed to identify those places of indicative national estate social significance. This processes was undertaken in four steps.

Step 1

The first step was to sort and organise the data according to the category and location of the place. In many instances a place had been identified at several workshops, but attributed with a different name or boundary. Some places identified were a subset of a larger place which had also been identified. Such factors needed to be clearly identified to allow a clear and rigorous assessment process to take place.

Step 2

The second step involved an evaluation of the adequacy of the data for the purposes of assessment. This was done by posing three questions:

- Is the place in the study area?
- Is sufficient information provided to enable assessment of the place?
- Is social value demonstrated in the information provided?

These questions were answered by examining the data forms filled in at the workshops and by considering mapped information. In some instances, workshop participants had identified a place by name, but had provided no other information, while in others the social value of a place had not been described or only minimal information provided. In these instances, and in cases where the place identified was not in the study area, places were excluded from further consideration in the assessment process.

Community values identified in the workshops, but not related to particular places within the Region, were also not able to be considered in this assessment. For example, comments by some workshop

participants on the value they placed on the entire Region, an entire district or all old-growth forest, were too generalised and not able to be documented by workshop participants to a level sufficient to allow the delineation of areas of national estate significance through this process.

Step 3

The third step was to identify the nature of a place's social significance and to gauge the strength and endurance of the value. This was done through the analysis of responses to several sets of questions, with the answers being recorded in a matrix system.

To identify the nature of a place's social significance a series of six questions were posed. These 'significance indicators' were derived from the wording of national estate sub-criterion G.1. They were:

- Does the place contribute to the community's sense of identity?
- Does the place have educational or scientific value for present or future generations?
- Does the place represent attitudes, beliefs or behaviour fundamental to the community?
- Does the community have a special attachment to the place because of its important contribution to community life?
- Does the place have an association with an event which has had a profound effect on the community?
- Is the place a landmark or icon to the community, either tangible or intangible?

To identify the strength and endurance of the social value attached to a place further questions were posed. For strength of community association with a place, they were:

- Is the association strong for the whole community?
- Is the association strong for a large portion of the community?
- Is the association strong for a small portion of the community?

For endurance or length of community association with a place, the questions were:

- Is the association with the community long term - beyond twenty years?
- Is the association with the community medium term - between 10 and 20 years?
- Is the association with the community relatively recent - less than 10 years?

Step 4

The fourth step in the assessment process involved the setting and application of the threshold of significance. A place was considered to meet the threshold if it had:

- a high value for any one of the significance indicators for the whole or a large portion of the community and had moderate or long-term association, and

- a high value for any three of the significance indicators for a small portion of the community, and had a moderate or long-term association.

2.2.3 Results

The social values project collected and analysed a vast amount of information with the following results:

- 95 places, including 20 large places encompassing many smaller places, were assessed as indicative places of national estate social significance (see Appendix C and Map 6);

- 165 places were unable to be assessed due to insufficient information, and

- 114 places were found not to meet the threshold for national estate significance.

Among the places found to be of indicative national estate social significance were some that are important to an immediate community for their recreation value. The Pemberton Swimming Pool, a 91 metre-long area of fresh water created through the damming of Lefroy Brook in 1928 and enjoyed by generations since, was one such place. Others, such as Mount Chudalup, were important because of their landmark and aesthetic qualities. Some places, such as the Mundaring Weir, were important because they were evocative of the history of an area or contributed strongly to a community's sense of place.

All places identified through the community workshops have some value to the community of the Region. Among those places not identified as being of indicative national estate significance are some that could receive recognition and management through other State processes. Mechanisms by which such places can be protected are being considered as part of the RFA process (see Section 4.5).

2.3 PLACES OF SOCIAL VALUE (ABORIGINAL)

The identification and assessment of places of importance to Noongar* communities within or associated with the South-West Forest Region was primarily based upon national estate criteria for social and aesthetic value (criteria G.1 and E.1 respectively) which recognise places that have strong or special association with a community for social, cultural or spiritual reasons and places which exhibit particular aesthetic qualities valued by a community.

Consultation with members of Noongar communities was important both in the design and implementation of the assessment workshops and in the development and presentation of Noongar community views within the RFA process. The consultative process began in December 1996 with a meeting to which Noongar community representatives from across the Region and representatives from the Aboriginal Legal Service, the Noongar Land Council and the Aboriginal Affairs Department were invited. From this and a subsequent meeting, a group called the Aboriginal Action Group (later renamed the Noongar Action Group) was formed by the Noongar participants to provide one mechanism for direct Noongar participation in the RFA process.

Meeting periodically, the Noongar Action Group discussed aspects of the RFA process and how best to design a consultation strategy which would meet the needs of governments and the Noongar community. These needs were twofold:

- to provide as much information as possible about the RFA process to Noongar people living in or connected to the Region, and to provide a forum in which views and concerns could be openly expressed, formally recorded and considered in the latter stages of the RFA process; and

- to identify and document places of cultural heritage importance within the Region - where this was the wish of community members - and to identify community wishes in relation to the care and management of these places and their possible listing in the Register of the National Estate.

To assist in the fulfilment of this latter need, a brochure was produced in collaboration with the Noongar Action Group entitled *Noongar people have your say in the RFA*. This brochure was widely distributed amongst community members.

**The word 'Noongar' can be spelt in numerous ways. The spelling of Noongar in this form should also be seen to encompass the Nyoongar, Nyungar, Noongah, Nyoongah and Nyungah spellings.*

2.3.1 Data sources

The Noongar communities of the South-West Forest Region provided the primary source of data for identifying and assessing places of indicative national estate Aboriginal heritage value during the CRA. Community workshops were held throughout the Region in seven locations. Data obtained from community members was, where possible, cross-referenced with previously recorded information in the Aboriginal Affairs Department cultural heritage database and from other existing reports and studies.

Information obtained through the Noongar community workshop process was also used as a primary data layer in the identification and assessment of places of aesthetic value in the Region (see Section 2.3.1).

2.3.2 Methodology

A community workshop process which enabled both the discussion of issues and the identification of places and their management needs to occur within the one forum was developed as a means to satisfy the needs of governments and the community within the available timeframe. These workshops were designed by consultants (Centre for Social Research, Edith Cowan University and McDonald Hales and Associates) with direction from the Noongar Action Group and government representatives.

Workshop locations

The locations for workshops were selected in consultation with the Noongar Action Group as being convenient central points where community members with interests in the South-West Forest Region could meet. Seven locations were selected: Busselton, Collie, Manjimup, Mount Barker, Narrogin, Northam and Pinjarra.

Workshop participation

One or two members of Noongar communities within each workshop locality were employed as Local Community Liaison Officers. These people played an invaluable role in encouraging the participation in workshops by distributing information, including videos, brochures and invitations, and by discussing with people the aims and importance of the workshops. Two members of the consultancy team, who are themselves members of the Noongar community, also actively encouraged participation by addressing community meetings and by contacting elders. This approach to encouraging participation proved highly successful, with a total of 112 community members attending the workshops.

Workshop design and process

Each workshop was designed to run for approximately four hours. Participants worked as one group during periods of discussion and broke into smaller groups to identify and document places of cultural heritage importance. The workshops were structured into three main phases.

The first phase was introductory and involved all participants in discussion about the aims of the workshop, the RFA process, national estate values and the range of places that may have national estate values to the community.

The second phase involved the discussion of issues of concern to the community with a particular focus upon issues relating to forest and cultural heritage management.

In the third phase participants worked in small groups contributing information on places of importance to their community and marking these places on maps.

All workshop participants were sent a summary of the workshop to ensure that an accurate record of the meeting had been taken. Copies of the full record of the consultation project have been deposited in regional centres for community use.

Identifying places of indicative national estate Aboriginal heritage value

The sorting and analysis of places identified as being of importance to Noongar communities was guided by community wishes and the quantity and nature of information available at the time of the project. Community members at many workshops expressed their belief that all places they identified were of equally high significance, and that it was inappropriate for people other than community members to assess those places. It was therefore necessary to employ a process of assessment and documentation which responded to community wishes, yet which was consistent with that which had been used in the assessment of non-Aboriginal national estate social values.

Following the workshop process, identified places within the Region were cross-referenced with information contained within the Aboriginal Affairs Department database and any other relevant national estate values identified.

Although the focus of the project was national estate social and aesthetic value, the occurrence of other national estate values, such as historic value, were also documented. Where time permitted, additional secondary research was carried out to enable the fullest possible documentation of places.

It was found that only a proportion of all places identified could be documented to the level required for possible listing in the Register of the National Estate. All places identified within the Region will be considered during the development of the RFA. Mechanisms by which places can be protected are being considered as part of the RFA process (see Section 4.5).

2.3.3 Results

The workshop process collected a large amount of data on places of Aboriginal community heritage value in the South-West Forest Region of Western Australia. The results of this project should not be seen as an assessment of all of the Aboriginal heritage places and values within the Region, although they are an accurate reflection of the places and the range of values identified by the workshop participants as being important to Noongar people. In total 59 places were identified within the Region (see Appendix D). Of these:

- 15 were able to be documented to the level required for possible listing in the Register of the National Estate;
- 1 place was already listed in the Register of the National Estate, and
- 43 places identified by workshop participants but were not able to be documented to the level required for possible listing in the Register of the National Estate.

Places able to be documented to the level required for possible listing in the Register of the National Estate are shown on Map 6. Places identified by workshop participants, but were not able to be documented to the level required for possible listing in the Register of the National Estate, are shown on Map 9.

Some places identified were important for spiritual and traditional reasons, others for their more recent historical associations. One example of the places able to be documented to the level required for listing in the Register of the National Estate was the Avon River, which is important to the community because the Wagyl (a mythical serpent) resides there and looks after the Noongar people of the Region. The river is also significant because of a number of sacred sites located along its course. Also identified and documented in the project was Ellensbrook, a nineteenth century homestead which operated as an educational mission outside of the jurisdiction of the then Aborigines Department. A large fringe camp was also situated around the property.

The project also resulted in the collection and summarisation of community views and concerns in relation to forest and cultural heritage management. In relation to the national estate, the major issues raised by the community were the protection of places of Aboriginal cultural heritage value from the effects of disturbance and development (particularly mining and recreational activities) and the need for involvement of Noongar people in decision-making processes about cultural heritage management. Issues which were raised as being of concern to Noongar communities generally, are listed in Appendix E.

The issues and concerns raised by communities throughout the consultation process were also considered in the development of the Noongar Position Paper which details the wishes of the Noongar community in relation to the outcomes of the RFA (see Appendix F).

2.4 PLACES OF AESTHETIC VALUE

The identification and assessment of aesthetic value in the South-West Forest Region were based on national estate sub-criterion E.1, which recognises places exhibiting particular aesthetic qualities 'valued by a community or cultural group' as having heritage significance (see Appendix B).

The working definition of 'aesthetic value' developed for regional assessments in Victoria was also used:

> Aesthetic value is the response derived from the experience of the environment or particular natural or cultural attributes within it. This response can be to either visual or non-visual elements and can embrace emotional response, sense of place, sound, smell and any other factors having strong impact on human thought, feelings and attitudes (Australian Heritage Commission and the Department of Conservation and Natural Resources 1994, p.5).

2.4.1 Data sources

Five datasets were used to identify and assess places of indicative national estate aesthetic significance within the South-West Forest Region. Four of the datasets (social values, Aboriginal heritage values, tourist literature review and forest experts) were compiled as part of the CRA process; the other (scenic quality mapping) had been developed by CALM as part of its Visual Resource Management system.

National estate sub-criterion E.1 stipulates that the aesthetic significance of a place is dependent upon it being valued by a community or cultural group. Information on aesthetic values gathered at the social values community workshops and Aboriginal community heritage workshops was therefore integral to the identification and assessment of aesthetic value. The tourist literature review dataset enabled a broadening of the community perspective gained through local workshops within the Region. The forests experts dataset contributed detailed local knowledge and expertise to the assessment process. The remaining dataset (scenic quality mapping) was used primarily in boundary delineation refinement.

The social values dataset

Ten community workshops were held across the Region to collect information for both the social and aesthetic values datasets. Section 2.3.2 describes the workshop process.

The Aboriginal heritage dataset

Seven Aboriginal community heritage and consultative workshops were held across the Region to collect information for both the Aboriginal heritage and aesthetic values datasets. Section 2.4.2 describes this workshop process.

The tourist literature review dataset

The information in the tourist literature review dataset was collected by research consultants (ERM Mitchell McCotter 1998). Tourism industry operators based in forested and predominantly natural environments can be seen as a purveyors of aesthetic value; much of their business focuses on the visually significant and aesthetically pleasing. Material generated by this industry both reflects and generates public knowledge and valuation of places by encouraging their visitation and much of it is distributed on a wide scale. Using current tourist brochures and guide maps as a reflection of public interest, it was possible to identify places valued for their aesthetic qualities by both the local communities and a broader public.

The forest expert dataset

The information for the forest experts dataset was collected by interviewing CALM regional officers with extensive first-hand knowledge of forest areas. Interviews were held with CALM forest staff in the Swan Regional Office, the Central Forest Regional Office and the Southern Forest Regional and District Office. Officers were asked to identify forest places they believed to be of aesthetic value, and to mark the areas on 1:100 000 scale maps. They were also asked to review and verify the results of the tourist literature review. In addition to being used as a layer of information in the identification of aesthetic value, the dataset was also used in the later stage of delineating boundaries of indicative areas of national estate aesthetic value.

The scenic quality mapping dataset

The Visual Resource Management system developed by CALM is a series of mapped zones which are an integration of scenic quality areas seen from travel routes and recreation-use areas. It is prepared

using map overlays, aerial photographs and field checking. The boundaries of areas delineated in this system as being of 'high visual quality' were used to assist in the delineation of places found to meet the threshold of significance for national estate aesthetic value. Used in this way, it was considered to be a complementary dataset.

Other sources

Information concerning previously identified places of aesthetic value within the South-West Forest Region was reviewed and considered in the compilation of data for the assessment of national estate aesthetic value. Sources accessed included government and non-government-generated reports, lists and databases together with any other relevant publications.

2.4.2 Methodology

The methodology for the aesthetic values component of the CRA was designed to achieve the best practicable understanding of the range and distribution of aesthetic places in the South-West Forest Region within the available timeframe. Information from the three primary datasets (social values, tourist literature review and forest experts) was combined into a matrix table and cross-referenced. Using this matrix system, places identified through research were then assessed against the threshold.

Places identified by the community as important for their aesthetic value and that met the threshold for social value (see Section 2.2.2) were considered to meet the threshold for aesthetic value. Following analysis of the number of times that individual places were mentioned in tourist literature sources, places that had been identified in seven or more tourist literature sources were also considered to meet the threshold.

Where community representatives at the workshops had identified an area as being of value to them, but had not fully documented its aesthetic significance, or where a place had been identified in less than seven tourist literature sources, or where it had been identified by forest experts, it was necessary for the aesthetic value of that place to be corroborated through a second primary dataset in order for it to meet the threshold for aesthetic value.

In summary, for a place to meet the national estate threshold for aesthetic value it was required to:

- have been identified by seven or more tourist literature sources, or
- have been identified as important for its aesthetic value and to have met the threshold for social value, or
- have been identified in at least two of the three primary datasets - tourist literature, forest experts and/or social values.

2.4.3 Results

In the South-West Forest Region 123 areas were considered to meet an appropriate threshold of national estate aesthetic significance as a result of studies carried out for the CRA. Following the boundary delineation process and the consideration of smaller areas which were located within larger areas that had also met the threshold in their own right, these were rationalised into 51 areas (see Appendix G and Map 7). These include the Pemberton forests area, the Chittering Valley and the Blackwood River Valley. In many instances indicative areas of aesthetic value, such as D'Entrecasteaux National Park, were also assessed as having social value.

2.5 HISTORIC VALUES

Historic places relate primarily to the non-Aboriginal culture of Australia, although some may also have Aboriginal values. Among the wide range of historic places associated with the forests of the South-West Forest Region are isolated sawmills, timber bridges, historic tramways built for timber-getting, fire towers and grave sites. The national estate criteria relevant to historic places are criteria A.3, A.4, B.2, D.2, E.1, F.1, G.1 and H.1 (see Appendix B).

To date, 28 historic places related to the forests of the Region have been identified as having national estate significance and are entered in the Register of the National Estate (see Appendix A). Other areas, listed as natural national estate places, also have historic values, as well as many others that have not been fully documented and whose significance has not been assessed.

2.5.1 Data sources

The following were the main data sources for the historic places investigation:

- Municipal Inventories (of the 33 municipalities located within the study area, 29 inventories were complete at the time CRA research was conducted);
- The Heritage Council of Western Australia's Register of Heritage Places;
- The Heritage Council of Western Australia's Places Register;
- The Register of the National Estate;
- South-West Development Authority Database;
- The National Trust of Australia (Western Australia) files;
- CALM Regional Management Plans;
- CALM Regional and District Office records;
- Regional Heritage Survey Reports;
- Select local histories, and
- Select thematic studies.

2.5.2 Data audit, thematic history and analysis

Stage one of the historic forest places study consisted of three tasks. The first was an audit of existing data on historic places in the Region. This included an examination of existing databases and other documentary sources which identified forest-related cultural places, the compilation of an inventory of identified places, and a general analysis of the databases in terms of data content, quality and organisation (Environment Forest Taskforce 1997b). The purpose of the audit was to identify the extent and quality of the available information.

A thematic history, exploring the development of the Region, with a particular focus on land use, from settlement to today was compiled as stage two of the historic places study (Bosworth and Brady 1997). Its purpose was to identify the range of historic themes which were represented in the development of the Region, and to provide an indication of the range of historic places which may be expected to occur within the Region.

Stage three of the historic places study consisted of an analysis of the results of stages one and two to identify data quality, geographic and thematic gaps in the current knowledge about historic places and to recommend work which could be carried out as part of the CRA to fill those gaps (Environment Forest Taskforce 1997b). It was found that of the total number of historic places already identified within the Region only five per cent had data that would, with little further investigation, be adequate for national estate assessment. A further 18 per cent had data of moderate quality which would require further historical research or physical documentation before it would be possible to assess the place. Intensive research would be required before assessment of the remaining 77 per cent of places was possible. The analysis also revealed considerable gaps in the geographic distribution of known historic places within the Region and that there were deficiencies in the representation of all historic themes.

The data audit, thematic history and their analysis demonstrated that the breadth and depth of the Region's historic resource stands largely untapped and that the scope for historic research is broad. Within the parameters of CRA, the lack of a clear pattern in the quality of existing data in relation to gaps in either geographical areas or regional themes made the prioritisation or development of individual gap-filing projects not possible. It was therefore determined that the most efficient means of ensuring the protection of places of national estate historic value within the Region was through the identification and evaluation of the legislative and non-legislative management and protection mechanisms currently in place to ensure the identification, assessment and care of historic places now and in the future, and the consideration of protective mechanisms for heritage places in the development of the RFA.. See Section 4.5 (Environment Forest Taskforce 1997a, O'Connor 1998).

3 National Estate Natural Values

3.1 INTRODUCTION

National estate natural values assessed in comprehensive regional assessment (CRA) of the South-West Forest Region range from values covering some thousands of hectares to values confined to single small sites. Identification and treatment of natural values follow three broad subdivisions:

- extensive natural values;
- localised natural values, and
- other natural values, including those relating to geology and geomorphology.

In the regional context, the assessment of national estate values requires a comparative appraisal of the significance of places having one or more attributes or values. The values are derived from the national estate criteria listed in Appendix B.

The development of thresholds for national estate significance vary depending on the level of current knowledge about the nature and extent of natural values and their distribution in the landscape at a local, regional or national level. A regional evaluation involves building and interpreting a more comprehensive and integrated knowledge base for assessment of significance than would be possible in considering a place, or places, in isolation.

As with national estate cultural values, a threshold is set in relation to the significance indicators and this threshold is specific to each national estate value. Thresholds of significance for each value were jointly agreed for the CRA by the Commonwealth and State technical committees.

All mapped indicative national estate natural areas have been digitised and are held by CALM in ARC/INFO format on a GIS platform.

3.2 EXTENSIVE NATURAL VALUES

The values considered in this aspect of the South-West Forest Region assessment are:

- old-growth forest;
- wilderness;
- natural landscapes, and
- forest ecosystems characteristic of class.

3.2.1 Data Sources

Disturbance history

Records of timber harvesting (dating back to the 1870s), past clearing for agriculture, symptoms of *Phytophthora cinnamomi* infection, clearing for mining and grazing are maintained in the CALM Forest Management Information System (FMIS). This was the primary source of disturbance data for the assessment of natural landscapes, old-growth forest and wilderness values in the Region.

Forest ecosystem mapping

The principal sources of information in the mapping of forest ecosystems are forest associations and vegetation complexes.

Forest associations are based primarily on work originally undertaken by the Forests Department of Western Australia in the 1950s and 1960s using 1:15 840 aerial photography and covered almost all the forested land in the Regional Forest Agreement (RFA) area. Classification was based on dominant tree species and crown cover density. "Non-forest" areas were classified according to broad structural categories.

This basic information has been refined and corrected by a variety of specific mapping projects since that time (Bradshaw *et al.* 1997).

The concept of vegetation complexes developed in the northern Darling Range by Heddle *et al.* (1980) was expanded to cover the remainder of the RFA Region. This approach builds on the detailed local site-vegetation type mapping, which integrates details on site characteristics, floristic composition and structural composition. The use of vegetation complexes allows vegetation mapping for the Region at a higher resolution than the mapping of essentially structural components and dominant species by Beard (1979a, 1979b, 1979c, 1979d, 1981). The mapping of vegetation complexes covered both the remaining intact native vegetation and cleared areas in the Region. A total of 312 vegetation complexes was defined and mapped for the South-West Forest Region (see CRA report for details).

Following the recommendations of a panel of independent scientists and experts, 27 forest ecosystems were derived for the RFA Region by sub-dividing the Forest Associations mapping of Bradshaw *et al.* (1997) using aggregates of vegetation complexes mapped by Mattiske Consultants (1997a). A sub-regionalisation within forest associations was undertaken using boundaries derived from the grouping of several vegetation complexes. This approach resulted in the subdivision of the jarrah forest into 11 forest ecosystems and the karri forest into six forest ecosystems (see CRA report for details).

While some forest ecosystems are very widespread and may encompass a variety of identifiable floristic communities across their range - for example the extensive Jarrah North West forest ecosystem which covers 499,598 hectares, others are more restricted - such as the Jarrah Red Tingle forest ecosystem which covers only 269 hectares.

3.2.2 Old-growth forest

The national operational definition of old-growth forest is 'ecologically mature forest where the effects of disturbances are now negligible' (JANIS 1997, p. 13). Although relatively large areas of old-growth forest remain within forest ecosystems in the southern part of the South-West Forest Region of Western Australia, there are few areas of old-growth forest in the northern part of the Region.

The assessment of old-growth forest of indicative national estate value is considered under sub-criterion B.1 and sub-criterion A.2. Sub-criterion B.1 focuses on examples of old-growth in rare forest ecosystems and in forest ecosystems where old-growth is rare or depleted ,while sub-criterion A.2 recognises the importance of aggregations of old-growth forests for the maintenance of existing natural processes (see Appendix B).

Data

The CRA old-growth assessment was the primary data source used in identifying old-growth values. The assessment was developed using a combination of the following CALM data sources:

- stand-age data in the karri and mixed karri forests, including the identification of stands dominated by mature and senescent trees;
- disturbance data, including disturbance mapped by aerial photo-interpretation and timber-harvesting, mining, clearing, disease and grazing records, and
- forest ecosystem data collected as a part of the CRA.

Aggregation of old-growth

Old-growth forest areas of indicative national estate significance under sub-criterion A.2 were identified by selecting aggregations of old-growth in a range of forest ecosystems considered to have sufficient size and integrity within the landscape to be identified for their importance in maintaining natural ecosystem processes.

Establishing the threshold

Aggregations of old-growth greater than 1800 hectares in the southern forests and greater than 200 hectares in the northern forests were considered to be above threshold where they occurred within natural landscapes or areas of high biophysical naturalness (class 4 and 5) greater than 40 hectares.

Box 3.1 Rule set used to identify indicative national estate areas of old-growth under sub-criterion A.2

Southern forests

- Intersect old-growth forest with natural landscapes and areas of biophysical naturalness classes 4 and 5 greater than 40 hectares.
- Apply a size threshold of 1800 hectares.

All other areas are excluded.

Northern forests

- Intersect old-growth forest with natural landscapes and areas of biophysical naturalness classes 4 and 5 greater than 40 hectares.
- Apply a size threshold of 200 hectares.

All other areas are excluded.

Results

Larger aggregations of old-growth forest occur in the Blackwood Plateau and throughout the karri and jarrah ecosystems in the southern forests. In the northern part of the RFA Region, aggregations of old-growth forest occur in jarrah and wandoo ecosystems from east of Perth to north and west of Collie, but are smaller and more isolated than those in the south. Areas of old-growth identified by this assessment are shown on Map 1.

Rare or depleted old-growth forests

While old-growth forests of a more extensive nature were dealt with under sub-criterion A.2, consideration was also given to those old-growth forest ecosystems that are rare, endangered or uncommon. These were assessed under national estate sub-criterion B.1. Two types of rare, endangered or uncommon old-growth were identified:

- *depleted old-growth* - old-growth within forest ecosystems where extant old-growth as a proportion of the forest ecosystems is less than 10 per cent (derived from the JANIS criteria), and

- *old-growth within rare forest ecosystems* - where old-growth as a proportion of the forest ecosystem may be greater than 10 per cent, but the ecosystems itself is rare, vulnerable or endangered (derived from the JANIS criteria).

Establishing the threshold

Ten rare, endangered or uncommon old-growth forest ecosystems were identified to be assessed for national estate significance under this sub-criterion. Given the scarcity of these ecosystems, all areas of old-growth greater than 40 hectares were considered as above threshold for this value, with the exceptions of wandoo forest and woodland. For these ecosystems, which generally occur in landscapes where the level of fragmentation is higher, larger areas (greater than 200 hectares) were considered necessary to meet the threshold for national estate significance.

Results

Table 3.1 shows the forest ecosystems within which rare or depleted old-growth forest was identified.

Table 3.1 Identified rare or depleted old-growth forest ecosystems

Depleted old-growth	Old-growth within rare forest ecosystems
Jarrah North East	Jarrah Rates Tingle
Jarrah North West	Jarrah Red Tingle
Western Wandoo Forest	Karri Rates Tingle
Western Wandoo Woodland	
Jarrah Sandy Basins	
Jarrah Leeuwin Ridge	
Karri West Coast	

This value occurs primarily in the northern part of the Region, with the exception of areas of old-growth jarrah/Rates Tingle and karri/Rates Tingle in the southern forests. In the north, the value occurs as isolated patches within jarrah and wandoo ecosystems. The largest of these are between the Brookton Highway and the Darkan River, and north of Collie to the Murray River. Areas identified by this assessment are shown on Map 1.

3.2.3 Wilderness

The nationally agreed criteria for a comprehensive, adequate and representative (CAR) reserve system for Australia's forests specify that 90 per cent (or more, if practicable) of areas of high quality wilderness that meets the minimum area requirements should be protected in reserves (JANIS 1997).

The assessment of wilderness is considered under sub-criterion B.1. The assessment of wilderness in the South-West Forest Region of Western Australia utilised the National Wilderness Inventory (NWI) methodology developed by the Australian Heritage Commission and adopted as the standard approach to the assessment of wilderness in RFAs throughout Australia.

Data

The data used in the NWI analysis comes from a number of sources. The distance related indicators (settlement, access and apparent naturalness) are essentially current AUSLIG digital mapping data updated with additional information in the detailed study areas. The disturbance information, which provides the base data for the biophysical naturalness indicator, is based primarily on the disturbance data developed for the identification and assessment of old-growth forest (see Section 3.2.2).

Method

The concept of wilderness embraces measures of remoteness and naturalness. The National Forest Policy Statement: A New Focus for Australia's Forests (Commonwealth of Australia 1992), states that 'forested wilderness areas will be protected by means of reserves developed in the broader context of protecting wilderness values of all lands'. Consistent with this, the approach to the identification of wilderness areas in the South-West Forest Region included non-forest vegetation types where they form a mosaic within largely forested areas.

The NWI methodology (Lesslie and Maslen 1995) produces a database of 'wilderness quality' across the Region. This is achieved by measuring the variation in wilderness quality across the landscape using four wilderness quality 'indicators' that represent the two essential attributes of wilderness: remoteness and naturalness.

These indicators are:

- remoteness from access;
- remoteness from settlement;
- apparent naturalness, or
- biophysical naturalness.

Establishing the threshold

The index of wilderness quality derives from a summing of these individual indices, and is represented by a range from zero to 20. To identify areas with high wilderness quality, the criteria used in this assessment were the nationally agreed criteria of areas with a NWI wilderness quality of at least 12 and an area larger than 8 000 hectares.

Results

This assessment of the South-West Forest Region identified no areas that met the nationally agreed size threshold. Several areas in the south of the Region were identified throughout the study were below the wilderness size threshold, but had high values of remoteness and naturalness. All these areas occur within natural landscapes (see Section 3.2.4 below).

3.2.4 Natural landscapes

Natural landscapes are large, relatively undisturbed areas with topographic and catchment integrity, where natural processes continue largely unmodified by the impacts of European settlement.

The following are natural processes:

- energy flows;
- nutrient cycling;
- hydrological processes;
- ecological processes such as succession, and
- evolutionary processes such as speciation and extinction.

At a national level, natural landscapes are considered rare, and are generally addressed under criterion B.1: importance for rare, endangered or uncommon flora, fauna, communities, ecosystems, natural landscapes or phenomena, or as a wilderness. Only in Tasmania were natural landscapes sufficiently prevalent to be assessed for significance under sub-criterion A.2: importance in maintaining existing processes or natural systems at the regional or national scale. In the South-West Forest Region natural landscapes were considered under sub-criterion B.1.

Method

Four measures were used to identify areas of potential natural landscape value:

- biophysical naturalness (or level of disturbance);
- sub-catchment and topographic integrity;
- size, and
- context in the landscape; i.e., nature of adjoining land use.

Naturalness

The assessment of naturalness was primarily based on the biophysical naturalness index developed for the assessment of wilderness values, using the National Wilderness Inventory (NWI) criteria (Lesslie and Maslen 1995). The index provides a six-class rating, from a value of 0, representing cleared lands, to a value of 5, representing areas that are unlogged, ungrazed and free of other significant unnatural disturbances. A detailed explanation of the biophysical naturalness index assigned to various types and levels of disturbance is presented in Table 3.2.

In identifying natural landscapes, consideration was given to factors such as the impact of timber harvesting, agriculture, mining, roads, settlements and other disturbances on the ecological processes of the surrounding areas. In the South-West Forest Region, wildfire is considered a natural process, and the effects of wildfire did not influence biophysical naturalness rating.

In keeping with the National Wilderness Inventory guidelines (Lesslie and Maslen 1995), the period since the last timber harvest was used to distinguish between biophysical naturalness values 3 and 4. Consideration was given to variation in forest types, land use history and timber harvesting practices.

The incidence of *Phytophthora cinnamomi* (dieback) was an important consideration in the identification of forested natural landscapes, with dieback often being the only 'unnatural' disturbance in areas which were otherwise natural or minimally disturbed. Where possible, areas where dieback has resulted in a major impact on the forest structure were differentiated from areas where the disease has simply been recorded as present. In the karri forests, for example, the impact of dieback is comparatively low, compared to jarrah forests where it can result in total crown death. Dieback has also affected heathlands in the south of the Region, such as in the D'Entrecasteaux National Park, but extensive dieback mapping has not been undertaken in these areas, and it was therefore not possible to consider the impact of dieback on these non-forest communities in the assessment of natural landscapes.

Table 3.2 The biophysical naturalness rating scheme

Class	Class description for South-West Forest Region CRA
5	Forest or non-forest ecosystems with no record of clearing, logging, grazing or dieback.
4	Karri ecosystems with selective logging records prior to 1930. Jarrah ecosystems, lightly logged once 1940-59, with no record of dieback. Previous seasonal grazing in heath and forest ecosystems in coastal areas
3	Karri ecosystems clearfelled before 1900, or selectively logged 1930-1969. Jarrah ecosystems with no record of logging but with record of dieback. Current seasonal grazing in heath and forest ecosystems in coastal areas.
2	Karri ecosystems logged after 1970. Karri and Jarrah ecosystems with records of logging but unclassified (does not distinguish whether clear fell or selective logging). Jarrah ecosystems with single or multiple records of logging 1940-1959, without records of dieback. Jarrah ecosystems logged 1960-1969, with no record of dieback. Jarrah ecosystems selectively logged after 1970, with no dieback records. Wandoo ecosystems with logging records.
1	Karri ecosystems clearfelled after 1900. Jarrah ecosystems last logged before 1940 with or without dieback. Jarrah ecosystems logged after 1940, with record of dieback. Jarrah ecosystems logged (other than selective logging) after 1970 with woodchip harvesting and without dieback. Remnant vegetation on private property.
0	Non-natural land cover. Rehabilitated mining areas. Cleared land or mining areas with no evidence of rehabilitation. Unclassified land

Sub-catchment and topographic integrity

Sub-catchment and topographic integrity were determined from an examination of the biophysical naturalness data, other disturbance data, sub-catchment boundaries and topographic information. The position of each disturbance within the catchment or landscape and its likely effect on the natural area identified was taken into account.

Boundaries were drawn around contiguous areas of high biophysical naturalness (classes 4 and 5). As far as possible, the boundaries were delineated using features such as rivers, ridge lines, wetlands, roads or the edge of disturbed areas such as logging coupes or farmland. Where such features were absent, the boundary of the biophysical naturalness class was used.

Size and integrity in the landscape

A thorough inspection of the size and distribution of areas of biophysical naturalness classes 4 and 5 in their landscape context was used to develop the size thresholds.

All areas of high biophysical naturalness (classes 4 and 5) were included initially. Areas of biophysical naturalness class 3 (unlogged jarrah with dieback or karri where the effects of disturbance are now low) were included if the area was not large and was surrounded by areas of high biophysical naturalness. Irregularities and discontinuities in the data were removed and size thresholds applied as discussed below.

Establishing the threshold

Size thresholds varied from 1 000 hectares, or greater in the northern forests, to 2 000 hectares or greater over the remainder of the Region. For topographically isolated areas in the northern forests, such as Mt Cooke, areas greater than 200 hectares were included. Within the remainder of the Region, topographic isolates such as peaks, or specific landform units such as swamps which formed discrete areas smaller than 2 000 hectares were also identified.

In the non-forest ecosystems within the Leeuwin-Naturaliste and Scott River National Parks and adjacent areas, where natural areas are scarce size thresholds were not applied, although narrow linear strips of high biophysical naturalness were excluded.

Results

Forty-two natural landscape areas of indicative national estate significance were identified. Larger areas of this value occur on the Blackwood Plateau, from the Scott River along the South Coast to the Hay River, and north-east of Walpole. Smaller areas occurring the northern forests between Collie and the Murray River, and along the Leeuwin-Naturaliste Ridge. Map 1 shows indicative natural landscape areas assessed as meeting the threshold for national estate significance.

3.2.5 Forest ecosystems characteristic of class

This value is addressed under sub-criterion D.1 which recognises the significance of places demonstrating the principal characteristics of a class of Australia's landscapes, environments or ecosystems. The classification and mapping of forest ecosystems in the South-West Forest Region was undertaken as a component of the CRA. This mapping of forest ecosystems has formed the basis for the identification of indicative areas of national estate significance as characteristic of the classes of ecosystems within the Region.

Method

The identification of areas of forest ecosystems characteristic of their class is undertaken in conjunction with the development of a comprehensive, adequate and representative (CAR) reserve system for the Region. The nationally agreed criteria for a CAR reserve system for forests in Australia (the JANIS criteria) seek the representation in reserves of:

- 15% of the pre-1750 distribution of each forest ecosystem;
- 60% of the remaining extent of vulnerable ecosystems, and
- 100% of the remaining extent of rare and endangered forest ecosystems (JANIS 1997).

Flexibility in the application of the reserve criteria is needed in consideration of differing regional circumstances to ensure that the CAR reserve system delivers optimal nature conservation outcomes, as well as acceptable social and economic outcomes (JANIS 1997).

Reserve design principles to be applied in the development of the CAR reserves system (JANIS 1997) include:

- boundaries should be set in a landscape context with strong ecological integrity, such as catchments;
- large reserved areas are preferable to small reserved areas, though a range of reserve sizes may be appropriate to adequately sample conservation values;
- boundary area ratios should be minimised and linear reserves should be avoided where possible, except for riverine systems and corridors identified as having significant value for conservation;
- reserves should be developed across major environmental gradients if feasible, but only if these gradients incorporate key conservation attributes which should be incorporated into the CAR reserve system;
- each reserve should contribute to satisfy as many reserve criteria as possible;
- reserve design should minimise the impact of threatening processes, particularly from adjoining areas, and
- reserves should be linked through a variety of mechanisms, wherever practicable, across the landscape.

Establishing the threshold

The application of the JANIS criteria and reserve design principles, and the consideration in the development of the CAR reserve system of national estate values such as natural landscapes, will ensure the inclusion within CAR reserves of examples of forest ecosystems characteristic of their class at appropriate levels of condition and integrity to be considered as meeting the threshold of national estate significance for this value.

Results

Areas meeting threshold of national estate significance for forest ecosystems characteristic of their class will be identified in conjunction with the development of the CAR reserve system for the RFA.

3.3 LOCALISED NATURAL VALUES

3.3.1 Flora

The South-West Forest Region is of considerable phytogeographic significance. The reasons for this include the high degree of endemism and the considerable diversity of its vascular flora. The high genus and species endemism of the Region is attributed to the evolution of new species in response to environmental perturbations of the late Tertiary and early Quaternary periods and the persistence of relict taxa in climatic refugia (see sub-criterion A.1 below).

Data sources

The flora assessment considered a total of 3 244 vascular plant taxa. Taxonomic problems and collection deficiencies for non-vascular flora (bryophytes, heptophytes, lichens and fungi) limited their value for the analysis. A total of 153 212 vouchered (specimens identified and retained in the Western Australian Herbarium) and non-vouchered flora records were available. These data were derived from the following government and private databases:

Table 3.3 CALM data sources for the national estate flor a assessment

Source	Vouchered?	Records
Western Australian Herbarium - WAHerb original records	Yes	36 137
Western Australian Herbarium – vouchered specimens from vegetation mapping	Yes	3 954
Western Australian Herbarium - vouchered specimens from RFA flora surveys	Yes	9 392
Floristic survey of the Tingle Mosaic (Wardell-Johnson *et al.* 1989, Wardell-Johnson *et al.* 1995)	Some	15 056
Havel site-vegetation type bulletins (Havel 1975a, Havel 1975b)	Yes	5 126
CALM Threatened Flora Database	Some	2 949
Banksia Atlas (Taylor & Hopper 1988)	No	2 896
TOTAL		70 384

Table 3.4 Other data sources for the national estate flora assessment

Source	Records
Alcoa of Australia Limited	19 784
Worsley Alumina Pty Ltd	9 864
Scott River National Park survey for BHP (Mattiske Consulting 1996)	637
Griffin Coal Mining	1 985
Water and Rivers Commission and Water Corporation	9 862
John Forrest National Park and Red Hill Survey (Mattiske & Burbidge 1991)	745
Mt Westdale – Dobaberry Swamp (Trudgen 1984)	813
Per Christensen PhD data (Christensen 1980)	4 662
Mapping of Vegetation Complexes in South-West Western Australia – Mattiske (Mattiske Consulting 1997a)	27 334
Shire of Mundaring (Mattiske Consulting 1997b)	2 016
TOTAL	82 828

Records from these databases were incorporated into a new database for the CRA flora and fauna assessments called 'WABiota'.

Site data validation against expert knowledge resulted in removal of records which were:

- outside the RFA Region;
- obviously mis-identified;
- non-current names, and
- exotics.

A method for prioritising the validation of geocodes was developed using climatic attributes and BIOCLIM (McMahon *et al.* 1995) to identify potential outliers as targets for validation. This approach was required because the large number of points within WABiota meant a detailed analysis of all records was not possible. Using BIOCLIM, for each point in WABiota, 35 climatic parameters were evaluated and summary statistics calculated. A test was then applied to determine the extent to which the climatic parameters for each of the individual points were within the environmental envelope described by the points as a whole. Points for which a given climatic attribute was more than two standard deviations outside the mean of that parameter were then checked manually and WABiota was updated to reflect the validated coordinates. A total of 5 086 records was validated in this manner; of these, 1752 existing geocodes were validated as being correct, and 3 334 records required a new geocode to be calculated. The data were then used to update the WAHerb database records.

Species attribution, assessment methodologies, threshold setting and results for the national estate assessment are described in separate sections for each national estate sub-criterion below.

Sub-criterion A.1: Importance in the evolution of Australian flora, fauna, landscapes or climate

Assessment for values under this sub-criterion involved the identification of places where the present distribution and ecology of the South-West flora reflect the influence of past evolutionary, climatic and environmental processes. These included places important for:

- endemic flora;
- relictual and primitive flora;
- flora refugia;
- flora with disjunct distributions, and/or
- flora at their range limits.

Endemic flora

Endemic plants provide an important insight into the process of evolution of flora. In some cases, biogeographic determinants such as terrestrial and oceanic climatic influences, soils and localised topographic variation may be the main controlling factors in the development of endemism. In other cases the role of climatic refugia in speciation during periods of climate change is important.

The degree of endemism in the flora of the South-West Forest Region is pronounced, as a consequence of factors including landscape stability, geographic isolation and adaptive speciation under climatic change on complex edaphic mosaics (Hopper 1979).

Method

The level of endemism of flora taxa in the South-West Forest Region is at least 75 per cent (Hopper 1992, Hopper *et al.* 1996). The assessment of flora endemism for the RFA focussed on narrow endemism (distribution less than 150 kilometres in the South-West Forest Region) and the distribution of these narrow endemics across the landscape.

Taxa were attributed for narrow endemism using published and unpublished sources including *Flora of the Perth Region, Flora of Australia,* draft *'Flora of the South-West'* and various journals. Where necessary, these were further validated against WABiota records. ARC/INFO coverages of

occurrences of endemics were produced using the geocodes in WABiota. These occurrences were scrutinised and validated by experts to determine those taxa with a distribution less than 150 kilometres in extent.

This analysis demonstrated the widespread occurrence of locally endemic plants across the South-West Forest Region. It was therefore determined to focus the assessment of endemism on the identification of areas where concentrations of endemic taxa occur as a consequence of past biogeographic processes. Such areas are termed centres of endemism.

Centres of endemism were defined by combining the output of two analytic processes on ARC/INFO GIS. Of the 350 taxa identified as being narrowly endemic (see Appendix H), only approximately 130 had sufficient records to allow modelling of predicted distributions using SpModel software. These were used to develop a modelled richness map for these taxa (Gioia *et al.* 1997). Centres of endemism were mapped by defining isopleths at +1, +2 and +3 standard deviations above the mean.

The remaining taxa, many of them rare or poorly known, had too few recorded locations for habitat modelling. For these taxa, centres of endemism were defined using endemic species richness based on site records. All records were projected onto the vegetation complex mapping of Mattiske Consulting (1997a), and the number of unique taxa was recorded for each mapped unit. This coverage was then overlaid with a 140 metre square grid and each grid cell given a value equalling the average number of unique taxa for all surrounding mapped vegetation units within a 3 231 metre radius (3 280 hectares being 10 times the average area of mapped vegetation complex units).

This analysis was plotted as an isopleth map of flora endemism (an isopleth map is similar to a contour map, except that contours represent elevation and isopleths represent some other value). For the map of flora endemism, isopleths represent the levels of standard deviation away from the mean count for all grid cells across the Region. The plotted standard deviations were +1, +2 and +3.

Establishing the threshold

Areas where the level of endemism was greater than or equal to two standard deviations above the mean for the Region were identified as centres of endemism. In order to ensure a level of condition and integrity appropriate to areas of national estate significance, the resultant isopleth map of centres of endemism was intersected with natural landscapes and biophysical naturalness data. Areas determined to meet the threshold of national estate significance for this value were centres of endemism within natural landscapes, or areas 40 hectares or larger of high biophysical naturalness (classes 4 and 5).

Results

Areas identified as meeting the threshold of national estate significance as centres of endemism are shown on Map 2. This value occurs in a limited number of smaller areas throughout the RFA Region with higher concentrations in the south. Areas with this value include:

- small discrete areas of Darling Scarp vegetation around John Forrest National Park;
- a number of small areas of various forest types along the Helena and Darkan Rivers, south of Kalamunda, near the Canning Reservoir and near Coffin Rock and Mt Talbot;
- a number of small areas between Yallingup and Donnybrook;
- areas in the Blackwood Plateau east of Karridale;
- shrub, herb and sedgeland ecosystems from the Scott River to the Donnelly River; and
- a large area including a number of forest ecosystems between Denmark and the Frankland River.

Relictual and primitive flora

Relictual taxa are generally regarded as those that exhibit taxonomic remoteness and/or phylogenetic primitiveness. While most of the Western Australian flora have undergone speciation as a response to palaeoclimatic variation during the late Tertiary and early Quaternary, some species have retained primitive characteristics or have been restricted to areas (refugia) with microclimatic conditions similar to those in earlier Gondwanan environments. Such species contribute significantly to the uniqueness of the Western Australian bioregion. Examples from the South-West Forest Region flora include the gymnosperms, monotypics in Gondwanan families and/or genera (e.g., Proteaceae, Restionaceae) and associated species (see Appendix H).

Method

A high proportion of flora of the South-West is of Gondwanan origin and the Australian flora as a whole tends to be primitive. In the South-West Forest Region, 94 taxa were identified as of phylogenetic interest for primitive or relictual characteristics. These included: primitive ferns; gymnosperms; taxa identified by experts or recorded in the literature as primitive; and the 43 monotypic genera which occur within the Region.

Point locations for primitive and relictual species were linked to corresponding mapped vegetation complexes. A 140 metre grid was applied and attributed in each cell for the average number of relictual species (based on attributed vegetation complex polygons) in the surrounding 3 280 hectares, and an isopleth map showing concentrations of relictual taxa was derived in a similar way to the endemic flora analysis described above.

Establishing the threshold

Areas determined to meet the threshold of national estate significance for this value were those with:

- concentrations of relictual taxa in excess of two standard deviations above the mean for the Region, and
- within natural landscapes, or areas 40 hectares or larger of high biophysical naturalness (classes 4 and 5).

Results

Centres important for relictual taxa identified as meeting the threshold of national estate significance are shown on Map 3. They are restricted to the southern forests and south coastal areas of the RFA Region. The larger concentrations include:

- areas in the Blackwood Plateau east of Karridale;
- shrub, herb and sedgeland ecosystems from the Scott River to the Donnelly River and in the Windy Harbour/Gardner River area;
- mixed jarrah/shrubland north of Mt Pingerup;
- mixed jarrah/shrubland around Granite Peak in the Mt Frankland National Park;
- karri/Yellow Tingle forests west of Walpole and karri/Red Tingle forests east of Walpole;
- mixed jarrah/shrubland between the Frankland and Kent rivers, centred on Lake Surprise, and
- mixed jarrah/shrubland in the headwaters of the Styx River and on Mt Lindesay.

Flora refugia

Refugia are areas where physical and biological attributes combine to provide an environment that is more resilient to climatic variation than surrounding areas, and are important centres for conservation. Refugia, and the taxa that are largely restricted to them, are important as sources of

genetic variation and centres for species radiation during periods of more favourable conditions. Consequently, these areas are important for maintaining flexibility and adaptability in times of climatic change, as well as providing an insight into the vegetation of a past period, and the biogeographic and evolutionary processes which have shaped the present biota.

Refugia associated with ancient features in the landscape or topographic anomalies are recognised as significant in allowing the persistence of species associated with wetter climates in the dry South-West (Main 1991, 1997; Hopper *et al.* 1996).

The geological formation of the South-Western landscape has allowed elements of terrestrial and aquatic Gondwanan flora and fauna to persist in small, perennially moist refugia within the South-West Forest Region. These include habitats within the tingle forests of the south, the cave habitats associated with limestone in the South-West, high rainfall zones through the assessment area, and wetlands, peaty swamps, sedgelands, and granite outcrops or monadnocks. Typically these environments retain the theoretical climatic features of Gondwanan Australia, relatively warmer and wetter conditions buffered from large seasonal fluctuations.

Method

Attribution of potential refuge areas was carried out by literature review and expert opinion. Refugia were considered to be those areas likely to have microclimate conditions similar to those cited in Hopper *et al.* (1996). ARC/INFO coverages were developed of topographic features such as areas with a south-east aspect on slopes greater than 15 degrees, rock outcrops and their immediate surroundings, and areas subject to inundation. Validation of these areas by intersection with the known locations for primitive or relictual species was considered, but not practicable due to the inadequacies in sampling, the small scale of some habitats and errors in the geocodes for existing species site records. Expert opinion favoured the identification of areas of appropriate physical characteristics within relatively undisturbed landscapes.

Establishing the threshold

Places were delineated on the basis that both the refuge-dependent forest community and the topographic unit on which it occurs (a sub-catchment or gorge, for example) were largely undisturbed by human activity. Areas determined to meet the threshold of national estate significance for this value were:

- granite monadnocks, areas with steep south-eastern aspect, and areas subject to inundation, and
- within natural landscapes, or areas 40 hectares or larger of high biophysical naturalness (classes 4 and 5).

Results

The analysis identified many hundreds of discrete areas scattered across the landscape which met the threshold for national estate significance. Features such as rock outcrops often formed clusters. Major concentrations of these features were evident in several localities, notably around the Helena River, and in the D'Entrecasteaux, Walpole and Mount Chudalup areas. Refugia identified by this assessment are shown on Map 2.

Biogeographic range of flora (including disjunction)

The pattern of distribution for the majority of the flora of the South-West is primarily a reflection of the long isolation of the Region, its complex edaphic patterns and the climatic processes active through the late Tertiary and Quaternary periods. These climatic processes were responsible for the advance and retreat of the arid zone to and from the South-West corner, and the rise and fall of sea levels, creating and removing coastal migration corridors (Hopper 1979).

This biogeographic history has led to flora species distribution patterns of great complexity, and depending on the mechanics of pollination, breeding systems and seed dispersal mechanisms of individual taxa, this fragmentation may or may not represent breeding isolation for the various taxa. As a result, some problem exists in separating taxa at the limit of their range and disjunction within this fragmented flora.

Flora taxa at their range limits

Taxa considered under this attribute were those with distributions reaching a range limit within the South-West Forest Region which can be attributed to past evolutionary and climatic processes. Four distinct patterns are recognised in the distribution of taxa reaching a range limit within the RFA Region:

- taxa extending along the South Coast from east of Albany;
- taxa extending down the West Coast from North of Lancelin;
- taxa extending into the Region from the interior, and
- taxa from the Swan Coastal Plain that extend into the streams and foothills of the Darling Scarp.

Method

The assessment of species at the limit of their range focused on taxa with range limits within the RFA Region rather than species dependent on forest or species with ranges cut by the western edge of the continent.

Taxa with distribution ranges entering the RFA Region from the north or the east and extending right through to the South-West coast were excluded from this assessment. It was assumed in these cases that distribution limits were determined by the edge of the continental land mass rather than biogeographic factors. Taxa considered narrowly endemic and fully contained within the Region were excluded but a number of endemic species with a substantial proportion of their distribution outside the RFA boundary were included.

Site locations for taxa reaching the limits of their range within the Region were plotted and these data were scrutinised for patterns. The major pattern observed was of species numbers increasing towards the boundary of the Region, this being consistent with the long history of changing climate and sea level resulting in fragmentary distributions.

Results

The collation of candidate taxa did not provide any insight in delineating areas of biogeographic importance for limit of range. The point data were generally scattered throughout the Region, except for those areas where little field survey has occurred. The complexity of species distribution was considered too difficult for meaningful analysis within the limitations of this assessment, but the presence of individual taxa attributed as being at their range limits (see Appendix H) will be included as supporting documentation for places identified as significant for other national estate values.

Flora taxa with disjunct distributions

Disjunct species were defined as those with populations separated by a substantial geographic distance from other populations, such that the disjunct populations are unlikely to interbreed. Such disjunction is commonly a result of the influence of past biogeographic events on species distribution.

Method

A list of candidate taxa was generated from published and unpublished sources (*Flora of the Perth Region, Flora of Australia*, draft *Flora of the South-West* and various journals) for testing for disjunct distribution by assessment of GIS coverages of point locations.

The absence of regular and systematic sampling is a major factor requiring consideration in the assessment of disjuncture in the flora of the South West Forest Region. Insufficient collecting can result in the appearance of disjunction in a species which in reality has a continuous distribution. Apparent disjuncture can also occur as a result of the mechanical transportation of seed of vagrant species. Where identified, such artefacts of insufficient collection or vagrant species distribution were excluded.

Centres of flora species disjunction were identified through the development of an isopleth map showing concentrations of taxa with disjunct distributions (see Appendix H), in a similar way to that for the endemic flora assessment.

Establishing the threshold

Areas determined to meet the threshold of national estate significance for this value were centres:

- with concentrations of disjunct species two standard deviations or more above the mean for the Region, and
- within natural landscapes, or areas 40 hectares or larger of high biophysical naturalness (classes 4 and 5).

Results

Areas determined to meet the threshold of national estate significance as centres for disjunct flora are shown on Map 3. This value occurs in a limited number of smaller areas throughout the RFA Region with a higher concentration in the southern sedgelands and forests. Areas with this value include:

- small discrete areas of Swan Coastal Plain vegetation north of the Swan River;
- small discrete areas of Darling Scarp vegetation around John Forrest National Park;
- a number of small areas of various forest types along the Helena and Darkan Rivers, south of Kalamunda, near the Canning Reservoir and near Coffin Rock;
- four small areas of mixed jarrah/sedgeland south of Collie;
- areas in the Blackwood Plateau east of Karridale;
- shrub, herb and sedgeland ecosystems from the Scott River to the Donnelly River;
- mixed jarrah/shrubland north of Mt Pingerup;
- an area of mixed Yellow Tingle forest north of Walpole, and
- mixed jarrah/shrubland between the Frankland and Kent rivers, centred on Lake Surprise.

Sub-criterion A.2: Importance in maintaining existing processes or natural systems at the regional or national scale

The identification of areas of national estate significance under this sub-criterion involves assessment of places important for the maintenance of natural ecosystem processes. These include abiotic processes, e.g., those related to hydrological and nutrient cycles, and biotic processes, i.e., those related to the life cycles and interdependence of plant and animal species in the forests, woodlands, heathlands, sedgelands, swamps and wetlands of the Region. Flora values which may be considered include:

- old-growth forest (see Section 3.2.2 extensive natural values);
- remnant vegetation, and
- places important for vegetation succession.

Remnant vegetation

Remnant vegetation provides important refuge and recruitment areas for both flora and fauna, and is important in maintaining existing natural systems within disturbed landscapes. Large-scale clearing for agriculture has occurred within parts of the RFA Region and the endurance of remnant vegetation in these landscapes is an important conservation issue. Clearing for urban development has also caused significant fragmentation of natural vegetation in some areas.

Biodiversity assessments conducted for the CRA included the mapping of remnant native forest and woodland vegetation using Landsat Thematic Mapper satellite data. No field validation or direct forest ecosystem attribution of these areas has been possible. While it is expected that the technique will provide reliable estimates of tree cover, it is unable to detect the condition of the understorey within

these stands. The mapped remnants may therefore include significant areas of native tree cover over exotic pasture. Extensive field work would be required to validate these data, and to provide an assessment of the condition and integrity of the remnants, particularly given the variable nature of past management of these lands.

Any areas of remnant vegetation requiring further consideration for the development of a comprehensive, adequate and representative reserve system are expected to be addressed at subsequent stages in the RFA process. The national estate State significance of such areas will also be considered at that time.

Places important for vegetation succession

The frequent fire and drought characteristic of the Mediterranean climate of the South-West are a major influence on the ecological processes in the Region (Hobbs *et al.* 1995). In the forested areas of the South-West, these influences tends to override other factors promoting vegetation succession, and the identification of areas for this value was not considered relevant to the national estate assessment in the Region.

Sub-criterion A.3: Importance in exhibiting unusual richness or diversity of flora

The floral richness of the South-West of Western Australia, particularly at the species level, is widely recognised (Hopper 1979). Genera such as *Acacia, Eucalyptus, Leucopogon, Stylidium, Grevillea, Dryandra and Caladenia* all contain in excess of 90 species within the Region (Hopper *et al.* 1996). This speciation is generally attributed to environmental perturbations during the late Tertiary and Quaternary periods.

The national estate assessment of this value sought to identify areas of particular significance for richness and diversity in the Region either for:

- species richness (alpha diversity), or
- vegetation community (beta) diversity.

Flora species richness

Species-level richness is often referred to as alpha (α), or within-area, diversity and is measured as the number of species occurring within an area of a given size.

Method

A species richness prediction map was generated from WABiota records and the distribution maps from species habitat models developed using SpModel software. The number of species within one by one kilometre grids were counted across the entire RFA area. Counts for all taxa and for endemic taxa were generated and maps at 1:500 000 were printed. Maps were generated for all taxa and for endemic species only. Isopleths linking cells of equal richness were mapped. Areas of species richness two or more standard deviations or higher above the mean for the Region were identified as areas of high species richness.

The species richness prediction maps were checked in a number of ways. Raw data from WABiota were counted for sections of the map and found to support the predictions of areas of high species richness. Expert opinion was also gained to verify these results.

Establishing the threshold

The threshold was established by intersecting isopleth maps of high species richness with natural landscapes and biophysical naturalness to identify areas of species richness in relatively undisturbed landscapes of an area considered adequate to ensure the maintenance of national estate values. Areas determined to meet the threshold of national estate significance for this value were those with:

- areas with species richness two standard deviations or more above the mean for the Region, and
- within natural landscapes, or areas 40 hectares or larger of high biophysical naturalness (classes 4 and 5).

Results

Two main areas of national estate significance for high species richness were identified through this assessment. All occurrences of this value are in the south of the RFA Region. These comprise two main areas:

- areas of jarrah forest on the Blackwood Plateau and coastal shrublands from Margaret River to the Vasse Highway; and
- areas of shrub, herb and sedgeland and mixed tingle forest from the Shannon river east to Denmark.

Areas determined to meet the threshold of national estate significance for species richness identified by this assessment are shown on Map 5.

Vegetation community diversity

Vegetation community diversity or beta diversity can be used as a surrogate measure of the rate of change of species, i.e., a between-area measure. It is often a reflection of environmental diversity, where strong gradients produce rapid transitions of different communities and their associated species. High community diversity is often seen where there are unusually diverse conjunctions or rapid transitions of community types in a small area, as a result of environmental gradients such as topography, drainage or soils.

Method

Assessment of community diversity was based on the vegetation complex mapping produced under the biodiversity assessment project 'Mapping of Vegetation Complexes for the South-West Forest Region' (Mattiske Consulting 1997a). Community richness was assigned to 140 x 140 metre grid cells across the RFA Region by counting the number of complexes occurring within a 3 231 meter radius (3 280 hectares being 10 times the average area of mapped vegetation units) of each cell. Isopleths linking cells of equal community richness at 0, +1 and +2 standard deviations from the mean for the Region were mapped in order to identify areas of high community richness.

Establishing the threshold

Scientific literature and the isopleth map of community diversity were examined by experts to delineate indicative areas of significance for this value and determine the appropriate isopleth to delineate areas of high vegetation community diversity. Areas with vegetation community diversity in excess of two standard deviations above the mean for the Region were recognised as having high community diversity.

The threshold was established by intersecting isopleth maps of high vegetation community diversity with natural landscapes and biophysical naturalness to identify areas of high vegetation community diversity in relatively undisturbed landscapes of an adequate size, condition and integrity for national estate significance. Areas determined to meet the threshold of national estate significance for this value were:

- areas with vegetation community diversity two standard deviations or more above the mean for the Region, and
- within natural landscapes, or areas 40 hectares or larger of high biophysical naturalness (classes 4 and 5).

Results

Areas determined by this assessment to meet the threshold of national estate significance for vegetation community richness are shown on Map 5. This value occurs in isolated small areas in the southern part of the RFA Region. These include:

- an area of peppermint and coastal heathland south-west of Margaret River;

- a small area of mixed peppermint and coastal heathland, and jarrah forest east of Augusta;
- several small areas of jarrah and karri forests south of the Vasse Highway from the Donnelly River to Northcliffe;
- an area of mixed jarrah/karri forest and shrub/herb/sedgelands south of the intersection of the South Western Highway and Wheatley Coast Road;
- small areas of karri/tingle forests and shrub/herb/sedgelands east and west of Walpole;
- an area of mixed jarrah/karri/tingle forest and shrub/herb/sedgelands south of Mt Frankland east of the Frankland River;
- an area of mixed jarrah forest and shrub/herb/sedgelands around Bow River, east of Walpole, and
- an area of mixed jarrah forest and shrub/herb/sedgelands north of Denmark from Little River to Mt Lindesay.

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

This sub-criterion recognises the importance of biotic elements that are rare or uncommon, or have become so through the effects of disturbances or threatening processes. The following values were assessed under this sub criterion:

- rare and threatened flora species, and
- rare, threatened or restricted communities.

Rare and threatened flora taxa

The Western Australian list of Declared Rare Flora (DRF), under the *Wildlife Conservation Act 1973* as at 30 November 1997, CALM's Priority Flora list as at 30 November 1997, and those taxa listed on Schedule 1 of the *Endangered Species Protection (ESP) Act 1992*, were used as the basis for this assessment. As the status of Priority Flora is currently being reviewed, and the status of priority flora is considered likely to change, this assessment was limited to the Declared Rare Flora. All known locations (1 053 data points) for DRF taxa were considered to be above threshold for this value. These point locations were scattered throughout the RFA Region, with concentrations east and north-east of Perth; between Busselton and Augusta; and from Lake Muir through Mt Frankland and east to Mt Lindesay.

Rare, threatened or restricted communities

Three levels of community definition were available for this assessment:

- Forest Ecosystems;
- Vegetation Complexes, and
- Threatened Ecological Communities.

Forest ecosystem mapping

Several forest ecosystems are rare and/or naturally restricted within the landscape: Bullich and Yate, Jarrah Rates Tingle, Jarrah Red Tingle and Karri Rates Tingle. Examples of these forest ecosystems within areas of biophysical naturalness of 4 or 5 and greater than 10 hectares in extent were considered to be above threshold for national estate significance. These are shown on Map 4.

Vegetation complex mapping

Mattiske Consulting (1997a) have mapped 312 vegetation complexes within the RFA Region. This mapping of vegetation enabled an analysis of those vegetation complexes that are either naturally rare

or restricted within the landscape or have become so through the effects of clearing and/or other disturbances. Of the 312 vegetation complexes mapped in the Region, 187 are less than 1 000 hectares in extent.

Given the comparatively small extent of many vegetation complexes, the first step in the analysis was to determine those vegetation complexes that were rare or restricted in the landscape. Swan Coastal Plain or wheat belt communities with partial distributions in the study area were omitted from the analysis. Eight vegetation complexes were identified from the vegetation complex mapping with less than 100 hectares in extent.

The second step in the analysis was to undertake an assessment of the level of depletion of vegetation complexes in the study area. This was achieved by comparing the mapped distribution of vegetation complexes with their extant distribution, using the biophysical naturalness data, which identified cleared land. Thirteen vegetation complexes were identified which retain less than five per cent of their former distribution. It must be noted that there has not been a detailed review of the current status of vegetation complexes, including condition and integrity within the landscape, and the effects of threatening processes.

Areas identified through steps 1 and 2 were then filtered to remove those vegetation complexes which did not have any polygons greater than 10 hectares (see Table 3.5), except for those very restricted communities which had been little affected by disturbance. Ten hectares was the smallest area considered reliable for the intersected data on vegetation complexes and disturbance.

The analysis identified 19 rare, restricted or depleted vegetation complexes that are listed in Table 3.5 and shown on Map 4.

Table 3.5 Rare, restricted and depleted vegetation complexes

Vegetation complex mapping unit	**Rare , Restricted or Depleted**
Abba flats, Abba gentle slopes (AB)	Depleted
Barrow Granites (BAg)	Rare
Blackwood Estuarine Flats (Bwy)	Depleted
Balingup footslopes (BLf)	Depleted
Dalmore granites (DMg)	Depleted
Darkan (Dk3)	Depleted
D'Entrecasteaux rocky dunes (Dr)	Rare and restricted
Farrar (Fa3)	Depleted
Gardner granites (Gg)	Rare and restricted
Gracetown karst areas (Gk)	Rare and restricted
Gracetown valleys (Gv)	Rare and restricted
Keystone (Kb)	Rare
Kilcarnup exposed dunes (with exposed organic matter) (KEf)	Rare and restricted
Kulikup (KUw)	Depleted
Mumballup (ML)	Depleted
Scott deep sandy gentle slopes (Sd2)	Rare and restricted
Scott wet flats (Sw)	Depleted
Wilyabrup exposed swamps (WEw)	Rare and restricted
Yarraleena (Ya)	Depleted

* Characters in brackets indicate symbols for the respective complexes on the maps of Mattiske *et al*, 1997.

Threatened ecological communities

A number of ecological communities in the South-West Forest Region botanical province have been identified and assessed by English and Blyth (1997) as being naturally rare in occurrence, depleted by European land use or vulnerable to continuing threatening processes. It should be noted that the significance of these ecological communities may be related to both flora and fauna components. Although most communities addressed in this study occur outside the RFA Region, twelve threatened communities within the RFA Region were identified as critically endangered or endangered, namely:

- subterranean aquatic root mat communities of the Leeuwin Naturaliste Ridge (4 types);
- *Banksia attenuata* and/or *Eucalyptus marginata* woodland on the eastern side of the Swan coastal plain;
- *Eucalyptus calophylla – Xanthorrhoea pressii* woodlands and shrublands, Swan coastal plain;
- Rimstone pools and cave structures;
- Scott River ironstone association;
- shrublands and woodlands on the eastern side of the Swan coastal plain;
- shrublands on dry clay flats;
- shrublands on southern Swan coastal plain ironstones, and
- southern wet shrublands, Swan coastal plain.

All known occurrences of the critically endangered and endangered communities have been assessed as meeting the threshold of national estate significance, and are shown on Map 4.

3.3.2 Fauna values

The South-West Forest Region consists of a comparatively uniform forested landscape quite unlike the deeply incised and varied landscapes of eastern Australia. As a consequence of this uniformity, the forests of the South-West are lower in faunal diversity than eastern forests, and species generally tend to occur broadly across the landscape. However this apparent homogeneity does not necessarily apply at the local level, where the distribution of fauna is affected by factors such as the diversity of understorey flora, soil moisture, rainfall, variations in relief and the presence of fire as a regular feature in the landscape.

The geological history of this landscape has greatly influenced the development of the fauna, supporting endemic species unique to the South-West such as the sunset frog (*Spicospina flammocaerulea*). It also allows the persistence of elements of Gondwanan invertebrates such as the mygalomorph spiders in small refugia where favourable environmental conditions have been maintained.

Even fire, one of the most defining elements of the South-West forests, has occurred as a mosaic across the landscape, producing a biota well-adapted to fire but also conversely, enabling the persistence of such relictual species in small, infrequently burned refugia in the landscape such as within the tingle forests.

The South-West forests also represent refugia for a number of once widespread critical weight-range vertebrate species that have contracted in distribution south-westwards into the forest environment. For example, the numbat and chuditch were once widespread species in the arid and semi-arid regions of Australia and following their decline, Perup and similar areas represent important refugia in historical times for critical weight range species.

Data

Western Australia has a comparatively long history of fauna management and survey by government, industry, research institutions and private individuals. However, this survey effort has typically been directed at particular taxa within portions of the assessment Region and has rarely involved comprehensive or systematic surveys over the whole Region. The most extensive fauna surveys conducted in the South-West include work in the southern forests by Christensen (1982) and intensive surveys by Alcoa Australia and Worsley Alumina within their mining lease areas. Prior to the CRA, no formally amalgamated electronic database existed for fauna records in the South-West Region equivalent to the atlases available in some eastern States. Datasets were held in a large number of

institutions and by private individuals both within Western Australia and nationally. These datasets vary greatly in reliability, ease of capture and storage format.

A survey and amalgamation of available datasets into a single fauna database at the Western Australian Museum was conducted for the CRA, and yielded approximately 63 710 records of birds, mammals, reptiles, frogs, and freshwater fish. Invertebrate survey effort in Western Australia varies greatly across taxa groups but has generally been very limited. 12 981 invertebrate records were collected for the biodiversity assessment, mainly covering arachnids, scorpions, land snails and inland crustacea. An additional 381 records were collected for 89 highly endemic, relictual or restricted ants, jewel beetles, aquatic macroinvertebrates and cave invertebrates. The amalgamation of these datasets produced the first comparatively comprehensive fauna database in Western Australia. While the compilation of this database is a significant achievement, its limitations are recognised. In brief, these are:

- the large number of incidental records and consequent strong bias in the data that is dependent on land use, access and observer bias;
- time constraints on data capture which introduced a bias towards easily captured records and effectively excluded a number of non-digital datasets that could not be captured within the time frame, and
- an absence of presence/absence records outside mining company records which places a strong reliance on incidental observation and limits the usefulness of the data for modelling.

The primary sources of data used in the study were:

- pre-disturbance fauna surveys conducted by the mining companies Alcoa of Australia and Worsley Alumina;
- vertebrate fauna databases compiled by CALM;
- a regional study of south-western fishes conducted by Murdoch University in association with the Water and Rivers Commission;
- Glenn Storr Bird Database, captured by the Western Australian Museum;
- CSIRO cockatoo study for the south-west Region;
- Birds Australia (RAOU) database for Western Australia species;
- selected vertebrate and invertebrate records from the Western Australian Museum;
- fauna studies of possible reservoir sites conducted by Water and Rivers Commission, and
- miscellaneous other studies provided by university researchers.

Experts in specific taxa contracted by the Western Australian Museum provided additional records for potential invertebrates of national estate significance.

In some cases limited survey data may be compensated for by the use of techniques such as species distribution modelling using environmental strata.

However, the success of modelling is limited by the availability of data, particularly in predicting the distribution of groups whose habitat requirements are at a finer scale than the available environmental stratifications.

Sub-criterion A.1: Importance in the evolution of Australian fauna

The assessment of fauna values under this sub-criterion involved the identification of places important as habitat for fauna with a present distribution and ecology in the South-West Forest Region which reflects the influence of past evolutionary, climatic and environmental processes. Distributions of the following were investigated:

- endemic fauna;
- relictual and primitive fauna;
- refugia;
- fauna taxa with disjunct distributions, and
- fauna taxa at their range limits.

Endemic Fauna

There are few vertebrates which can be regarded as forest-associated endemics in the South-West Forest Region (Hopper *et al.* 1996). Most of the endemic mammals and birds in the South-West Forest Region consist of highly mobile species that occur, or originally occurred, widely over the Region. Herpetofauna and fish, however, include species with narrow habitat parameters and highly restricted distributions as a consequence of past environment change. Similarly, a significant proportion of the invertebrate taxa appear to be locally endemic. For example, Abbott (1995) demonstrated that 23 per cent of known insect species from karri forest are known only from that forest type. The current taxonomic and ecological knowledge of invertebrates in Western Australia is limited and places constraints on the comprehensiveness of the assessment of national estate significance for fauna endemism.

Method

Experts were asked to rank species according to their level of endemism. In order to ensure the best possible capture of data for invertebrates, which were recognised as a particularly important group when considering endemism, the database was supplemented by a questionnaire distributed to scientists with recognised expertise in the invertebrates of the South-West Forest Region. The questionnaire particularly sought to obtain additional information on highly restricted endemics.

The analysis of endemism was focused on species restricted within the RFA Region, i.e., highly restricted species with low mobility including endemic frogs, fish, spiders (arachnids), crustaceans, cave invertebrates, aquatic invertebrates, ants and jewel beetles (see Appendix I). To this were added locally endemic reptiles and mammals. Birds were excluded because of their high mobility. The analysis was based on point data only as there were insufficient records to enable the development of isopleth map based on grids such as that produced for the assessment of endemic flora.

Establishing the threshold

Areas identified as significant for endemic fauna were captured point data for highly restricted endemics intersected with natural landscapes and areas of high biophysical naturalness. Areas determined to meet the threshold of national estate significance for this value were those with site records for endemic fauna species occurring within natural landscapes, or areas 40 hectares or larger of high biophysical naturalness (classes 4 and 5).

Results

Trends in the data show concentrations of these taxa across parts of the Southern Forest Region, notably in the tingle forests eastwards to Mount Frankland, and along the Leeuwin-Naturaliste Ridge. Smaller concentrations are scattered through the northern jarrah forests. Areas identified by this assessment to meet the threshold of national estate significance for endemic fauna values are shown on Map 2.

Primitive or relictual fauna

As with plants, relictual fauna species are generally regarded as those that exhibit taxonomic remoteness or phylogenetic primitiveness, or both. Western Australia is remarkable for the proportion of phylogenetically significant fauna found in a Region with comparatively lower species diversity than found in forests in the east. This high level of phylogenetically significant fauna reflects the geological and climatic history of the Region, which has allowed such species to persist in small

refugia. These refuge areas, and the relictual species they support, provide an important record of the evolution of the Australian fauna.

Method

All vertebrate species included in the database and the selected invertebrate species that could be captured within the time frame of the assessment were ranked by the Western Australian Museum and external experts for phylogenetic distinctiveness, taxonomic status and relictual characteristics. Species that ranked highly for these values were included in the analysis.

As with endemic fauna species, the analysis of primitive and relict species focused on highly restricted species with low mobility, i.e., fish, spiders (arachnids), crustaceans, cave invertebrates, aquatic invertebrates, ants and jewel beetles. Analysis was based on point data only, as there were insufficient records to enable the development of isopleth map based on grids such as that produced for the assessment of endemic flora.

Establishing the threshold

Areas identified as significant for primitive and relictual fauna were identified through the intersection of point data with natural landscapes and areas of high biophysical naturalness. Areas determined to meet the threshold of national estate significance for this value were those with site records for primitive and relictual fauna species occurring within natural landscapes, or areas of high biophysical naturalness (classes 4 and 5) 40 hectares or larger.

Results

Species identified as primitive or relictual taxa are listed in Appendix I. Trends in the data indicate concentrations of relict taxa across the south of the Region including the Leeuwin-Naturaliste Ridge and also within the tingle forests and eastwards towards Mount Frankland. Smaller centres important for primitive and relictual fauna are scattered through the northern forests. Areas identified by this assessment as meeting the threshold of national estate significance for primitive and relictual fauna taxa are shown on Map 2.

Refugia

Core habitat areas are important to the continuing viability of the Western Australian fauna, particularly during periods of environmental change. In this assessment, refugia were identified by examining which forest ecosystems had the potential to act as refugia for fauna during times of environmental perturbation.

Moist sites were highlighted as important habitats for relictual invertebrates and fish species that had survived past climate and environmental change (Horwitz *et al.* 1997, Hopper *et al.* 1996). The CRA consultants report on the response of aquatic invertebrates to disturbance highlighted the following sites as being important for such fauna: monadnocks and their surrounds, wetlands, peatlands, tumulus springs (organic mound springs), aquatic root mat communities, headwater swamps, tingle forest and south coast dunes and heath. Such habitats have important biodiversity conservation values.

Since European settlement, the relative isolation of the South-West Forest Region and the occurrence of plants containing 1 080 has apparently provided some refuge for fauna from the impacts of introduced species such as foxes. The Perup area is an important example of a contemporary fauna refuge; these areas are addressed under sub-criterion A.2 below.

Method and results

The identification of refugia was based on the work described in Hopper *et al.* (1996) on the characteristics of sites likely to be important for relictual species. Identified units in the landscape with agreed physical attributes were areas with steep south-eastern aspect, granite monadnocks, wetlands and areas subject to inundation. The identification of these areas within relatively undisturbed areas of the landscape was conducted for the assessment of flora refugia and these areas, which are shown on Map 2, are regarded as an appropriate surrogate for areas significant as fauna refugia.

Fauna taxa with disjunct distributions

Fauna species in the South-West Forest Region with disjunct distributions tend to be dependent on a narrow array of habitat parameters that occur irregularly through the landscape. Exceptions to this are species such as the brush-tailed phascogale *(Phascogale tapoatafa)*, the Mardo *(Antechinus flavipes)* and the common brushtail possum *(Trichosurus vulpecula)* which represent western populations of species widely distributed in eastern Australia.

Method

The level of disjunction in the distribution of fauna species in the Region was assessed by scientists at the Western Australian Museum according to the following parameters (from lowest to highest priority):

1. mainly continuous distribution;
2. small discrete patches, clustered within small area;
3. primary range and peripheral isolates;
4. several major parts to range, separated by significant gap, and
5. small discrete patches, widely separated.

Species where disjunction was considered by relevant experts to be an artefact of survey limitations were excluded from analysis. Species with highly localised distributions were considered under the assessment of endemic fauna. Species with distributions which met the third, fourth or fifth criteria above were regarded as taxa with disjunct distributions and the relevant site records were plotted and included in the assessment.

Results

Analysis of the data showed few trends in the distribution of species with disjunct distribution within the RFA Region. This is considered likely to be both a reflection of the complex history of the area and a consequence of inadequate sampling. Modelling of disjunct species such as the brush-tailed phascogale was considered, but determined to be not possible because of inadequate survey coverage across the Region and a lack of records at sufficient resolution (under two minutes). Consequently, the data were not considered adequate to systematically identify areas of national estate significance for this value.

Fauna taxa at their range limits

Taxa that reach range limits within the RFA Region tended to be those associated with environments to the north or east or on the coast that extend into the tall forest landscape. Although some biogeographic limits are suggested within the RFA Region, e.g., between the northern and southern jarrah forest herpetofauna, these are not well understood and further survey work is required to make these relationships clearer.

Method

Fauna were attributed with rankings related to range limits based on the following criteria:

- range completely overlaps the RFA Region;
- no range limits within the Region;
- confined to part of RFA Region, and therefore has limits of range within the Region (including species where only a small proportion of the range fell outside the RFA Region), and
- range extends from outside to within the RFA Region.

Species whose range limits appeared to be an artefact of inadequate fauna survey were excluded. Species whose range was entirely within the RFA Region were regarded as endemics and considered under the assessment of endemic fauna. Species with a range extending into the RFA Region from outside its boundary were attributed as species at the limit of their range for this assessment.

Establishing the threshold and results

Analysis of the data showed few region-wide trends in the distribution of fauna species at the limit of their range within the RFA Region. As for disjuncture, this is considered likely to be both a reflection of the complex history of the area and a consequence of inadequate sampling. The results for the Region were not comprehensive enough nor available at a fine enough resolution for species distribution patterns to become apparent. Consequently, the data were not considered adequate to systematically identify areas of national estate significance for this value.

Sub-criterion A.2: Importance in maintaining existing processes or natural systems at the regional or national scale

This sub-criterion recognises that certain places are of particular importance to the conservation of natural processes and systems. Such places are particularly significant where they play an important role in systems and processes that occur at a regional or national level. Natural landscapes identified and assessed under criterion B 1 are also considered to be important for maintaining natural ecosystem processes at the landscape scale. The identification of these values involved assessment of the presence in the landscape of:

- habitat for migratory species, and
- important wildlife habitats.

Habitat for migratory species

There are no RAMSAR identified sites within the South-West Forest Region. While some of the bird species of the forested South-West undertake seasonal movements in or out of the tall forest area of the South-West to feed or breed, these movements are not well understood and there are comparatively few migratory species that undertake migrations over long distances. There is only one known fish species that migrates, the pouched lamprey *(Geotria australis)*, a common species which seeks the upper reaches of coastal river systems to breed. Although lampreys are a common species, breeding biology and locations are not well understood and only a few breeding records exist (Morgan *et al.* 1996). Data are not considered adequate to identify areas of national estate significance.

Important wildlife habitats

The focus of this assessment was to identify areas of wildlife habitat of key importance in maintaining natural processes and systems, that had not already been identified by assessments under other criteria. Areas such as refugia (identified under criterion A.1) are clearly of importance in maintaining natural biotic processes as are natural landscapes and old-growth forests (identified under criterion B.1). A number of fauna species in the South-West Forest Region have a recognised dependence on key habitat requirements, such as the association of the large cockatoos with hollow-bearing trees or the importance of semi-permanent forested streams to native fish such as the locally endemic Balston's pygmy perch (*Nannatherina balstoni*) and the salamander fish (*Lepidogalaxidas salamandroides*). The widespread and changing spatial distribution of these features across the landscape, however means that the identification of specific areas of national estate significance is difficult.

Some landscape elements however, are recognised as important wildlife habitats and can be spatially identified. Two key habitat types were identified for analysis:

- important wetlands, and
- contemporary fauna refuges.

Important wetlands

Wetlands in the South-West Forest Region important for nature conservation are listed in the *Directory of Important Wetlands in Australia* (ANCA 1996) and in *A National Plan for Shorebird Conservation in Australia* (Watkins 1993) developed by the Royal Australasian Ornithologists Union.

Establishing the threshold

As the *Directory of Important Wetlands in Australia* and *A National Plan for Shorebird Conservation in Australia* identify wetlands of national significance, all wetlands listed in these documents were considered to meet the threshold of national estate significance for this value.

Results

The wetlands identified under this criterion are:

- Avon River Valley;
- Blackwood River (lower reaches);
- Broke Inlet System;
- Byenup Lagoon System;
- Cape Leeuwin System;
- Chittering Needonga Lakes;
- Doggerup Creek System;
- Gingilup-Jasper Wetland System;
- Kwornlup Lake;
- Lake Muir;
- Maringup Lake;
- Mount Soho Swamps, and
- Wannamal Lake System.

These are shown on Map 1.

Contemporary fauna refuges

In the period since European settlement the impacts of land clearance, major changes in land management practices and the introduction of feral predators has had a profound impact on the distribution of the fauna of the South-West Forest Region. The ranges of many of the smaller mammals in particular have contracted significantly, and in some cases these species have survived only in restricted areas of the landscape. Places such as the proposed Perup Nature Reserve are recognised as having been of critical importance in maintaining populations of species which elsewhere have declined or become locally extinct. The introduction of fox-baiting by the Department of Conservation and Land Management has brought about a dramatic improvement in the ability of native fauna to survive in or recolonise some areas, and reintroduction programs are currently being implemented by CALM.

The identification of contemporary fauna refuges was based on the historical changes in the distributions of critical weight range species. Site records of selected fauna species from after 1960 were considered to reflect areas important as contemporary fauna refuges. Species considered in this analysis were the western ring-tailed possum, woylie, quokka and tammar wallaby. The western ring-tailed possum was identified as a species with generally narrow habitat requirements whereas the three macropods are critical weight range species that have undergone historical declines in distribution and abundance.

Establishing the threshold

The post-1960 distribution records of critical weight range species were plotted on the GIS and intersected with natural landscapes and biophysical naturalness data to delineate undisturbed contemporary fauna refuge areas in the landscape. Areas determined to meet the threshold of national estate significance for this value were those with:

- post-1960 site records for selected fauna species occurring within, and
- natural landscapes, or areas 40 hectares or larger of high biophysical naturalness (classes 4 and 5).

Results

Fifty site locations were identified as indicating areas meeting the threshold of national estate significance as contemporary fauna refuges. This value is represented as point distribution data with point locations occurring along the Leeuwin-Naturaliste Ridge, Windy Harbour, the Walpole area and near the Tone and Perup Rivers. These are shown on Map 2.

Sub-criterion A.3: Importance in exhibiting unusual richness or diversity of fauna

The comparatively uniform forested landscape of the South-West Forest Region supports a fauna relatively depauperate in diversity when compared to the forests of eastern Australia, with vertebrate species in particular tending to occur broadly across the landscape. Although this homogeneity does not necessarily apply at the local level, where the distribution of fauna is affected by factors such as the diversity of understorey flora, soil moisture, rainfall, variations in relief and the presence of fire as a regular feature in the landscape, the fauna richness of the South-West Forest Region is not comparable to its floral richness.

Richness of fauna species

Reliable data on which to base species richness mapping in the South-West Forest Region was not available. The absence of systematic survey across the Region, and the reliance on incidental observations effectively means that until such work is done there is no reliable surrogate for species richness.

Modelling of the distribution of species was attempted, but due to the lack of adequate point data, proved to be unreliable. All species that ranked highly for national estate and biodiversity values criteria were modelled. This involved over 100 species. Modelling was based on records between 31° south and 118° west. All records for bird and mammal records available at a precision of nine seconds were used. Frog and reptile records at a precision of one minute were used due to the unavailability of records at a higher precision.

Model outputs were considered by a panel of experts. Only 24 species were accepted as having models that reasonably reflected known current or historical distributions. Within these range extents, few models adequately predicted distribution to the satisfaction of the experts.

It was determined that the available data and distribution maps for fauna were not robust enough to allow fauna species richness to be reliably predicted across the Region.

Sub-criterion B.1: Importance for rare, endangered or uncommon fauna

This sub-criterion recognises the importance of fauna elements with very limited occurrences, as a result of either natural or unnatural processes.

Rare and threatened fauna

Rare and threatened fauna were derived from lists of rare or threatened species in the *Wildlife Conservation Act* 1970.

Method

Known locations of rare, threatened, endangered and uncommon species were derived from the Western Australian Museum fauna database, which amalgamated available data from a variety of sources. These site locations were then plotted on a GIS. Fauna modelling of these species was attempted but was largely unsuccessful because of the limited suitable data available for most species. The assessment therefore used only the point locations. It should be noted that in instances where multiple records occur within a very limited area for a single species that these may appear as a single location. For the *Geocrinia* frog complex, for example, representative points were chosen for known sites in very close proximity.

Given the limited quality and availability of fauna data in the South West Forest Region and the high percentage of incidental sightings included in available data, point data for highly mobile species was not considered appropriate for use in this assessment. Available data records for rare and threatened mammals and birds in particular, had low spatial reliability and were excluded when considered against the large-scale movement of many species across the landscape. Site records used were consequently limited to those for rare and threatened reptile, frog and invertebrate species.

Establishing thresholds

All recorded locations for rare and threatened reptile, frog and invertebrate species were considered to meet the threshold of national estate significance for this value.

Results

A total of 490 point locations were identified as meeting the threshold of national estate significance for rare and threatened fauna taxa. Concentrations occur around Mundaring, along the Leeuwin-Naturaliste Ridge and in the Walpole area. The point data are shown on Map 2.

3.4 OTHER NATURAL VALUES

3.4.1 Geological, geomorphological and soils values

Introduction

The goal of the geological, geomorphological and soils values assessment was the identification of geodiversity; i.e., natural range (diversity) of geological (bedrock), geomorphological (landform) and soil features, assemblages, systems and processes. Geodiversity includes evidence for the history of the earth and a range of processes currently acting on rocks, landforms and soils (Environment Forest Taskforce 1997c). It is fundamental to broader ecological processes and it is also important in contributing to the richness and interest of our natural environment, including opportunities for scientific study of the earth's development.

The RFA Region incorporates a diverse system in terms of its geology, geomorphology, pedology and hydrology. Additionally, the Region traverses a range of climatic types and thus various different climatically-driven processes operate across its length and breadth (V & C Semeniuk Research Group 1998).

The assessment of national estate geological, geomorphological and soils values involved the identification of key components of the geodiversity of the RFA Region and the identification of places that illustrate these components.

Data sources

The assessment of geodiversity was undertaken by the consultants V & C Semeniuk Research Group, and was based primarily on a review of current literature and consultation with relevant experts. There is an old geological heritage database held by the Western Australian Department of Minerals and Energy, but this has not been maintained for several years. Many of the sites identified in this assessment were from the personal knowledge of local experts. While many of these sites were recognised as being important, they lacked precise locational information. Where sites could not be accurately located, they were deemed below threshold.

Previous studies

Several previous studies have been undertaken that cover the Region which addressed the identification of geological and geomorphological values. These include:

- Lemmon *et al.* 1979 - *Important Geological Sites in the Perth and Southwestern area of Western Australia.* Geological Society of Australia, WA Division. This report focuses on major geological and geomorphological sites in the Perth area and the south-west and south coast areas which occur in the RFA area;

- Carter J.D. 1987 - *Important Geological Localities Beyond the Perth Region. Their Significance and Value, Protection and Presentation.* Geological Society of Australia, WA Division. This report focuses on major geological and geomorphological sites across Western Australia, including the south-west and south coast areas which occur in the RFA area;

- V.&C. Semeniuk Research Group 1996 - *Classification and Evaluation of Natural Wetland Regions of the Southern Coastal Plain, Between the Blackwood and Nornalup/Walpole Estuaries Southwestern Western Australia.* This report describes the regional wetland types, their values and significance, and

- Marine Parks and Reserves Selection Working Group 1994 - *A Representative Marine Reserve System for Western Australia.* Western Australia Department of Conservation and Land Management. This report describes the regional estuaries, beaches and the adjoining marine environments, including their biological and geomorphological values and significance. It recommends areas of high conservation value for declaration as marine park.

A series of other studies are also relevant to the identification of geodiversity values. These include:

- Hodgkin E. and Clark R. 1988 *An Inventory of Information on the Estuaries and Coastal Lagoons of South West Australia.* Environmental Protection Authority, Perth;

- Matthews P.G. 1985 - *Australian Karst Index 1985.* Australian Speleological Federation. Provides a description of major karst areas found across Australia and their significance;

- Geological Survey of Western Australia 1990 - *Geology and Mineral Resources of Western Australia, Memoir 3.* WA Department of Mines. This report describes stratigraphic types sections in Western Australia, including those found within the RFA Region, and

- McArthur W.M. 1991 - *Reference Soils of South-Western Australia.* WA Department of Agriculture. Soil reference sites for southwestern Australia, including the RFA Region, were located and described.

Regional Geological and Geomorphic history

Basement geology

Regional geology has a major influence on the pattern of landforms of the area, and consequently many authors have used a geological framework as the basis for the primary classification of landform and soil units, or for the subdivision of terrain units (e.g., Churchward and McArthur 1980). Landform units which occur within the study area are related to the main rock types that underlie a given geologic unit, as well as the structural features such as major faults and splinter faults.

At a sub-continental scale the main geological units (each with a series of lithologic provinces) found within the study area are:

- the Yilgarn Craton;
- the Albany-Fraser Orogen;
- the Leeuwin Block, and
- the sedimentary rocks of the Perth Basin, Bremer Basin and Wilga and Collie Basins.

These units, and their interfaces, determine to a large extent the disposition of major landforms in the Region (V & C Semeniuk Research Group 1998). A conspicuous component of the regional landscape is the numerous granitic outcrops associated with the Yilgarn Craton, Albany-Fraser Orogen and the Leeuwin Block.

Regional scale geomorphology

Geomorphic units found in the Region include:

- Darling Plateau;
- Collie and Wilga Lowlands;
- Leeuwin-Naturaliste Ridge;
- Ravensthorpe Ramp;
- Blackwood Plateau;
- Scott Coastal plain, and
- D'Entrecasteaux-Albany Coastal Zone.

Each of these units have a distinctive suite of landforms and soils as a result of geomorphic and pedological processes. In addition, the units influence the development of small scale hydrological features and the types of wetlands found within the Region.

The evolution of many regional geomorphic or terrain features in the Region is linked to Mesozoic to early Cenozoic, and then late Cenozoic geologic and geomorphic history. For instance, the evolution of the major plateau features are linked to Mesozoic-Cenozoic tectonic events, while the evolution of smaller scale terrain features, such as the aeolian landforms, laterite duricrusts and wetlands are linked to late Cenozoic process, particularly in the Pleistocene.

The development of certain aspects of the southern part of the Region, particularly the Ravensthorpe Ramp is linked to the separation of southern Australia from Antarctica during the Mesozoic, continuing into the early Cenozoic. The geological processes involved in this rifting resulted in the development of subsidence and associated continental margin basins (e.g., remer Basin), step faulting of the basement to develop ramp-like features at the southern continent edge.

In the latest Cenozoic times, the history of the Region is closely associated with an arid zone setting in which aeolian features and processes become dominant (Glassford 1980) concealing evidence of the previous pluvial times. The blanketing of the terrain by aeolian sand deposits, the filling of drainage channels by the same deposits, the fall-out and illuviation of clay-rich dust and the emplacement of aeolian sand bodies such as the yellow/orange sand sheets on the continental shelf, the Swan coastal plain and the Darling Plateau, are all part of this history.

A series of aeolian landforms in coastal and near coastal zones are those formed as a result of dune ingressions into the hinterland. There are also linear dune fields formed in earlier climatic regimes. Aeolian landforms may be currently forming, or may be Holocene or Pleistocene features. Where such dunes are large scale, their blocking of the coastal migration of surface water has formed distinctive wetlands.

Wetlands of the Region

The occurrence of wetlands in the Region were subdivided by geology, geomorphology (physiography), climate, the hydrological framework and Cenozoic history, because it is the sum of these factors that determine the style of wetland development and the style of wetland types that occur within the area (V & C Semeniuk Research Group, 1995a, 1995b).

Those wetlands occurring within the coastal zone were dealt with separately as these are shaped largely by marine influences interacting with the terrestrial processes, whereas inland wetlands are more laterally extensive areas, the product of geology and landscape interacting with climate and hydrology (V & C Semeniuk Research Group 1998).

Fossil sites

The Region contains one of two major fossil sites in Western Australia important for recording the evolution of vertebrate fauna (RFA World Heritage Report, 1998). Caves found on the Leeuwin Ridge, situated between Cape Leeuwin and Cape Naturaliste, provide significant records of the evolution of the vertebrate fauna of the south-west Region of Western Australia over the past 2 million years. These document changes in the vertebrate fauna associated both with the effects of influxes of fauna from eastern areas of the continent, and with long periods of isolation caused by climatic change, particularly arid phases affecting the centre of the continent. Other fossil sites illustrate the evolution and development of flora within the Region.

Palaeoplains, palaeo-drainage systems and palaeosols

The Region lies on the western edge of an area that extends from Norseman to near Manjimup and Collie, that is recognised as highly significant for relict landforms such as palaeoplains. The deeply weathered surfaces in this Region, which include expansive lateritic, bauxitic and kaolinitic surfaces were formed in Tertiary times and rank amongst the best examples of these landscape remnants in the world (RFA World Heritage Report 1998).

These palaeoplains also include palaeo-drainage systems. The best example of these lie predominantly to the east of the study area, but a some examples are found in the Region. Important examples of relict soils or palaeosols were identified as part of this assessment.

Caves

The Leeuwin Ridge cave sites are important landforms in their own right and contain evidence of the unusual stability of Quaternary climates in this South-West Region of Western Australia, particularly associated with glacial periods (RFA World Heritage Report, 1998).

Other caves in the Region illustrate a range of geomorphic features and the effects of changing hydrological processes over time, e.g., Cape Beaufort sea cave.

Method

The assessment of geodiversity values involved the following steps:

- collation and review of existing information on sites important for geological, geomorphological and pedological values within the Region;
- subdivision of the Region into geological and geomorphological units;
- survey of local and other experts on the known places important for geological, geomorphological and pedological values;
- consolidation of all data into a single computer-based database and GIS layer;
- comparative review of site significance;
- delineation of site attributes relevant to the national estate criteria (e.g., sites containing evidence of past environmental conditions), and
- development and application of thresholds

This work was undertaken by the consultant in conjunction with State and Commonwealth officers on the RFA assessment team. A technical advisory committee provided feedback on site significance and the application of thresholds. Where the significance of sites was poorly documented, or the specific area of importance was not accurately defined, these sites were deemed below threshold.

National Estate Values

Sub-criterion A.1: Importance in the evolution of Australian flora, fauna, landscapes or climate

Assessment for values under this sub-criterion involved identification of places where the present geology, landforms and soils features reflects the influence of past climatic, geological, geomorphological and pedological processes.

A series of terrane types can be distinguished that relate to different periods in the sequence of geological events within the Region. These included:

- Precambrian terranes;
- Palaeozoic and Mesozoic terranes;
- Tertiary terranes, and
- Quaternary terranes.

Each terrane type identified in the Region contains specific features which illustrate geological and geomorphological processes operating during that period of geological history. For example, the presence of geomorphic features such palaeo-channels and palaeosols illustrate past wetter climates and other environmental determinants in Tertiary times. Fossil sites provide a record of the biota

which previously existed in the area. Conspicuous elements of these terranes are features such as the Collie Basin, the Ravensthorpe Ramp, the Bunbury Basalt (e.g., Black Point), and ubiquitous laterites of the Darling and Blackwood Plateaux.

The assessment focussed on places that are:

- sites clearly demonstrating relationships between geological and geomorphic units found in the Region;
- important sedimentary, igneous and metamorphic rock exposures that illustrate rock types, structures and petrology associated with each episode in the geological history of the Region;
- sites containing evidence of past environmental conditions (palaeoenvironments), including important fossil localities;
- relict landforms (i.e., formed by processes no longer active at the site), and
- sites containing relict soils (palaeosols).

Results

Fifty sites were identified that demonstrated relationships between geological and geomorphological units, and rock types, petrology and structures associated with each terrane type. Twelve fossil and pollen sites were identified and 18 caves were identified as being important for palaeontology. Palaeosols were identified in three sites illustrating Pleistocene soil development and relationships between a sequence of soil development. Twenty eight wetland and fluvial features were identified which illustrated past geomorphological processes.

Sub-criterion A.2: Importance in maintaining existing processes or natural systems at the regional or national scale

The identification of areas of national estate significance under this sub-criterion involves assessment of places important for the maintenance of ongoing earth (geological, geomorphological or pedological) processes. Sites where there is clear evidence ongoing processes related to the action of water and wind in shaping and moving the component materials of geomorphic features within the landscape are also important.

Identification of such places involved assessment of the presence in the landscape of:

- fluvial landforms;
- caves;
- wetlands;
- aeolian landforms, and
- coastal geomorphological features.

Results

Fifty three caves were identified as being important for geomorphological and or hydrological processes. Other sites demonstrated other geomorphological features associated with the solution and deposition of calcium carbonate by water. A series of wetland types, each with specific geomorphological features, were identified along the south coast of the Region primarily within D'Entrecasteaux National Park.

A series of coastal geomorphological features were identified on the south coast of the study area. These features included aeolian landforms such as the Yeagarup dunes and the south coast inlets and estuaries contained primarily within D'Entrecasteaux National Park. The geomorphological and biological values of many of these areas have been documented by the Marine Parks and Reserve Selection Working Group 1994 and most have been recommended as marine parks. It was considered beyond the scope of this assessment to document and assess the range of geomorphological features in the coastal zone and adjoining marine environment.

A series of aquifer recharge areas were also identified but were considered below threshold given the difficulty in delineating the exact area important for this value and insufficient information on the significance of each area.

Sub-criterion A.3: Importance in exhibiting unusual richness or diversity of flora, fauna, landscapes or cultural features

The identification of areas of national estate significance under this sub-criterion recognises the value of places where large numbers and/or a diversity of geological features and/or landforms are assembled within a relatively small area.

Identification of such places involved assessment of the presence in the landscape of:

- sites with a rich array of rock types, structures or textures;
- sites with a diversity of landforms of a particular class;
- sites where different classes of landforms are closely juxtaposed or interrelated, and
- rich or diverse fossil localities.

This assessment represents the first regional overview of geological and geomorphological values. Given the limited information currently available on the range of geological and geomorphological features within the Region, it was difficult to systematically identify those sites which were unusually rich or diverse. Some sites, e.g., fossil sites, were obvious candidate areas under this sub-criterion, but most lacked adequate documentation to be above threshold.

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

This sub-criterion recognises the importance of abiotic elements within the landscape with very limited occurrences as a result of natural processes.

Identification of such places involved assessment of the presence in the landscape of:

- areas or sites with uncommon or rare geology or landforms;
- rare combinations of geological, geomorphological features;
- geological, geomorphological features that are unusual or outstanding in some way, and
- rare fossil sites.

Many of the sites identified under sub-criteria A.1 and A.2, which provide evidence of past or present processes, also illustrated rare or uncommon geological or geomorphological features. For example, the megaripples in the Yeagarup dunes, are a rare example of this geomorphological feature which illustrates active sand transportation processes inland. Similarly, the Cape Beaufort Sea Cave is an unusual example of limestone and basalt features.

In total 55 sites were identified with rare or uncommon geological or geomorphological features.

Sub-criterion 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

This sub-criterion addresses the importance to the national estate of teaching and research sites which have generally been used over a considerable period and are expected to play an important future role in education and development of a better understanding of the geological and geomorphic history of the Region. It also includes reference areas which have been used to describe particular aspects of the regional geodiversity.

Reference soils

As an outcome of the objectives of the Australian Society for Soil Scientists to establish reference soil sites, 'Reference Soils of South-Western Australia' (McArthur 1991) was published. Within this

work, reference sites for south-western Australia, including the RFA Region, were located and described. Thirty seven sites are significant as important reference areas.

Stratigraphic type sections, mineral locations, fossil and pollen sites, quarries and other excavation

Sites that are important as mineral locations, fossil locations, pollen locations, or type igneous or metamorphic locations identified under sub-criterion A.1 are also important reference sites. Eight type stratigraphic locations were also identified from the Geological Survey of Western Australia (1990).

Teaching or research sites

A series of teaching sites, related to those used in university and school geological studies were identified, e.g., Canal Rocks and Cape Naturaliste area. Research sites such as Bunker Bay, Cape Naturaliste area and Yilgarn Craton near Lake Muir are important areas for the research into the geological history of the Region.

Sub-criterion 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

This sub-criterion recognises the significance of identifying and conserving 'representative examples' of the range of geological, geomorphic and pedological features of the Australian environment.

Identification of such places involved assessment of the presence in the landscape of:

- areas that illustrate the major geological features of each geological unit found within the study (where exposed);
- areas that illustrate the major landform features found within the study area, and
- reference soil localities which describe soil types found within the study area.

Scope for interpreting many geological features is often best where they are exposed at the earth's surface either naturally, or by human disturbance in quarry sites etc. There may be a series of exposures or an array of sites that reflect a common geological history, but the importance of each site in illustrating clearly this geological history may be impeded by the surface conditions at each site.

In assessing sites that are characteristic of geological and geomorphological classes, it is necessary to rely on those sites that best illustrate these features identified under other sub-criterion. Many of the sites identified under sub-criterion A.1 and sub-criterion A.2 were thus also assessed under this sub-criterion.

A total of 59 sites were identified with this value, plus eight stratigraphic type sections and 37 soils reference sites.

3.4.2 Natural history sites

Sub-criterion 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

This sub-criterion recognises the importance of type localities and teaching and research sites which have generally been used over a considerable period and are expected to play an important future role in education and the development of a better understanding of Australian natural history.

Type localities

Western Australia was the source for many early descriptions of Australian plants. Unfortunately, many localities, especially those for type specimens collected last century, cannot be fixed more precisely than 'Western Australia'.

Also several species still require lectotypification; i.e., a type specimen must be designated from among authentic specimens studied by the author describing that species.

This assessment attempted to develop a list of known Western Australian type localities for rare and threatened vascular plants, as it was thought initially possible to collate this within the CRA time frame. Candidate taxa included those listed as rare or threatened in the South-West Forest Region on the Western Australian Declared Rare Flora database. Taxa considered were limited to the vascular flora because of current taxonomic problems and collection deficiencies for non-vascular flora (bryophytes, heptophytes, lichens and fungi). However, the taxonomy of many rare and threatened plants is in a state of constant flux. Many groups are currently under review, both in terms of their taxonomy and their distribution, and the potential identification of type localities is therefore limited.

It was determined that a comprehensive, systematic identification of type localities was beyond the scope of this assessment. Type localities previously identified opportunistically through the previous joint AHC/CALM regional assessment of national estate values in the Southern Forest Region will be considered in the delineation of areas in the Region to be considered for listing in the Register of the National Estate

Research, teaching and benchmark sites

Academics and universities with expertise in the natural sciences were contacted to provide details of major sites well recognised as candidate areas under this sub-criterion. Two areas were delineated as a result of this process. Both of these related to geoheritage values and were considered under the assessment of geoheritage values.

4 National Estate Outcomes

4.1 NATIONAL ESTATE OUTCOMES: CULTURAL VALUES

The national estate assessment of the cultural values of the forests of the South-West Forest Region was designed to achieve the best practicable understanding of the range and distribution of forest places of cultural significance within the timeframe of the comprehensive regional assessment (CAR). The assessment was based on a study of social, aesthetic, Aboriginal and historic values.

The indicative places of national estate, social and aesthetic value, identified by the communities of the South-West, help to fill one of the major gaps in the understanding of national estate forest values. The following are among the main outcomes of the assessment of social and aesthetic values:

- identification of over 160 indicative national estate forest places of particular importance to the communities of the South-West;
- identification of a wide range of places, including single trees, river valleys and whole areas of forest, that provide the community with a sense of identity and attachment to forests, and
- a greater understanding of which places are valued by the community and why. This will be used to inform the development of conservation strategies for places of social significance to ensure they are considered in forest management and underlines the importance of on-going consultation in forest and cultural heritage management.

The thematic history and data audit conducted for the CRA has clarified the extent and quality of the historic resource in the South-West Forest Region and provided an indication of its potential for future research. This work demonstrated that systematic surveys for the identification of cultural heritage places would be beyond the capacity of the CRA. The protection of cultural heritage values in forests will primarily be addressed through the development of protection mechanisms (see Section 4.5).

4.2 FUTURE RESEARCH: CULTURAL VALUES

The principal factors in identifying cultural places of potential national estate significance in the South-West Forest Region were the standard of existing documentation for individual places and the extent to which new data could be gathered within the time frame of the CRA. As a result, the national estate projects for the CRA have identified and documented only a portion of the potential national estate forest places of cultural value.

Both the community heritage and Aboriginal consultative workshops were invaluable sources of information about places of social, Aboriginal and aesthetic value. Many places of social value to both Aboriginal and non-Aboriginal communities were unable to be fully assessed due to the limited availability of information. Additionally, there will be many places of cultural heritage value to various community groups that were not represented at the workshops. These places may be identified in the future through community-based consultation processes.

The broad scope for historic place investigation and assessment within the South-West Forest Region both thematically and geographically meant that any research conducted within the parameters of the CRA could only begin to fill the gaps identified in the record. Historic values were identified as part of the assessment process for some places of social value. However, the identification of these values in this way did not allow for their assessment within the context of the Region, as is the aim of CRA. The detailed research needed to comprehensively assess places in terms of national estate criteria A.3, A.4, B.2, D.2, F.1 and H.1 would require systematic survey and assessment resources far beyond the scope of the RFA process. Further research focussing on these values would enhance the understanding of some of the places already documented, as well as help to identify other forest places of national estate significance.

4.3 NATIONAL ESTATE OUTCOMES: NATURAL VALUES

The assessment of national estate values for the CRA of the South-West Forest Region has resulted in the identification of indicative areas of national estate significance for a wide range of natural values. These include extensive values such as natural landscapes and old-growth forest, localised values such as locations supporting populations of rare and endangered species, and centres of endemism, disjuncture or species or community richness. Although the larger areas of indicative national estate significance occur within the less disturbed forests in the south of the Region, several areas of substantial size with aggregations of national estate natural values have also been identified in the northern forests.

The principal factors in identifying areas of potential national estate significance for natural values in the South-West Forest Region were the standard and availability of existing data and the extent to which new data could be gathered within the time frame of the CRA. Collation of existing data, together with additional work commissioned as part of the CRA, particularly the mapping of vegetation and the development of new aggregated databases such as the flora and fauna databases, provided a sound basis for improving the understanding of the nature and distribution of national estate natural values in the Region.

Although the limitations of data have meant that not all values were able to be examined and some not as exhaustively as might be wished, the results of the assessment represent a considerable enhancement of our understanding of national estate natural values in the South-West Forest Region.

4.4 FUTURE RESEARCH: NATURAL VALUES

The assessment of natural values was as rigorous as information and time constraints permitted. Inevitably in a study of this scope, there are some values that have been incompletely assessed and some for which assessment was not possible, due to the limitations of the available data. One of the outcomes of the data review and development of the integrated fauna database for the CRA was a recognition that knowledge of fauna values would be enhanced by comprehensive and systematic fauna survey across the South-West Forest Region.

It is also anticipated that flora and fauna modelling, still under development, will contribute to a better understanding of the distribution and habitat requirements of flora and fauna of the Region, and may be of particular use in the ongoing identification of areas of key habitat for species of conservation significance.

4.5 PROTECTION OF NATIONAL ESTATE VALUES

An objective of the Regional Forest Agreement (RFA) is to provide for the conservation of environment and heritage values through the development of a comprehensive, adequate and representative reserve system and ecologically sustainable forest management. Fundamental to the environment and heritage objectives for the RFA is ensuring that national estate values are adequately protected.

While some national estate values, particularly extensive values such as old-growth forests and natural landscapes, may be best protected by formal reservations. The protection of other values, particularly site values such as historic or archaeological features, may be best achieved through other mechanisms such as management prescription.

A component of the CRA has been the assessment by an independent expert advisory group of the systems and processes for ecologically sustainable forest management. Included in this assessment was an examination of the mechanisms for the conservation of heritage values. The recommendations of the expert advisory group are contained in the report *Assessment of Ecologically Sustainable Forest Management in the South-West Forest Region of Western Australia* (Ferguson *et al.* 1997).

In developing the RFA for Western Australia, governments will consider the level of representation of national estate values in reserves, the recommendations of the expert advisory group on ecologically sustainable forest management, and the results of an assessment of mechanisms for the protection of national estate values.

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Glossary

aeolian landforms
Landforms formed by the transportation and deposition of sediments by wind.

ARC/INFO
Software used to display and analyse spatially represented data.

assemblages
Collections of populations of different species that live in the same area.

bauxite
Residual deposits formed under special climatic conditions consisting essentially of hydrated aluminium oxides.

biodiversity
See biological diversity.

biological diversity
The variety of all life forms: the different plants, animals and micro-organisms, the genes they contain, and the ecosystems they form. Biological diversity is usually considered at three levels: genetic diversity, species diversity, and ecosystem diversity. It is sometimes considered at the level of landscape diversity.

biophysical
A combination of physical features, such as climate, soils, geology and landforms, and biological features, such as flora and fauna.

bioregion
A region defined by a combination of biological, social and geographic criteria rather than geopolitical criteria; generally, a system of related, interconnected ecosystems.

bryophytes
Liverworts, mosses and hornworts: green, non-vascular land plants without seeds, numbering at least 18 000 species. They are among the simplest of the terrestrial plants but occupy a variety of habitats and show considerable diversity.

Cenozoic
The most recent era in geological-time, commencing 66 million years BP The Cenozoic includes the Tertiary and the Quaternary periods.

clear-felling
A logging system that results in the felling of all standing trees.

comprehensive regional assessment
A joint Commonwealth–State assessment of all forest values - environmental, heritage, economic and social - leading to the establishment of a comprehensive, adequate and representative reserve system, agreements on forest management, and the signing of a regional forest agreement.

comprehensive, adequate and representative reserve system
A reserve system displaying the features of comprehensiveness, adequacy and representativeness.
Comprehensiveness - the degree to which the full range of ecological communities and their biological diversity is incorporated in the reserve system.
Adequacy - the reserve system's ability to maintain the ecological viability and integrity of populations, species and communities.
Representativeness - the extent to which areas selected for inclusion in the reserve system are capable of reflecting the known biological diversity and ecological patterns and processes of the ecological community or ecosystem concerned.

conservation
The protection, maintenance, management, sustainable use, restoration and enhancement of the natural environment.

conservation advice and principles
The Australian Heritage Commission has a statutory obligation to provide advice on the protection of the National Estate. The advice is based on conservation principles that are aimed at protecting and maintaining national estate places and values. Advice is available for land management agencies and individuals who own places that have been identified as having national estate value.

context
The position of a feature or area in the landscape relative to the rest of the landscape or topographic features, other vegetation or disturbance. For example, some values such as old-growth forest need to be considered in context; i.e., in terms of their relationship to disturbance, other vegetation and the landscape in general.

criteria
Used by the Australian Heritage Commission to determine whether places meet the requirements for listing ion the Register of the National Estate. The criteria are stipulated in the Australian Heritage Commission Act 1975.

disjunct
Populations physically separated from one another; i.e., there is no or minimal gene flow between the populations. They are formed over time as a result of the appearance of a barrier in a formerly continuous distribution. Disjunct populations often have features that are distinctive in an evolutionary sense from those of the 'parent' population and in time may become separate species.

disturbance
Encompasses a range of factors that affect the condition of natural areas. Disturbance may be natural or human induced. Natural disturbance includes wildfires and rainstorms and is part of natural ecological processes. Human-induced, or 'unnatural', disturbance includes timber harvesting, agricultural clearing, mining and grazing. The factors that are important when considering disturbance are the origin, duration and intensity of the disturbance and its impact on the environment.

disturbance data
Records of disturbances such as clearing, grazing, fire or timber harvesting that may affect themes, species or assemblages being assessed.

diversity
A measure of the physical or biological complexity of a system. It refers to a range of features, from artefact scatters to species presence.

duricrust
A hard soil horizon formed in the weathering zone at, or near, the land surface as a result of accumulation of particular chemical components. These are often exposed by erosion of less hardened overlying material.

ecological processes
Biotic and abiotic processes which are characterised by the interdependence of living organisms in their physical environment.

ecosystem
A set of normally co-occurring and interacting species associated with a particular setting in the physical environment. The aggregate of plants, animals and other organisms, and the non-living parts of the environment with which these organisms interact. A dynamic complex of plant, animal, fungal, and micro-organism communities and the associated non-living environment interacting as an ecological unit.

endemic species
Species confined to a specific Region or locality.

epoch
A subdivision of a period in geological time. For example, the Holocene and Pleistocene epochs are subdivisions of the Quaternary period.

Era
A unit of geological time which is subdivided by periods. For example, the Cenozoic era is subdivided into the Tertiary and Quaternary periods.

forest
In the context of the Western Australia–Commonwealth RFA, an area, incorporating all living and non-living components, i.e., dominated by trees having usually a single stem and a mature or potential mature stand height

exceeding 8 metres and with existing or potential projective cover of overstorey strata about equal to or greater than 5 per cent.

forest associations
A method of classifying forest types based on associations of the dominant tree species in the canopy.

forest community
A vegetation classification that subdivides a forest type by either structure or understorey floristic composition.

forest type
A vegetation classification defined by the dominant overstorey species.

genetic diversity
The variety of genetic information contained in all individual plants, animals and micro-organisms. It occurs within and between populations of species as well as between species.

geoconservation
The identification and protective management of geological, geomorphological and soil features, assemblages, systems and processes (geodiversity) for their intrinsic, ecological or heritage values.

geodiversity
The natural range (diversity) of geological (bedrock), geomorphological (landform) and soil features, assemblages, systems and processes. Geodiversity includes evidence for the history of the earth (evidence of past life, ecosystems and environments) and a range of processes (biological, hydrological and atmospheric) currently acting on rocks, landforms and soils.

geographic information system (GIS)
A system displaying spatially represented data; for example ARC/INFO.

geoheritage
Those components of geodiversity that are important to humans for purposes other than destructive exploitation; things we would wish to retain for present and future generations.

geological characteristics
Features and structures associated with the formation of the earth's crust as well as major landform units such as mountains.

geology
The scientific study of the earth as a whole, including its origin, structure, composition, history, and past and present processes. Geological features contribute to geodiversity.

geomorphology
The scientific study of landforms including past and present processes responsible for landform development. Geomorphological features contribute to geodiversity.

Gondwanan
Refers to those characteristics or features relating to an ancient phase of the earth's development, when the land masses of the Southern Hemisphere were joined together. This agglomeration of the southern continents is termed Gondwana.

habitat
The place or environment in which an organism naturally occurs.

heritage
Encompasses all those things we have inherited from previous generations. Heritage includes places (including national estate places), things (moveable objects) and folklore (customs, songs and sayings).

Holocene
The most recent epoch of geological time, commencing 10 000 years BP.

hydrological
Pertaining to the science of water, its properties, movement, and distribution over the earth's surface.

igneous
Igneous rock is rock formed by the solidification of magmas, from a molten state either extrusive on the earth's surface (associated with volcanic activity), or intrusive into the rocks forming the earth's crust.

illuviation
The process of depositing soil material leached from one horizon in the soil to another, usually from an upper to a lower horizon in the soil.

Interim Biogeographic Regionalisation of Australia (IBRA)
A bioregional framework delineating natural regions in each State and Territory based on biophysical, environmental and vegetation considerations - for example, climate, soils, landform, vegetation, flora and fauna, and land use - that allow cross-border regionalisation.

interim list
The Australian Heritage Commission enters places on the interim list by announcing, in the press and in the Commonwealth Government Gazette, its intention to register those places. Once a place is on the interim list, and before it can be entered on the Register of the National Estate, there is a minimum statutory period of three months during which any person can object to the proposal in writing. If objections are received they must be given due consideration by the Commission, but uppermost consideration must be given to the national estate significance of the place.

isopleth
A line drawn on a map connecting points having the same numerical value of a given variable, analogous to a contour line on a topographic map.

kaolinite
A clay mineral resulting from the weathering of feldspars (a common mineral of granite).

karst
Environments with distinctive landforms and drainage characteristics resulting from the relatively high solubility of some rock types, notably limestones and dolomites, in natural waters.

laterite
An iron oxide rich duricrust or hardpan formed under special climatic conditions.

lithology
The general characteristics of rock formations, such as composition and texture, and the sequence in which the formations were laid down.

maintenance
The continuous protective care of the fabric, contents or setting of a place, as distinct from repair. Repair involves restoration or reconstruction.

Mesozoic
Belonging or relating to the geological time between the Paleozoic and Cenozoic; from 245 million years BP to 66 million years BP. This era includes the Triassic, Jurassic and Cretaceous periods and is commonly known as the age of dinosaurs, conifers, cycads and ferns.

metadata
Information about the content, quality, condition and other characteristics of datasets.

metamorphic
Describes rocks in the earth's crust which have undergone change since their original deposition; through the influence of heat and pressure, especially applied to the recrystallisation of sedimentary rocks.

microclimate
The suite of climatic variables (temperature, humidity etc) associated with a small part of an environment such as a river bank, the base of a tree or under a small stand of trees.

National Estate
Is a collection of places, components of the natural or cultural environment of Australia, that have aesthetic, historic, scientific or social significance or other special value for future generations and for the present community.

National estate values
The aesthetic, historic, scientific or social values attributed to places by the Australian Heritage Commission.

old-growth forest
The National Forest Policy Statement defined old-growth forest as 'forest that is ecologically mature and has been subjected to negligible unnatural disturbance such as logging, roading and clearing'. For the purposes of this assessment, the proposed operational interpretation from JANIS (1996) was used; i.e., old-growth forest is ecologically mature forest where the effects of disturbances are now negligible'.

palaeo-
A prefix denoting association with prehistory.

palaeoclimatic
The climatic conditions (moist, dry, glacial, etc.) considered to be associated with a defined area at any point in prehistory.

Palaeozoic
The era of geological time from 570 million years BP to 245 million years BP. This era lies between the Precambrian and Mesozoic, and is the oldest era during which life is known to have existed. It includes the Cambrian, Ordovician, Silurian, Devonian, Carboniferous and Permian periods.

pedology
The science involving the characteristics, development, distribution and classification of soils.

period
A unit of geological time; a subdivisions of an era. For example, the Cretaceous, Jurassic and Triassic periods subdivide the Mesozoic era. The Tertiary and Quaternary periods, are further subdivided into epochs.

petrology
The science of the mineralogical and chemical composition of rocks, and their classification.

phylogenetic
Referring to the evolutionary line of descent of an individual taxon or groups of taxa.

physiography
The science of the earth's exterior physical features, climate, life, etc., and of the physical movements or changes on the earth's surface.

Pleistocene
The epoch of geological time from 1.6 million years BP to 10 000 years BP. Ice ages and extensive glaciation predominated throughout the Pleistocene.

pluvial
A time geological history of heavier precipitation than normal.

Precambrian
That part of geological time prior to 570 million years BP.

primitiveness
used taxonomically to describe species that have features associated with the evolutionary past of a group. For example, the salamander fish has features rarely found in fish of the southern hemisphere and is regarded as therefore being primitive.

Quaternary
The present geological period, which began 1.6 million years BP. and includes the Pleistocene and Holocene epochs.

RAMSAR
The Convention on Wetlands of International Importance, commonly referred to as the RAMSAR Convention.

rare species
Species with small world populations that are not at present endangered or vulnerable but are at risk.

recovery plan
A comprehensive plan that details, schedules and costs all actions deemed necessary to support the recovery of a threatened species or ecological community.

refugia, refuges
Biological communities or geographic entities that, because of their moderating structural characteristics or physical isolation, or both, provide a sanctuary to which species or groups of species have retreated or have been confined in response to threatening processes, including climatic change.

regional forest agreement
An agreement, between the Commonwealth and a State or Territory government, for the long-term management and use of forests in a particular Region. The purpose is to reduce uncertainty, duplication and fragmentation in government decision making by establishing a durable agreement on the management and use of forests.

Register of the National Estate
The national inventory of places of natural, historic and Aboriginal heritage significance that have been rigorously assessed by the Australian Heritage Commission and deemed worth conserving for present and future generations. The Register serves to notify all Australians, and particularly planners and decision makers, of places of national estate significance.

relictual
Used to describe species associated with former ecosystems that have disappeared or have retracted to small pockets. For example, tingle forest contains a number of relictual species that appear to relictual species from Gondwanan rainforests.

richness
A measure of the abundance of individual elements within a particular place. For instance, the species richness of an ecological vegetation class is the number of species that occur within that class. The concept is closely related to diversity.

riparian
Associated with river banks.

scoping agreement
An agreement, between the Commonwealth and a State or Territory government, that establishes the broad parameters for regional forest agreements.

sedimentary
Pertaining to rocks deposited as sediments in water and arranged in strata, as opposed to igneous rocks.

selective logging
The logging of a selected portion of a stand of trees, usually according to pre-determined criteria relating to the intensity of the logging and the nature of the stand remaining after logging.

speciation
Where a species evolves into a series of new species, normally in response to selection pressures such as changing environment.

species
A group of organisms capable of interbreeding freely with each other.

species diversity
To the variety of living species.

speleology
The study of caves and their associated features.

stratigraphic type section
An sample of layered sedimentary rock which can be used to define a formation or establish chronology in geological time.

succession
The change in vegetation composition over time, one community 'succeeding' over the other. For example, wet forests in areas such as gullies that are protected from fire and other disturbance may eventually become

rainforest. This occurs over a long period, in which rainforest species first colonise the understorey and, as the emergent eucalypts die out, rainforest species become the dominant species in the canopy.

taxon (pl. taxa)
The named classification unit to which individuals or species are assigned.

tectonic
Relating to processes of physical movement of macro-scale geological structures of the earth's crust.

terrane
A group of rocks having a common age or origin.

Tertiary
The period of geological time from 66 million years BP to 1.6 million years BP, being preceded by the Mesozoic era and followed by the Quaternary period.

Tertiary
A period (or era) of geological history from about 66 million years before present to 1.6 million years BP.

threshold
The level at which a value is considered acceptable for entry ion the Register of the National Estate. Thresholds are developed through scientific assessment or expertise and an analysis of data within a regional context.

type locations
The location or collection point of a specimen from which a plant, animal or rock type was first described.

type specimen (biological/geological)
The original specimen from which a new species (biological or geological) is scientifically described.

value
Refers to the particulars of a place that have worth, merit or significance.

vascular plant
A plant that possesses a vascular system, the conducting tissue that enables the transport of water, minerals and synthesised food materials throughout the plant and provides mechanical support.

vulnerable species or ecosystems
Species or ecosystems that are approaching a reduction in range of 70 per cent or are subject to threatening processes that may cause their loss at the bioregional level.

wet sclerophyll forest
Open eucalypt forest with tall trees and a relatively complex understorey of ferns, cycads and shrubs. Replaces dry sclerophyll forest in wetter areas with more fertile soils. Generally in areas with annual rainfall greater than 1 000 millimetres.

wilderness
Land that, together with its plant and animal communities, is in a state that has not been substantially modified by, and is remote from, the influences of European settlement or is capable of being restored to such a state, is of sufficient size to make its maintenance in such a state feasible, and is capable of providing opportunities for solitude and self-reliant recreation.

wilderness quality
A measure of differing levels of human impact on the natural environment, as part of a continuum of remote and natural conditions varying from pristine to urban. Wilderness quality is measured in terms of four variables: remoteness from settlement, remoteness from access, apparent naturalness, and biophysical naturalness.

woodland
A vegetation type dominated by woody vegetation having a mature or potential mature stand height exceeding 5 metres, with an overstorey canopy cover of less than 20 per cent.

Abbreviations and Acronyms

AGPS	Australian Government Publishing Service
AHC	Australian Heritage Commission
ANCA	Australian Nature Conservation Agency
ANZLIC	Australia New Zealand Land Information Council
AUSLIG	Australian Surveying and Land Information Group
BP	before present
CALM	Department of Conservation and Land Management
CAR	comprehensive, adequate and representative
CRA	comprehensive regional assessment
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DRF	Declared Rare Fauna
ESFM	Ecologically Sustainable Forest Management
GIS	geographic information system
GPS	global positioning system
IBRA	Interim Biogeographic Regionalisation of Australia
JANIS	Joint Australian and New Zealand Environment and Conservation Council and Ministerial Council of Forestry, Fisheries and Aquaculture National Forest Policy Statement Implementation Subcommittee
NWI	National Wilderness Inventory
RAMSAR	Convention on Wetlands of International Importance
RAOU	Royal Australasian Ornithologists Union
RFA	Regional Forest Agreement

Appendix A Forest places on the Register of the National Estate

Table A.1 Forest places on the Register of the National Estate: registered places and interim-listed places

Place Name	RNEDB No.	AHC File No.	Primary Class	Status
Abbey Farm Homestead, Yallingup	009468	5/02/046/0002	Historic	Registered
Alexandra Bridge - Old, Karridale	009402	5/02/040/0005	Historic	Registered
All Saints Anglican Church, Donnybrook	009518	5/02/050/0006	Historic	Registered
Anchor Inn, Donnybrook	009513	5/02/050/0001	Historic	Registered
Araluen-Canning Dam Reserve, Pinjarra	010671	5/13/001/0003	Natural	Registered
Avon Downs Protected Area, Wandering	009938	5/06/116/0001	Indigenous	Registered
Avon Valley National Park, Toodyay	009998	5/07/114/0015	Natural	Registered
Banksia goodii Site A, Denmark	019334	5/01/071/0028	Natural	Interim List
Banksia goodii Site C, Denmark	019337	5/01/971/0030	Natural	Interim List
Banksia goodii Site E, Narrikup	019338	5/01/081/0030	Natural	Interim List
Banksia goodii Site F, Narrikup	019332	5/01/081/0029	Natural	Interim List
Basildene Farmhouse, Margaret River	009405	5/02/040/0008	Historic	Registered
Beechina, Chidlow	010680	5/13/017/0004	Natural	Registered
Beedelup National Park & Adjacent Area, Pemberton	009561	5/02/054/0004	Natural	Interim List
Beelaring Spring Nature Reserve, Wundowie	009995	5/07/114/0013	Natural	Registered
Bindoon and Chittering Lakes Reserve, Bindoon	010189	5/10/132/0001	Natural	Registered
Blackbutt Area, Manjimup	018638	5/02/056/0011	Natural	Interim List
Blackwood Inn including Barn, Mullalyup	009516	5/02/050/0004	Historic	Registered
Blue Gum Creek Nature Reserve, Narrikup	018605	5/01/071/0027	Natural	Interim List
Bolbelup Area, Rocky Gully	018592	5/01/073/0005	Natural	Interim List
Boorara Area, Northcliffe	016184	5/02/054/0029	Natural	Interim List
Bow River Area, Walpole	018591	5/01/074/0016	Natural	Interim List
Boyup Brook Tourist Centre	018189	5/02/043/0005	Historic	Registered
Brooklands, Balingup	009517	5/02/050/0005	Historic	Registered
Brookton Highway Strip, Kelmscott	009942	5/07/090/0001	Natural	Interim List
Bushmead Rifle Range Area, Helena Valley	017825	5/13/026/0072	Natural	Registered
Caladenia christineae Site A, Yornup	019308	5/02/044/0007	Natural	Interim List
Caladenia christineae Site E, Nyamup	019309	5/02/054/0061	Natural	Interim List
Caladenia Herringtoniae Site A/C, Winfieldii Site, Nyamup	019325	5/02/054/0064	Natural	Interim List
Caladenia Herringtoniae Site B, Manjimup	019323	5/02/044/0009	Natural	Interim List
Caladenia Herringtoniae Site C, Manjimup	019322	5/02/044/0010	Natural	Interim List
Caladenia Herringtoniae Site D, Manjimup	019324	5/02/056/0012	Natural	Interim List
Caladenia Herringtoniae Site E, Manjimup	019321	5/02/054/0067	Natural	Interim List
Caladenia Herringtoniae Site F, Rocky Gully	019329	5/02/054/0068	Natural	Interim List

Table A.1 (Cont'd) Forest places on the Register of the National Estate: registered places and interim-listed places

Place Name	RNEDB No.	AHC File No.	Primary Class	Status
Caladenia Herringtoniae Site G, Rocky Gully	019333	5/02/054/0069	Natural	Interim List
Caladenia Herringtoniae Site H, Rocky Gully	019343	5/02/054/0070	Natural	Interim List
Caladenia Herringtoniae Site I, Rocky Gully	019342	5/02/054/0071	Natural	Interim List
Caladenia plicata Site A, Mount Barker	019344	5/01/081/0031	Natural	Interim List
Caladenia plicata Site B, Narrikup	019346	5/01/081/0032	Natural	Interim List
Caladenia plicata Site C, Nyamup	019347	5/02/054/0074	Natural	Interim List
Caladenia plicata Site D, Nyamup	019348	5/02/054/0075	Natural	Interim List
Caladenia plicata Site E, Northcliffe	019345	5/02/054/0076	Natural	Interim List
Cape Leeuwin Lighthouse	009399	5/02/040/0002	Historic	Registered
Cape Naturaliste Lighthouse and Reserve	016693	5/02/046/0040	Historic	Registered
Challar Area, Nyamup	018598	5/02/054/0052	Natural	Interim List
Chitelup Area, Rocky Gully	018641	5/01/073/0006	Natural	Interim List
Chitelup Area, Rocky Gully	018641	5/01/073/0006	Natural	Interim List
Chorkerup Area, Narrikup	018644	5/01/081/0021	Natural	Interim List
Christineae Site B, Mount Barker	019310	5/01/081/0023	Natural	Interim List
Christineae Site C, Mount Barker	019320	5/01/081/0024	Natural	Interim List
Christineae Site D, Mount Barker	019319	5/01/081/0025	Natural	Interim List
Clackline Nature Reserve, Clackline	009969	5/07/109/0001	Natural	Registered
Crendon Homestead, Donnybrook	009521	5/02/050/0009	Historic	Registered
Crowea Area, Northcliffe	018639	5/02/054/0055	Natural	Interim List
D'Entrecasteaux Area, Northcliffe	018635	5/02/054/0003	Natural	Interim List
D'Entrecasteaux Lighthouse, Northcliffe	019861	5/02/054/0078	Historic	Registered
Dale MPA, Kelmscott	009945	5/07/090/0004	Natural	Interim List
Deep Area, Walpole	014860	5/02/054/0012	Natural	Interim List
Denbarker Area, Denmark	016165	5/01/074/0008	Natural	Interim List
Denmark Area, Denmark	018651	5/01/081/0020	Natural	Interim List
Devils Lair Archaeological Site	009406	5/02/040/0009	Indigenous	Registered
Dickson Area, Nannup	016174	5/02/056/0004	Natural	Interim List
Dingup Area, Manjimup	018606	5/02/054/0053	Natural	Interim List
Diuris drummondii Site A, Yornup	019307	5/02/044/0008	Natural	Interim List
Diuris drummondii Site B, Nyamup	019326	5/02/054/0062	Natural	Interim List
Diuris drummondii Site C, Nyamup	019327	5/02/054/0063	Natural	Interim List
Diuris drummondii Site D, Rocky Gully	019328	5/01/081/0026	Natural	Interim List
Donnybrook Sunklands Areas, Nannup	009408	5/02/040/0011	Natural	Interim List
East Brook Area, Pemberton	016168	5/02/054/0022	Natural	Interim List
Ellen Brook Nature Reserve, Upper Swan	010731	5/13/026/0035	Natural	Registered
Ellensbrook Farmhouse, Margaret River	009404	5/02/040/0007	Historic	Registered
Fernhill Homestead, Manjimup	009555	5/02/054/0001	Historic	Registered
Fontys Pool and Gardens, Manjimup	009565	5/02/054/0007	Historic	Registered
Foul Bay Lighthouse	019844	5/02/040/0027	Historic	Registered
Frankland Area, Walpole	014865	5/02/054/0057	Natural	Interim List
Gastrolobium brownii Site, Parryville	019349	5/01/074/0018	Natural	Interim List
Giblett - Hawke Area, Pemberton	018664	5/02/054/0004	Natural	Interim List
Golden Valley Homestead, Outbuilding and Garden, Balingup	009523	5/02/050/0011	Historic	Registered
Gooseberry Hill National Park, Kalamunda	010674	5/13/012/0002	Natural	Registered
Greenmount National Park, Greenmount	010679	5/13/017/0003	Natural	Registered
Hay Location 601, Nornalup	016079	5/01/074/0005	Natural	Registered
Jamieson Hill Area, Denmark	016810	5/01/074/0010	Natural	Interim List
Jane Area, Northcliffe	014996	5/02/054/0013	Natural	Interim List
John Forrest National Park, Swan View	010681	5/13/017/0005	Natural	Registered

Table A.1 (Cont'd) Forest places on the Register of the National Estate: registered places and interim-listed places

Place Name	RNEDB No.	AHC File No.	Primary Class	Status
Kalamunda National Park, Piesse Brook	010676	5/13/012/0004	Natural	Registered
Karnet Nature Reserve, Serpentine	010692	5/13/023/0004	Natural	Registered
Karri MPAs, Walpole	009563	5/02/054/0005	Natural	Registered
Kennedia glabata site, Northcliffe	019341	5/02/054/0072	Natural	Interim List
Kwornicup Nature Reserve, Mount Barker	018602	5/01/081/0015	Natural	Interim List
Lake Barnes Area, Narrikup	018603	5/01/081/0016	Natural	Interim List
Lake Jasper Aboriginal Sites Complex	018636	5/02/056/0013	Indigenous	Registered
Lake Muir Area (Revised), Rocky Gully	018655	5/02/054/0002	Natural	Interim List
Lake Muir Area, Manjimup	009556	5/02/054/0002	Natural	Registered
Lake Wannamal, Gingin	010210	5/10/137/0007	Natural	Registered
Lambertia orbifolia Site A, Narrikup	019330	5/01/081/0027	Natural	Interim List
Lambertia orbifolia Site B, Narrikup	019331	5/01/081/0028	Natural	Interim List
Laxmannia jamesii Site, Denmark	019340	5/01/074/0017	Natural	Interim List
Leeuwin-Naturaliste Ridge Area, Margaret River	009410	5/02/040/0013	Natural	Registered
Lesmurdie Falls National Park, Kalamunda	010675	5/13/012/0003	Natural	Registered
Lesmurdie Falls National Park, Kalamunda	010675	5/13/012/0003	Natural	Registered
Light Keepers Cottages Stone (3), Augusta	009401	5/02/040/0004	Historic	Registered
Lomandra Ordii Site, Northcliffe	019350	5/02/054/0077	Natural	Interim List
Millbrook Mill and Limekiln, Yallingup	009503	5/02/046/0037	Historic	Registered
Moondyne Nature Reserve, Toodyay	010000	5/07/114/0017	Natural	Registered
Morangup Nature Reserve, Wundowie	017965	5/07/114/0023	Natural	Registered
Mount Shadforth Area, Denmark	009364	5/01/074/0001	Natural	Interim List
Muirillup Area, Northcliffe	018672	5/02/054/0059	Natural	Interim List
Old Karridale Townsite Chimney, Karridale	009403	5/02/040/0006	Historic	Registered
Ongerup Lagoon Area, Mount Barker	018601	5/01/081/0014	Natural	Interim List
Paynedale, Donnybrook	009520	5/02/050/0008	Historic	Registered
Pemberton National Parks, Pemberton	009560	5/02/054/0004	Natural	Registered
Police Station and Gaol (Former), Mount Barker	009390	5/01/081/0008	Historic	Registered
Powlalup Nature Reserve, Balingup	009515	5/02/050/0003	Natural	Registered
Proposed South Coast National Park, Walpole	009557	5/02/054/0003	Natural	Registered
Randell Road Area, Frankland	018588	5/01/081/0012	Natural	Interim List
Reserve 22797, Harvey	009539	5/02/052/0007	Natural	Registered
Reserve No 22096, Culham	009997	5/07/114/0014	Natural	Registered
Roe Area, Walpole	016187	5/02/054/0054	Natural	Interim List
Russell MPA, Kelmscott	009944	5/07/090/0003	Natural	Interim List
Scott National Park, Augusta	009409	5/02/040/0012	Natural	Registered
Serpentine National Park, Serpentine	010693	5/13/023/0005	Natural	Registered
Shannon Area, Northcliffe	009567	5/02/054/0009	Natural	Interim List
Sleeman Creek Nature Reserve, Narrikup	018583	5/01/071/0027	Natural	Interim List
Smith Brook Area, Manjimup	018595	5/02/054/0051	Natural	Interim List
Soldiers Memorial Hall, Donnybrook	009519	5/02/050/0007	Historic	Registered
Southampton Homestead, Balingup	009514	5/02/050/0002	Historic	Registered
St Leonards Anglican Church, Denmark	017663	5/01/074/0012	Historic	Registered
St Ronans Well Reserve, York	010032	5/07/121/0026	Historic	Registered
St Werburghs Chapel, Mount Barker	009384	5/01/081/0002	Historic	Registered
Surface MPA, Collie	009508	5/02/048/0001	Natural	Interim List

Table A.1 (Cont'd) Forest places on the Register of the National Estate: registered places and interim-listed places

Place Name	RNEDB No.	AHC File No.	Primary Class	Status
Timber Mill Workshop Complex, Yarloop	009533	5/02/052/0001	Historic	Registered
Tone - Perup Area, Manjimup	018654	5/02/043/0001	Natural	Interim List
Tone - Perup River Area, Manjimup	009371	5/02/043/0001	Natural	Registered
Tone River Area, Frankland	018596	5/02/043/0006	Natural	Interim List
Tootanellup Nature Reserve, Rocky Gully	018586	5/01/081/0010	Natural	Interim List
Twin Swamp Reserve, Upper Swan	010729	5/13/026/0033	Natural	Registered
Upper Swan Bridge Archaeological Site	010752	5/13/026/0056	Indigenous	Registered
Wallcliffe Homestead, Margaret River	009398	5/02/040/0001	Historic	Registered
Walpole Nornalup Area, Walpole	014997	5/02/054/0011	Natural	Interim List
Walpole-Nornalup National Park and Adjacent Area, Walpole	009559	5/02/054/0011	Natural	Interim List
Walyunga Archaeological Site, Upper Swan	014829	5/13/026/0063	Indigenous	Registered
Walyunga National Park, Upper Swan	010728	5/13/026/0032	Natural	Registered
Wamballup Nature Reserve, Kendenup	018600	5/01/081/0013	Natural	Interim List
Warren National Park and Adjacent Area, Pemberton	009562	5/02/054/0004	Natural	Interim List
Warrup Area, Manjimup	018589	5/02/044/0006	Natural	Interim List
Whicher Range Area, Busselton	009400	5/02/040/0003	Natural	Registered
Willmott Area, Rocky Gully	018587	5/01/081/0011	Natural	Interim List
Windy Harbour Cliffs, Northcliffe	009558	5/02/054/0003	Natural	Registered

Appendix B National estate criteria

Without limiting the generality of subsection (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 the following.

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.

Appendix C Indicative national estate places of social value (non-Aboriginal)

Table C.1 Indicative national estate places of social value (non-Aboriginal)

Place name	Place name
Amphion fire exclusion area	Inglehope Forest Block
Armadale Settlers Common	Inkpen Reserve
Barlee Park Reserve	Jane Block
Barrabup Pool Precinct	Jarrahdale Precinct
Beedelup National Park	John Forrest National Park
Beyonderup Falls	Kitty's Gorge
Bibbulmun Track	Lake Jasper
Big Brook Forest	Lake Lechenaultia
Blackwood River Conservation Park	Lane Poole Reserve
Boranup Karri Forest	Langford Park
Boulder Rock and surrounding bushland	Leeuwin-Naturaliste National Park
Bourke and Bending Gullies	Long Gully Bridge
Bramley Forest Block	Mahogany Inn
Bridle Trail, old railway track	Marrinup Precinct
Broke Inlet	Mason and Bird Tramway
Buckingham	Molloy Island
Cambray	Mount Chudalup
Chittering Valley	Mount Frankland
Churchman's Brook Bushland	Mount Lindesay
D'Entrecasteaux National Park	Nanga Precinct
Dalgarup Forest	Noble Falls
Darling Range Regional Park	Nornalup Inlet
Darlington Reserves	Northcliffe Forest Park
Dombakup Conservation Park	Old Yelverton Townsite and Forest Block
Donnelly River Mill Precinct	Pemberton Swimming Pool
Dorothy Scott Bushland	Pemberton Townsite Precinct
Dwellingup Primary School and surrounding bush	Quinninup Forest Backdrop
Ellis Creek Precinct	RSL Hall, Dwellingup
Fish Creek Hut	Saunder's Sheoak Sawmill
Forest Grove State Forest	Serpentine National Park
Founders Forest	Shannon National Park
Frankland River	Sullivan Rock
Fred Jacoby Park	Thousand Acre Forest Northcliffe
Gervasse Block	Valley of the Giants
Giblett Block	Wallcliffe, Prevally and Kilcarnup
Glen Eagle Forest	Walpole Inlet
Glen Mervyn Dam	Walpole Nornalup National Park
Glenlynn Block Portion	Walyunga National Park
Gloucester National Park	Warren National Park
Goblin Swamp	Warren River
Grimwade Precinct	Wellington Dam
Harris River Dam	Wellington Mills Settlement
Hawke Block (north and south)	Willow Springs Precinct
Helena Valley	Windy Harbour
Hester Forest Block	Worsley Church
Holyoake Precinct	Yeagerup Lake and Dunes
Huzza, South Point and Gracetown	

Appendix D Indicative national estate places of social value (Aboriginal)

Table D.1 Indicative national estate places of social value (Aboriginal)

Place name
Avon River
Boronia gully burial and camping ground
Bowelling camping area
Burnside
Duranillin camping area
Ellensbrook
Harris River Road camps
Kudardup Caves
Quininup brook, site complex and lizard traps
Rainbow Cave (Ng'lgardup)
Scott River Engravings/Dunnet's Farm
Towerrinning Lake and Moodiarup
Walcliffe cave, cliffs and burials
'White City' camping area
Yeriminup Hill, camping area, ceremonial ground, burial ground

Table D.2 Aboriginal places identified, but not documented to the level required for listing

Place name
Allenson Reserve
Batalling lizard trap
Black Point
Blackwood River
Bolton Pools
Canal Rocks
Capercup
Chapman Hill
Cobbler Pool
Collie Burial
Collie Burials and Scarred Tree
Collie River and Harris River
Collie Spring
Cordering
Cosy Corner
Cowaramup Bay
Eight Mile Pool
Frankland River
Gibraltar Rock
Gracetown burial, midden and massacre site
Helena Hill State Forest
Hithergreen Farm
Jalbarragup
Kilcarnup
Lily Pool Camp

Table D.2 (Cont'd) Aboriginal places identified, but not documented to the level required for listing

Margaret River
Measle Bridge
Minninup Pool
Moses Rock
Nalyerin Lake burial
Nannup scarred trees
Naturaliste-Leeuwin Ridge
Pioneer Graves
Scarp Pool
Skippy Rock - Boranup Forest
Spring
Sues Bridge
Telfer pool
Tone River
Varis Road scarred tree
Wuridjong Pool
Yalingup Siding
Yerimup/Frankland hunting and camping area

Appendix E Desired outcomes from the RFA for the Noongar Aboriginal community

Noongar joint–management with CALM in the South-West Forest Region
Noongar people consider that their traditional knowledge of the natural environment has much to contribute to appropriate forest management; and that it is their right to do so under either Native Title legislation or the principles of natural justice.

Unrestricted access by Noongar people to all areas of the forest including national parks and nature reserves for a full range of spiritual, cultural and recreational purposes
Workshop participants emphasised their ties to areas of the forest, indeed to the forest as a whole, rather than simply to discrete 'sites'.

Unrestricted Noongar hunting rights in South-West Forest Region
Noongar people have retained their hunting and gathering traditions and wish to continue these practices and pass them on to their children.

Receipt of benefits from forest-based industries
Because of the traditional association with the land, many hold the view that industries based on the extraction of forest products or minerals from the area covered by the RFA should be required to allocate to the Noongar community an agreed percentage of the value of these resources. These payments could be used to support programs in such areas as education, health, housing and employment.

Noongar participation in developing and reviewing the RFA
Noongar people see it as essential that they be directly involved in drawing up the RFA and in reviewing its on-going operation. Appropriate mechanisms are needed for this purpose.

Employment of more Noongar people by CALM

Initiation of programs of cross–cultural training for all CALM personnel in order to increase their awareness of issues of Noongar identity and culture

Access to places of Aboriginal heritage value as a matter of cultural survival through the maintenance of traditional connections, rights and interests in land

Provision for promoting, funding and disseminating Noongar interpretations of places of Aboriginal heritage value

Incorporation in the RFA of a plan for the management of Noongar heritage places
Noongar communities want the RFA to provide for adequate consultation with them on all issues related to the management, protection, conservation and rehabilitation of Noongar heritage places.

Protection of Noongar heritage places from destruction or damage caused by clearing, logging, development, mining and any other activity in the South-West Forest Region.

Appendix F Noongar Position Paper

It is considered that principles relating to Indigenous peoples outlined in *The Montreal Process* [criterion 3.6 indicators - cultural, social and spiritual needs and values a) and b) and in the *Convention on Biological Diversity* (Articles 8 (j) and 10 (c)] should be adopted and implemented by land management agencies in the South-West Forest Region as soon as possible with the full participation of Noongar people.

Noongar communities in the South-West Forest Region wish to see the following outcomes incorporated into the RFA:

1) the development of a formal consultative process between land management agencies in the RFA Region and Noongar communities is essential in order to ensure the effective involvement of Noongar people in the CRA/RFA process;

2) a formal process be negotiated and established for Noongar people to be involved in land management and planning decisions in the RFA Region, both now and in the future, and where necessary governments to undertake any legislative reform required to implement this;

3) Noongar people be fully involved in the identification, assessment and development of protective mechanisms and guidelines for Noongar cultural and spiritual places, values and interests in the RFA Region;

4) government and industry provide funding and employment and training opportunities for Noongar people to be actively involved and employed in culturally appropriate land management and interpretive programs;

5) government and industry establish mechanisms for the sharing of economic gains with the Noongar communities of the South-West Forest Region;

6) governments support, facilitate and resource the Noongar community to inform and educate the wider community about Noongar values and interests in the South-West Forest Region;

7) governments recognise Noongar intellectual property rights in respect of Noongar traditional knowledge of forest flora, fauna and other resources;

8) governments ensure that implementation of the WA RFA will not adversely affect Native Title rights and interests;

9) governments facilitate the development of regional and local agreements between Noongar communities, government and industry, and

10) government and industry provide compensation to local Noongar communities for destruction of or damage to cultural heritage places.

*Note: *Noongar can be spelt in numerous ways. The spelling of Noongar in this form should also be seen to encompass the Nyoongar, Nyungar, Noongah, Nyoongah and Nyungah spellings.*

Appendix G Indicative national estate places of aesthetic value

Table G.1 Indicative national estate places of aesthetic value

Place name	Place name
Armadale settler's common	John Forrest Area
Avon River Valley	King Jarrah Tree (Manjimup)
Beedelup Area	Kitty's Gorge
Bibbulum Track	Lake Leschenaultia
Blackwood River Valley	Lane Poole Area
Boorara Tree and Lane Poole Falls Area	Leeuwin - Naturaliste Area
Boulder Rock and surrounding bushland	Marrinup Falls
Canning, Churchman Brook and Wungong Reservoirs	Moon's Crossing and River Road Bridge Area
Chittering Valley	Mount Frankland
D'Entrecasteaux Area	Mount Lindesay
Darling Range National Park	Mundaring Weir Road
Deep River Rapids Area	Noble Falls
Diamond Tree Tower	North Dandalup Dam
Dickson Area	Northcliffe Forest Park
Dombakup Conservation Park	Oakley Dam and Falls
Donnelly River Valley	Pemberton Forest Area
Ellis Brook Valley	Serpentine Reservoir and Falls
Frankland River	Shanghai Gully
Glen Eagle Forest	Shannon Area
Glen Mervyn Dam	Sullivan Rock
Goblin Swamp & Carey Brook picnic area	Walpole - Nornalup Area
Grimwade Settlement	Warren Area
Harewood Forest Area	Wellington Dam
Harris River Dam and Valley	Wellington Mill and King Jarrah Tree (Collie)
Helena River and Reservoir	Yarra Road
Hoffmans Mill	

Appendix H Flora species-related values

Table H.1 Flora species-related values

Taxon name	Endemism	Range end	Relictual primitive	Disjuncture	Monotypic
Acacia acanthoclada		x			
Acacia alata var. tetrantha		x			
Acacia anarthros	x				
Acacia aphylla	x				
Acacia auronitens		x			
Acacia barbinervis		x			
Acacia bidentata		x			
Acacia brachypoda	x				
Acacia browniana var. glaucescens	x				
Acacia browniana var. intermedia		x			
Acacia browniana var. obscura	x				
Acacia campylophylla		x			
Acacia chapmanii subsp. australis ms	x				
Acacia clydonophora		x			
Acacia crassistipula		x			
Acacia crassiuscula		x			
Acacia crispula		x			
Acacia cummingiana	x	x			
Acacia cuneifolia ms	x				
Acacia dilatata		x			
Acacia drewiana subsp. drewiana		x			
Acacia drummondii subsp. affinis	x	x			
Acacia ephedroides		x			
Acacia ericifolia		x			
Acacia erinacea		x			
Acacia fagonioides		x			
Acacia ferocior		x			
Acacia flagelliformis	x				
Acacia gemina ms		x			
Acacia glaucoptera		x			
Acacia gonophylla		x			
Acacia harveyi		x			
Acacia heteroclita subsp. heteroclita ms		x			
Acacia horridula	x				
Acacia incrassata		x			
Acacia inops	x				
Acacia insolita subsp. efoliolata ms	x	x			
Acacia laricina var. laricina		x			
Acacia lasiocalyx		x			
Acacia lasiocarpa var. bracteolata		x			
Acacia lasiocarpa var. bracteolata long peduncle variant (GJ Keighery 5026)	x				
Acacia lasiocarpa var. lasiocarpa		x			
Acacia lateriticola glabrous variant (BR Maslin 6765)	x				
Acacia latipes		x			
Acacia latipes subsp. latipes ms		x			
Acacia leioderma	x	x			
Acacia leptospermoides subsp. leptospermoides		x			
Acacia lullfitziorum ms		x			
Acacia luteola		x			
Acacia meisneri		x			
Acacia microbotrya		x			
Acacia mooreana	x				
Acacia multispicata		x			
Acacia nyssophylla		x			
Acacia oncinophylla subsp. oncinophylla	x				
Acacia oncinophylla subsp. patulifolia	x				

Table H.1 (Cont'd) Flora species-related values

Taxon name	Endemism	Range end	Relictual primitive	Disjuncture	Monotypic
Acacia pulchella var. reflexa acuminate bracteole variant (RJ Cumming 882)	x				
Acacia pycnocephala		x			
Acacia restiacea		x			
Acacia rigens		x			
Acacia rigida ms		x			
Acacia scalpelliformis	x				
Acacia semitrullata	x				
Acacia sessilis		x			
Acacia shuttleworthii		x			
Acacia spathulata		x			
Acacia spathulifolia		x			
Acacia sphacelata subsp. sphacelata ms		x			
Acacia subflexuosa		x			
Acacia subflexuosa subsp. subflexuosa		x			
Acacia subracemosa	x				
Acacia sulcata var. sulcata		x			
Acacia tayloriana	x				
Acacia trigonophylla		x			
Acacia trinalis ms	x	x			
Acacia ulicina		x			
Acacia uliginosa	x				
Acacia varia var. crassinervis		x			
Acacia varia var. parviflora		x			
Acacia volubilis	x				
Acanthocarpus canaliculatus		x			
Acetosa vesicaria		x			
Acidonia microcarpa					x
Actinobole uliginosum		x			
Actinodium cunninghamii	x				
Actinostrobus acuminatus		x	x		
Actinostrobus pyramidalis		x	x		
Actinotus laxus ms	x				
Actinotus leucocephalus		x			
Actinotus omnifertilis	x				
Actinotus sp. Walpole (J.R.Wheeler 3786)	x				
Actinotus whicherae ms	x				
Actites megalocarpa					x
Adenanthos apiculatus	x	x			
Adenanthos barbiger subsp. barbiger ms	x				
Adenanthos barbiger subsp. intermedius ms	x				
Adenanthos cuneatus		x			
Adenanthos cygnorum subsp. cygnorum		x			
Adenanthos detmoldii	x				
Adenanthos drummondii		x			
Adenanthos pamela x	x				
Adiantum aethiopicum			x		
Agonis flexuosa var. latifolia	x				
Agonis juniperina	x				
Agonis marginata		x			
Agonis sp.coarse tea-tree(J.R.Wheeler 2939)	x				
Agonis sp.Lake Jasper (B.Hammersley 567)	x				
Agrostocrinum scabrum					x
Alexgeorgea ganopoda	x				
Alexgeorgea nitens		x			
Allocasuarina acuaria		x			
Allocasuarina campestris		x			
Allocasuarina huegeliana		x			
Allocasuarina lehmanniana subsp. lehmanniana		x			
Allocasuarina microstachya		x			
Allocasuarina ramosissima		x			

Table H.1 (Cont'd) Flora species-related values

Taxon name	Endemism	Range end	Relictual primitive	Disjuncture	Monotypic
Allocasuarina trichodon		x			
Amanita carneiphylla	x				
Amperea micrantha	x				
Amperea protensa	x				
Amyema preissii		x			
Anarthria humilis		x			
Andersonia amabile ms	x				
Andersonia annelsii ms	x				
Andersonia auriculata	x				
Andersonia brevifolia		x			
Andersonia hammersleyana ms	x				
Andersonia lehmanniana subsp. lehmanniana		x			
Andersonia lehmanniana subsp. pubescens		x			
Andersonia macronema	x				
Andersonia parvifolia		x			
Andersonia simplex	x				
Andersonia sp.Beardmore Rd (A.R.Annels & R.W.Hearn 4409)	x				
Andersonia sp.Collis Rd (G.Wardell-Johnson GWJ5A)	x				
Andersonia sp.Ironstone (B.J.Keighery & N.Gibson 227)	x				
Andersonia sp.Mitchell River (B.G.Hammersley 925)	x				
Andersonia sp.Mt Lindesay (B.G.Hammersley 335)	x				
Anigozanthos bicolor subsp. exstans	x	x			
Anigozanthos humilis subsp. chrysanthus	x				
Anigozanthos preissii	x				
Anigozanthos pulcherrimus		x			
Anigozanthos viridis subsp. metallica ms	x	x			
Anogramma leptophylla			x		
Anthocercis gracilis	x				
Anthocercis sylvicola	x		x		
Anthotium humile		x			
Aotus carinata	x				
Aotus cordifolia				x	
Aotus genistoides				x	
Aristida ramosa				x	
Arnocrinum preissii		x			
Asplenium aethiopicum			x		
Asplenium flabellifolium			x		
Asplenium obtusatum				x	
Asplenium trichomanes			x	x	
Astartea sp.big bracteoles (A.R.Annels 995)	x				
Astartea sp.Gingalup (N.Gibson & M.Lyons 119)	x				
Astartea sp.juniperina (G.J.Keighery 9558)	x				
Astartea sp.long stalks (D.Foreman 1490)	x				
Astartea sp.Mt Johnston (A.R.Annels 5645)	x				
Astartea sp.Rivers (K.Newbey 1740)	x				
Astartea sp.Scott River (D.Backshall 88233)	x				
Astartea sp.wing tips (M.E.Trudgen 12044)	x				
Asteridea gracilis		x			
Asterolasia grandiflora	x	x			
Asterolasia nivea	x	x			
Astroloma epacridis		x			
Astroloma foliosum	x				
Astroloma glaucescens		x			
Astroloma macrocalyx	x				
Astroloma microdonta		x			

Table H.1 (Cont'd) Flora species-related values

Taxon name	Endemism	Range end	Relictual primitive	Disjuncture	Monotypic
Astroloma serratifolium		x			
Astroloma sp.Cataby (E.A.Griffin 1022)	x				
Astroloma sp.Nannup (R.D.Royce 3978)	x				
Astroloma stomarrhena		x			
Astroloma xerophyllum		x			
Austrofestuca pubinervis		x		x	
Austrostipa elegantissima		x			
Austrostipa trichophylla		x			
Austrostipa variabilis		x			
Azolla filiculoides			x	x	x
Baeckea arbuscula	x				
Baeckea astarteoides	x				
Baeckea blackettii		x			
Baeckea crispiflora		x			
Baeckea grandiflora		x			
Baeckea preissiana		x			
Baeckea pygmaea	x	x			
Baeckea schollerifolia	x	x			
Baeckea sp. Chittering (R.J.Cranfield 1983)	x				
Baeckea sp.Darling Range (R.J.Cranfield 1673)	x				
Baeckea tenuifolia	x	x			
Banksia chamaephyton	x	x			
Banksia coccinea		x			
Banksia dryandroides		x			
Banksia gardneri var. brevidentata		x			
Banksia gardneri var. gardneri		x			
Banksia goodii		x			
Banksia incana		x			
Banksia meisneri subsp. ascendens	x				
Banksia meisneri var. ascendens	x				
Banksia micrantha	x	x			
Banksia occidentalis	x				
Banksia occidentalis subsp. occidentalis	x				
Banksia prionotes		x			
Banksia quercifolia	x	x			
Banksia repens		x			
Banksia seminuda	x				
Banksia seminuda subsp. seminuda	x				
Banksia telmatiaea		x			
Banksia verticillata	x			x	
Banksia violacea		x			
Baxteria australis	x				x
Beaufortia anisandra		x			
Beaufortia decussata	x				
Beaufortia elegans		x			
Beaufortia eriocephala		x			
Beaufortia incana		x			
Beaufortia macrostemon	x				
Beaufortia micrantha var. micrantha		x			
Beaufortia sparsa	x				
Billardiera coriacea		x			
Billardiera drummondiana var. collina	x				
Billardiera drummondiana var. drummondiana	x	x			
Billardiera parviflora var. guttata	x			x	
Billardiera parviflora var. parviflora	x				
Billardiera sericea		x			
Billardiera sp.Walpole (A.R.Annels 277)	x				
Blancoa canescens		x	x		x
Blennospora sp.Ruabon (B.J.Keighery & N.Gibson 20)	x				
Boronia albiflora		x			
Boronia anceps ms	x			x	
Boronia capitata subsp. clavata		x			
Boronia capitata subsp. gracilis	x				

Table H.1 (Cont'd) Flora species-related values

Taxon name	Endemism	Range end	Relictual primitive	Disjuncture	Monotypic
Boronia crenulata subsp. pubescens ms	x				
Boronia crenulata var. pubescens ms	x				
Boronia ericifolia	x	x			
Boronia exilis ms	x				
Boronia fastigiata subsp. fastigiata ms	x				
Boronia fastigiata subsp. tenuior ms	x				
Boronia humifusa ms	x				
Boronia juncea subsp. laniflora ms	x				
Boronia juncea subsp. minima ms	x				
Boronia penicillata		x			
Boronia ramosa subsp. ramosa		x			
Boronia scabra subsp. scabra ms		x			
Boronia virgata	x				
Borya laciniata		x			
Borya longiscapa	x				
Bossiaea aquifolium subsp. laidlawiana	x				
Bossiaea aquifolium subsp. laidlawiana	x				
Bossiaea concinna		x			
Bossiaea dentata		x			
Bossiaea disticha	x				
Bossiaea leptacantha		x			
Bossiaea modesta	x				
Bossiaea webbii	x				
Brachysema celsianum				x	
Brachysema melanopetalum	x				
Brachysema minor		x			
Brachysema modestum	x				
Brachysema papilio ms	x				
Brachysema sericeum	x				
Burchardia bairdiae	x	x			
Byblis gigantea		x			
Caladenia abbreviata ms	x				
Caladenia applanata subsp. applanata ms	x				
Caladenia applanata subsp. erubescens ms	x				
Caladenia arenicola ms		x			
Caladenia bryceana subsp. bryceana ms		x			
Caladenia busselliana ms	x				
Caladenia caesarea subsp. maritima ms	x				
Caladenia caesarea subsp. transiens ms	x	x			
Caladenia chapmanii ms				x	
Caladenia christineae ms	x				
Caladenia citrina ms	x				
Caladenia dorrienii	x	x			
Caladenia ensata	x				
Caladenia evanescens ms	x				
Caladenia falcata		x			
Caladenia filifera		x			
Caladenia flaccida subsp. pulchra ms		x			
Caladenia flava subsp. sylvestris ms	x				
Caladenia flava subsp. sylvestris ms	x				
Caladenia gardneri ms	x				
Caladenia harringtoniae ms	x				
Caladenia heberleana ms		x		x	
Caladenia infundibularis	x				
Caladenia integra		x			
Caladenia interjacens ms	x				
Caladenia longicauda subsp. clivicola ms	x				
Caladenia longicauda subsp. longicauda ms	x				
Caladenia longicauda subsp. merrittii ms	x				

Table H.1 (Cont'd) Flora species-related values

Taxon name	Endemism	Range end	Relictual primitive	Disjuncture	Monotypic
Caladenia longicauda subsp. redacta ms	x				
Caladenia lorea ms		x			
Caladenia luteola ms	x	x			
Caladenia nivalis ms	x				
Caladenia pachychila ms		x			
Caladenia paludosa ms	x				
Caladenia polychroma ms		x			
Caladenia rubrichila ms	x				
Caladenia saccharata		x			
Caladenia starteorum ms	x				
Caladenia subdita	x	x			
Caladenia triangularis x		x			
Caladenia uliginosa subsp. candicans ms	x				
Caladenia uliginosa subsp. patulens ms	x				
Caladenia uliginosa subsp. uliginosa ms	x				
Caladenia varians subsp. meridionalis ms	x				
Caladenia varians subsp. nobilis ms		x			
Caladenia varians subsp. talbotii ms	x	x			
Caladenia viridescens	x				
Caladenia winfieldii ms	x				
Caladenia xantha ms		x			
Callistachys lanceolata					x
Callitris canescens		x	x		
Callitris glaucophylla		x	x		
Callitris roei		x	x		
Calochilus robertsonii	x				
Calothamnus graniticus	x				
Calothamnus graniticus subsp. leptophyllus				x	
Calothamnus hirsutus		x			
Calothamnus pachystachyus	x	x			
Calothamnus pallidifolius	x				
Calothamnus planifolius		x			
Calothamnus preissii		x			
Calothamnus rupestris	x				
Calothamnus schaueri	x				
Calothamnus sp.Mt Lindesay (B.G.Hammersley 439)	x				
Calothamnus sp.Scott River (R.D.Royce 84)	x				
Calothamnus torulosus		x			
Calotis erinacea		x			
Calycopeplus oligandrus	x				
Calycopeplus paucifolius		x			
Calymperastrum latifolium	x				
Calytrix asperula		x			
Calytrix aurea		x			
Calytrix breviseta subsp. breviseta	x				
Calytrix fraseri		x			
Calytrix oncophylla	x				
Calytrix pulchella				x	
Calytrix sapphirina		x			
Calytrix similis	x	x			
Calytrix simplex subsp. simplex	x			x	
Calytrix strigosa		x			
Calytrix sylvana	x	x			
Calytrix violacea		x			
Carex tereticaulis				x	
Cartonema philydroides		x			
Cassytha glabella forma dispar		x			
Cassytha glabella forma glabella		x			
Casuarina obesa		x			
Caustis sp.Boyanup (G.S.McCutcheon 1706)	x				
Centrolepis caespitosa	x				

Table H.1 (Cont'd) Flora species-related values

Taxon name	Endemism	Range end	Relictual primitive	Disjuncture	Monotypic
Centrolepis cephaloformis subsp. cephaloformis		x			
Centrolepis strigosa subsp. strigosa		x			
Cephalotus follicularis					x
Chamaescilla corymbosa var. latifolia		x			
Chamaescilla sp.Ellen Brook (G.J.Keighery 12501)		x			
Chamaescilla spiralis		x			
Chamaexeros longicaulis	x		x		
Chamaexeros serra		x			
Chamelaucium erythrochlorum	x				
Chamelaucium floriferum ms	x				
Chamelaucium floriferum subsp. diffusum ms	x				
Chamelaucium floriferum subsp. floriferum ms	x				
Chamelaucium forrestii subsp. forrestii ms	x				
Chamelaucium hamatum ms				x	
Chamelaucium roycei	x				
Chamelaucium sp. Gingin (N Marchant s.n. 4.11.88) [aff. pauciflorum]	x				
Chamelaucium uncinatum		x			
Cheilanthes austrotenuifolia			x		
Cheilanthes distans			x		
Cheilanthes lasiophylla		x	x		
Cheiranthera preissiana var. planifolia				x	
Cheiranthera preissiana var. preissiana	x				
Chordifex amblycoleus ms	x				
Chordifex gracilior ms	x				
Chordifex jacksonii ms	x				
Chordifex serialis ms				x	
Choretrum lateriflorum	x				
Chorilaena quercifolia					x
Chorizandra multiarticulata				x	
Chorizema carinatum		x			
Chorizema cytisoides		x			
Chorizema diversifolium	x				
Chorizema racemosum		x			
Chorizema retrorsum	x				
Chorizema ulotropis				x	
Chrysocephalum semicalvum		x			
Comesperma scoparium		x			
Commersonia pulchella		x			
Conospermum amoenum		x			
Conospermum amoenum subsp. amoenum		x			
Conospermum caeruleum subsp. caeruleum		x			
Conospermum caeruleum subsp. contortum	x				
Conospermum caeruleum subsp. debile	x				
Conospermum caeruleum subsp. marginatum	x				
Conospermum canaliculatum subsp. canaliculatum		x			
Conospermum capitatum subsp. capitatum	x				
Conospermum capitatum subsp. velutinum		x			
Conospermum crassinervium		x			
Conospermum densiflorum subsp. densiflorum		x			
Conospermum densiflorum subsp. unicephalatum	x				
Conospermum filifolium subsp. filifolium		x			

Table H.1 (Cont'd) Flora species-related values

Taxon name	Endemism	Range end	Relictual primitive	Disjuncture	Monotypic
Conospermum flexuosum subsp. flexuosum	x	x			
Conospermum flexuosum subsp. laevigatum	x				
Conospermum glumaceum		x			
Conospermum huegelii		x			
Conospermum paniculatum	x				
Conospermum polycephalum		x			
Conospermum quadripetalum	x			x	
Conospermum stoechadis subsp. sclerophyllum		x			
Conospermum stoechadis subsp. stoechadis		x			
Conospermum triplinervium		x			
Conospermum undulatum	x	x			
Conospermum wycherleyi ms		x			
Conostephium minus	x	x			
Conostephium preissii		x			
Conostylis androstemma		x			
Conostylis aurea		x			
Conostylis candicans subsp. candicans		x			
Conostylis caricina subsp. caricina	x				
Conostylis juncea		x			
Conostylis latens		x			
Conostylis misera	x	x			
Conostylis prolifera		x			
Conostylis teretifolia subsp. planescens	x				
Conostylis teretifolia subsp. teretifolia		x			
Conothamnus neglectus	x				
Conothamnus trinervis				x	
Convolvulus erubescens				x	
Convolvulus remotus		x			
Corybas abditus		x			
Corybas limpidus	x	x			
Corymbia ficifolia	x				
Corymbia haematoxylon	x				
Corynotheca micrantha var. elongata		x			
Corynotheca micrantha var. panda		x			
Cosmelia rubra		x			x
Crowea angustifolia var. dentata	x				
Cryptandra arbutiflora var. pygmaea	x				
Cryptandra congesta	x				
Cryptandra mutila		x			
Cryptandra myriantha		x			
Cryptandra pungens		x			
Cryptandra scoparia var. scoparia		x			
Cyanicula ixioides subsp. candida ms	x	x			
Cyanicula ixioides subsp. ixioides ms	x	x			
Cyathochaeta stipoides	x				
Cyclosorus interruptus			x	x	
Cymbonotus preissianus					x
Cymbopogon obtectus		x			
Cymbopogon procerus		x			
Dampiera eriocephala		x			
Dampiera heteroptera	x				
Dampiera juncea		x			
Dampiera lindleyi		x			
Dampiera orchardii		x			
Dampiera spicigera		x			
Dampiera teres		x			
Darwinia apiculata	x				
Darwinia ferricola	x				
Darwinia pimelioides	x				
Darwinia pinifolia		x			
Darwinia sp.Williamson (G.J.Keighery 12717)	x				
Darwinia thymoides subsp. St Ronans (J.J.Alford & G.J.Keighery 64)	x				
Dasypogon hookeri	x				
Dasypogon obliquifolius		x			

Table H.1 (Cont'd) Flora species-related values

Taxon name	Endemism	Range end	Relictual primitive	Disjuncture	Monotypic
Daviesia alternifolia		x			
Daviesia brachyphylla		x			
Daviesia cardiophylla		x			
Daviesia debilior subsp. sinuans	x	x			
Daviesia dilatata		x			
Daviesia elongata subsp. elongata	x				
Daviesia gracilis		x			
Daviesia hakeoides subsp. hakeoides		x			
Daviesia hakeoides subsp. subnuda		x			
Daviesia incrassata subsp. teres		x			
Daviesia microphylla	x	x			
Daviesia nematophylla		x			
Daviesia nudiflora subsp. nudiflora		x			
Daviesia oppositifolia		x			
Daviesia polyphylla		x			
Daviesia teretifolia		x			
Daviesia triflora		x			
Deyeuxia inaequalis	x				
Dianella revoluta var. revoluta		x			
Diaspasis filifolia					x
Dicrastylis glauca		x			
Dillwynia acerosa	x				
Dillwynia dillwynioides		x			
Dioscorea hastifolia		x			
Diplolaena andrewsii	x				
Diplolaena graniticola ms	x	x			
Diplopeltis huegelii var. lehmanii ms		x			
Diplopogon setaceus	x				x
Diuris amplissima	x				
Diuris brumalis		x			
Diuris heberlei	x	x			
Diuris magnifica		x			
Diuris micrantha	x				
Diuris porrifolia		x			
Dodonaea adenophora		x			
Dodonaea bursariifolia		x			
Dodonaea ericoides		x			
Dodonaea inaequifolia		x			
Dodonaea pinifolia		x			
Drakaea confluens ms	x	x			
Drakonorchis barbarossa ms		x			
Drepanocladus aduncas	x				
Drepanocladus fluitans	x				
Drosera barbigera		x			
Drosera binata				x	
Drosera bulbosa		x			
Drosera erythrogyne		x			
Drosera erythrorhiza subsp. magna		x			
Drosera fimbriata	x	x			
Drosera helodes	x				
Drosera heterophylla		x			
Drosera hyperostigma	x				
Drosera leucoblasta		x			
Drosera macrophylla		x			
Drosera marchantii subsp. marchantii	x				
Drosera nitidula subsp. omissa	x				
Drosera parvula		x			
Drosera ramellosa				x	
Drosera roseana	x				
Drosera scorpioides		x			
Drosera silvicola	x				
Drosera spilos	x	x			
Drosera stelliflora	x				
Drosera stolonifera subsp. compacta		x			
Drosera stolonifera subsp. porrecta		x			
Drosera walyunga	x				
Drosera zonaria		x			
Dryandra arctotidis		x			
Dryandra armata var. armata	x				
Dryandra armata var. ignicida		x			
Dryandra aurantia	x				

Table H.1 (cont'd) Flora species-related values

Taxon name	Endemism	Range end	Relictual primitive	Disjuncture	Monotypic
Dryandra bipinnatifida subsp. multifida		x			
Dryandra blechnifolia	x	x			
Dryandra carlinoides		x			
Dryandra drummondii subsp. hiemalis		x			
Dryandra echinata	x				
Dryandra fraseri		x			
Dryandra fraseri var. fraseri		x			
Dryandra hewardiana		x			
Dryandra mimica				x	
Dryandra mucronulata subsp. mucronulata		x			
Dryandra mucronulata subsp. retrorsa	x	x			
Dryandra nivea subsp. Morangup (M Pieroni 94/2)	x				
Dryandra nivea subsp. uliginosa	x				
Dryandra nobilis subsp. nobilis		x			
Dryandra polycephala	x	x			
Dryandra porrecta	x	x			
Dryandra praemorsa var. praemorsa	x				
Dryandra praemorsa var. splendens	x				
Dryandra preissii	x	x			
Dryandra proteoides		x			
Dryandra pteridifolia subsp. vernalis	x	x			
Dryandra serra	x				
Dryandra sessilis var. cordata	x			x	
Dryandra squarrosa subsp. argillacea	x				
Dryandra stuposa		x			
Dryandra subpinnatifida var. imberbis	x	x			
Dryandra vestita		x			
Eleocharis keigheryi		x			
Epiblema grandiflorum var. cyaneum ms	x				x
Epiblema grandiflorum var. grandiflorum					x
Epiblema grandiflorum var. grandiflorum ms					x
Epilobium billardierianum subsp. intermedium	x				
Eremaea asterocarpa		x			
Eremaea asterocarpa subsp. brachyclada	x				
Eremaea blackwelliana	x				
Eremaea fimbriata		x			
Eremaea purpurea	x				
Eremophila eriocalyx		x			
Eremosyne pectinata					x
Eriachne ovata		x			
Eriochilus dilatatus subsp. undulatus ms		x			
Eriochilus pulchellus ms				x	
Eriochilus scaber subsp. orbifolia ms	x				
Eriochilus valens ms	x				
Eriostemon nodiflorus subsp. nodiflorus		x			
Eryngium sp.Lake Muir (E.Wittwer 2293)	x				
Eucalyptus albida		x			
Eucalyptus aspersa	x	x			
Eucalyptus brevistylis	x		x		
Eucalyptus buprestium		x			
Eucalyptus calcicola	x				
Eucalyptus clivicola		x			
Eucalyptus decipiens subsp. adesmophloia	x				
Eucalyptus decurva		x			
Eucalyptus doratoxylon		x			
Eucalyptus exilis		x			
Eucalyptus falcata		x			
Eucalyptus ficifolia	x				
Eucalyptus flocktoniae		x			

Table H.1 (Cont'd) Flora species-related values

Taxon name	Endemism	Range end	Relictual primitive	Disjuncture	Monotypic
Eucalyptus goniantha subsp. goniantha	x				
Eucalyptus graniticola ms	x				
Eucalyptus guilfoylei	x		x		
Eucalyptus incrassata		x			
Eucalyptus jacksonii	x		x		
Eucalyptus jucunda				x	
Eucalyptus laeliae	x				
Eucalyptus lane-poolei		x			
Eucalyptus lane-poolei var. Whicher (S.D.Hopper 6316)	x				
Eucalyptus latens	x				
Eucalyptus loxophleba		x			
Eucalyptus loxophleba subsp. loxophleba		x			
Eucalyptus loxophleba x wandoo	x				
Eucalyptus macrocarpa subsp. macrocarpa		x			
Eucalyptus macrocarpa x pyriformis	x				
Eucalyptus marginata subsp. elegantella	x				
Eucalyptus marginata subsp. thalassica	x				
Eucalyptus marginata x megacarpa	x				
Eucalyptus obtusa ms		x			
Eucalyptus occidentalis		x			
Eucalyptus phaenophylla subsp. phaenophylla		x			
Eucalyptus phylacis	x				
Eucalyptus pluricaulis subsp. pluricaulis		x			
Eucalyptus rudis subsp. cratyantha	x	x			
Eucalyptus salmonophloia		x			
Eucalyptus salubris		x			
Eucalyptus staeri		x			
Eucalyptus todtiana		x			
Eucalyptus uncinata		x			
Eucalyptus virginae ms	x				
Eucalyptus wandoo subsp. pulverea		x			
Euchilopsis linearis					x
Eutaxia cuneata				x	
Eutaxia parvifolia		x			
Exocarpos aphyllus		x			
Festuca pubinervis		x		x	
Fimbristylis velata				x	
Frankenia tetrapetala		x			
Franklandia triaristata	x				
Gahnia ancistrophylla		x			
Gahnia australis		x			
Gahnia drummondii		x			
Gastrolobium brownii	x				
Gastrolobium congestum	x				
Gastrolobium ovalifolium		x			
Gastrolobium parviflorum		x			
Gastrolobium parviflorum var. parviflorum ms	x				
Gastrolobium parvifolium		x			
Gastrolobium pusillum		x			
Gastrolobium rotundifolium		x			
Gastrolobium spinosum var. grandiflorum		x			
Gastrolobium tomentosum	x	x			
Gastrolobium tricuspidatum		x			
Gastrolobium trilobum		x			
Gastrolobium truncatum	x	x			
Gastrolobium velutinum	x	x			
Genus sp.Shannon (P.G.Wilson 1237B)	x				x
Gilberta tenuifolia		x			x
Glischrocaryon roei		x			
Glossostigma diandrum				x	

Table H.1 (Cont'd) Flora species-related values

Taxon name	Endemism	Range end	Relictual primitive	Disjuncture	Monotypic
Glossostigma drummondii				x	
Gnephosis tenuissima		x			
Gompholobium aristatum		x			
Gonocarpus cordiger		x			
Gonocarpus hexandrus subsp. hexandrus	x				
Gonocarpus nodulosus		x			
Gonocarpus pithyoides		x			
Gonocarpus simplex		x			
Gonocarpus trichostachyus		x		x	
Goodenia arthrotricha	x	x			
Goodenia berardiana		x			
Goodenia convexa		x			
Goodenia hassallii		x			
Goodenia havilandii		x			
Goodenia katabudjar ms	x				
Goodenia leptoclada	x				
Goodenia pinifolia		x			
Goodenia scapigera		x			
Grevillea althoferorum		x		x	
Grevillea brachystylis subsp. australis	x				
Grevillea brachystylis subsp. brachystylis	x				
Grevillea bronwenae	x				
Grevillea candolleana	x				
Grevillea centristigma	x				
Grevillea corrugata	x				
Grevillea crowleyae	x				
Grevillea curviloba subsp. curviloba	x				
Grevillea curviloba subsp. incurva	x				
Grevillea depauperata	x	x			
Grevillea disjuncta		x			
Grevillea diversifolia subsp. subtersericata	x				
Grevillea drummondii	x				
Grevillea elongata	x				
Grevillea endlicheriana		x			
Grevillea fasciculata		x			
Grevillea fuscolutea	x				
Grevillea manglesii subsp. dissectifolia	x				
Grevillea manglesii subsp. manglesii	x				
Grevillea manglesii subsp. ornithopoda	x				
Grevillea manglesioides	x				
Grevillea mccutcheonii ms	x				
Grevillea monticola	x				
Grevillea nudiflora		x			
Grevillea occidentalis	x				
Grevillea papillosa	x				
Grevillea pimeleoides	x				
Grevillea preissii subsp. preissii		x			
Grevillea prominens	x				
Grevillea rara	x				
Grevillea ripicola	x			x	
Grevillea scabra	x	x			
Grevillea sp.Scott River (G.J.Keighery 4070)	x				
Grevillea spinosissima	x	x			
Grevillea synapheae subsp. pachyphylla		x			
Grevillea synapheae subsp. synapheae		x			
Grevillea tenuiflora		x			
Grevillea tenuiloba		x			
Grevillea teretifolia		x			
Grevillea thelemanniana	x				
Grevillea umbellulata subsp. acerosa		x			
Grevillea umbellulata subsp. umbellulata		x			
Grevillea uncinulata subsp. florida		x			
Grevillea uncinulata subsp. uncinulata		x			

Table H.1 (Cont'd) Flora species-related values

Taxon name	Endemism	Range end	Relictual primitive	Disjuncture	Monotypic
Guichenotia macrantha		x			
Guichenotia micrantha		x			
Guichenotia sarotes		x			
Guichenotia tuberculata ms		x			
Gymnoschoenus anceps	x				
Gyrostemon sheathii		x			
Haemodorum brevisepalum		x			
Haemodorum loratum		x			
Haemodorum simulans		x			
Haemodorum venosum		x			
Hakea candolleana				x	
Hakea cristata	x				
Hakea erinacea		x			
Hakea falcata	x				
Hakea ferruginea		x			
Hakea florida	x				
Hakea gilbertii		x			
Hakea incrassata		x			
Hakea lehmanniana		x			
Hakea linearis	x				
Hakea loranthifolia	x				
Hakea marginata subsp. leptocarpa ms		x			
Hakea myrtoides	x	x			
Hakea petiolaris				x	
Hakea petiolaris subsp. angusta ms	x				
Hakea petiolaris subsp. petiolaris	x				
Hakea petiolaris subsp. trichophylla ms	x				
Hakea scoparia		x			
Hakea sp.Walyunga(L.Penn s.n.)	x				
Hakea sp.Williamson (B.J.Keighery & N.Gibson 226)	x				
Hakea stenocarpa		x			
Hakea tuberculata				x	
Halgania anagalloides var. anagalloides ms		x			
Halgania corymbosa	x				
Halgania cyanea var. cyanea		x			
Halgania cyanea var. latisepala ms				x	
Halgania lavandulacea		x			
Haloragis aculeolata	x				
Halosarcia indica subsp. bidens		x			
Halosarcia lepidosperma		x			
Halosarcia pergranulata		x			
Halosarcia pergranulata subsp. pergranulata		x			
Halosarcia syncarpa		x			
Heliotropium curassavicum		x			
Helipterum laeve		x			
Helipterum pyrethrum	x				
Hemiandra australis ms	x				
Hemiandra glabra subsp. glabra		x			
Hemiandra linearis		x			
Hemiandra rutilans	x				
Hemigenia barbata	x	x			
Hemigenia glabrescens	x	x			
Hemigenia obovata				x	
Hemigenia pimelifolia		x			
Hemigenia platyphylla		x			
Hemigenia sp.Wilroy (B.J.Conn 2150)	x	x			
Hemigenia westringioides		x			
Hensmania turbinata		x			
Hibbertia commutata	x				
Hibbertia crassifolia		x			
Hibbertia depressa	x				
Hibbertia exasperata		x			
Hibbertia ferruginea	x				
Hibbertia furfuracea	x				
Hibbertia hypericoides	x				
Hibbertia inclusa		x			

Table H.1 (Cont'd) Flora species-related values

Taxon name	Endemism	Range end	Relictual primitive	Disjuncture	Monotypic
Hibbertia microphylla		x			
Hibbertia miniata	x				
Hibbertia montana	x				
Hibbertia ovata	x				
Hibbertia pachyrrhiza	x				
Hibbertia pulchra	x				
Hibbertia recurvifolia		x			
Hibbertia rupicola		x			
Hibbertia serrata	x				
Hibbertia silvestris	x				
Hibbertia sp.hairy sepals (J.R.Wheeler 2464)	x				
Hibbertia sp.Stirlings (J.R.Wheeler 2453)	x	x			
Hodgsoniola junciformis	x				x
Homalosciadium homalocarpum					x
Homalospermum firmum					x
Hyalosperma simplex subsp. graniticola	x				
Hybanthus volubilis	x			x	
Hydatella dioica	x				
Hydatella sessilis ms	x				
Hydrocotyle hamelinensis ms	x				
Hydrocotyle lemnoides	x				
Hydrocotyle pilifera var. pilifera	x				
Hydrocotyle striata	x				
Hypocalymma ericifolium	x				
Hypocalymma sp.Scott River (A.S.George 11773)	x				
Hypolaena caespitosa ms	x				
Hypolaena macrotepala	x				
Hypolaena viridis ms	x				
Hypoxis occidentalis var. occidentalis		x			
Isoetes australis			x	x	
Isoetes drummondii			x	x	
Isolepis congrua		x			
Isolepis fluitans				x	
Isolepis oldfieldiana				x	
Isopogon asper		x			
Isopogon axillaris	x				
Isopogon buxifolius var. buxifolius	x	x			
Isopogon buxifolius var. obovatus	x	x			
Isopogon buxifolius var. spathulatus		x			
Isopogon cuneatus		x			
Isopogon drummondii		x			
Isopogon formosus subsp. dasylepis	x				
Isopogon formosus subsp. formosus		x			
Isopogon heterophyllus		x			
Isopogon latifolius	x				
Isopogon longifolius		x			
Isopogon sp.Brookton Hwy (H.Demarz 444)	x				
Isopogon teretifolius subsp. teretifolius ms	x				
Isotoma pusilla		x			
Isotropis drummondii		x			
Jacksonia alata		x			
Jacksonia angulata		x			
Jacksonia densiflora		x			
Jacksonia epiphyllum ms		x			
Jacksonia fasciculata		x			
Jacksonia floribunda		x			
Jacksonia nutans ms	x	x			
Jacksonia restioides		x			
Jacksonia sp.Collie (C.J.Koch 177)	x				
Jacksonia sparsa ms	x				
Jansonia formosa	x				x
Johnsonia inconspicua	x				
Johnsonia teretifolia	x	x			
Juncus aridicola				x	
Juncus meianthus ms	x				

Table H.1 (Cont'd) Flora species-related values

Taxon name	Endemism	Range end	Relictual primitive	Disjuncture	Monotypic
Kennedia glabrata	x	x			
Kennedia macrophylla	x				
Kennedia microphylla	x				
Kingia australis					x
Kunzea ciliata	x				
Kunzea ericifolia subsp. ericifolia	x				
Kunzea micromera		x			
Kunzea spathulata	x				
Lachnostachys ferruginea		x			
Lachnostachys verbascifolia		x			
Lambertia echinata subsp. occidentalis	x				
Lambertia echinata var. citrina ms	x	x			
Lambertia inermis var. inermis		x			
Lambertia multiflora var. darlingensis	x			x	
Lambertia orbifolia	x			x	
Lambertia rariflora subsp. lutea	x				
Lambertia rariflora subsp. rariflora	x				
Lambertia uniflora		x			
Lasiopetalum bracteatum	x				
Lasiopetalum cardiophyllum	x				
Lasiopetalum cordifolium subsp. acuminatum ms	x				
Lasiopetalum cordifolium subsp. cordifolium	x				
Lasiopetalum floribundum	x				
Lasiopetalum pterocarpum ms	x				
Latrobea genistoides		x			
Lawrencella rosea	x				
Laxmannia arida				x	
Laxmannia brachyphylla		x			
Laxmannia grandiflora subsp. grandiflora		x			
Laxmannia grandiflora subsp. stirlingensis		x			
Laxmannia jamesii	x	x			
Laxmannia omnifertilis		x			
Laxmannia ramosa subsp. ramosa		x			
Laxmannia sp.Little Lindesay (B.G.Hammersley 1615)	x				
Lechenaultia floribunda		x			
Lechenaultia formosa		x			
Lechenaultia laricina	x	x			
Lechenaultia pulvinaris		x			
Lechenaultia tubiflora		x			
Lepidobolus chaetocephalus		x			
Lepidobolus preissianus		x			
Lepidosperma brunonianum		x			
Lepidosperma carphoides				x	
Lepidosperma drummondii		x		x	
Lepidosperma obtusum	x				
Lepidosperma persecans				x	
Lepidosperma resinosum		x			
Lepidosperma scabrum		x			
Lepidosperma sp.A2 Island Flat (G.J.Keighery 7000)		x			
Leporella fimbriata					x
Leptinella drummondii	x				x
Leptocarpus canus		x			
Leptocarpus ceramophilus ms				x	
Leptocarpus crassipes ms	x				
Leptocarpus diffusus ms	x				
Leptocarpus elegans ms	x				
Leptocarpus tephrinus ms	x				
Leptoceras menziesii					x
Leptomeria dielsiana	x				
Leptomeria empetriformis		x			
Leptomeria ericoides	x				
Leptomeria furtiva ms	x				
Leptomeria lehmannii		x			
Leptospermum sp.A J.Thompson (Dr A.Morrison s.n.03/12/1892)	x				

Table H.1 (Cont'd) Flora species-related values

Taxon name	Endemism	Range end	Relictual primitive	Disjuncture	Monotypic
Leptospermum spinescens		x			
Lepyrodia glauca	x				
Lepyrodia porterae ms	x				
Leucopogon alternifolius	x				
Leucopogon cordatus	x				
Leucopogon corifolius	x	x			
Leucopogon crassifolius		x			
Leucopogon cymbiformis				x	
Leucopogon elegans				x	
Leucopogon fimbriatus		x			
Leucopogon florulentus		x			
Leucopogon gibbosus		x			
Leucopogon gilbertii	x				
Leucopogon glaucifolius				x	
Leucopogon gracilis	x				
Leucopogon gracillimus	x				
Leucopogon hirsutus	x				
Leucopogon lasiophyllus		x			
Leucopogon oldfieldii		x			
Leucopogon oppositifolius		x			
Leucopogon ovalifolius		x			
Leucopogon planifolius		x			
Leucopogon polystachyus	x				
Leucopogon squarrosus	x	x			
Leucopogon striatus		x		x	
Leucopogon tamariscinus		x			
Leucopogon tenuicaulis ms	x				
Leucopogon tenuis		x			
Levenhookia pauciflora				x	
Lilaeopsis polyantha				x	
Lindsaea linearis			x		
Logania buxifolia		x			
Logania flaviflora		x			
Logania micrantha		x		x	
Logania tortuosa		x			
Lomandra collina		x			
Lomandra effusa		x			
Lomandra hastilis				x	
Lomandra mucronata		x			
Lomandra ordii	x				
Loxocarya magna	x				
Lycopodiella serpentina			x		
Lysiana casuarinae		x			
Lysinema elegans	x				
Lysinema fimbriatum	x	x			
Lysinema lasianthum	x				
Lysiosepalum rugosum		x			
Macarthuria australis		x			
Macarthuria keigheryi	x	x			
Macropidia fuliginosa	x	x			x
Macrozamia riedlei			x		
Maireana oppositifolia		x			
Marsilea mutica			x	x	
Meeboldina cana ms		x			
Meeboldina crassipes ms	x				
Meeboldina decipiens ms	x				
Meeboldina denmarkica	x				
Melaleuca aspalathoides	x				
Melaleuca basicephala	x				
Melaleuca baxteri	x				
Melaleuca blaeriifolia	x	x			
Melaleuca bracteosa		x			
Melaleuca brevifolia		x			
Melaleuca camptoclada	x	x			
Melaleuca coronicarpa		x			
Melaleuca densa	x				
Melaleuca diosmifolia	x	x			
Melaleuca holosericea		x			
Melaleuca huegelii subsp. huegelii	x				
Melaleuca incana subsp. Gingilup (N.Gibson & M.Lyons 593)	x				

Table H.1 (Cont'd) Flora species-related values

Taxon name	Endemism	Range end	Relictual primitive	Disjuncture	Monotypic
Melaleuca micromera	x	x		x	
Melaleuca ringens	x				
Melaleuca seriata		x			
Melaleuca teretifolia		x			
Melaleuca trichophylla		x			
Melaleuca viminea subsp. demissa ms		x			
Melaleuca violacea		x			
Melanostachya ustulata ms	x		x		x
Mesomelaena preissii		x			
Mesomelaena pseudostygia		x			
Metzgeria decipiens				x	
Meziella trifida	x				x
Microcorys longifolia		x			
Microtis familiaris	x				
Microtis globula	x				
Microtis media subsp. quadrata	x				
Mirbelia ovata		x			
Mitreola minima				x	
Monotoca leucantha		x			
Monotoca tamariscina		x			
Muehlenbeckia polybotrya		x			
Myoporum caprarioides				x	
Myriocephalus appendiculatus		x			
Myriocephalus pygmaeus				x	
Needhamiella pumilio					x
Nemcia acuta	x	x			
Nemcia alternifolia ms	x				
Nemcia axillaris	x	x			
Nemcia congesta ms	x				
Nemcia cordata ms	x				
Nemcia coriacea		x			
Nemcia crenulata				x	
Nemcia cyanophylla ms	x				
Nemcia epacridoides	x				
Nemcia hookeri		x			
Nemcia ilicifolia		x			
Nemcia obovata		x			
Nemcia reticulata		x			
Nemcia sparsa ms	x				
Nemcia tricuspidata		x			
Neofuscelia subbarbatica	x				
Nicotiana rotundifolia		x			
Nuytsia floribunda					x
Olearia cassiniae	x				
Olearia conspicua ms		x			
Olearia strigosa				x	
Opercularia rubioides		x			
Opercularia spermacocea		x			
Ophioglossum gramineum			x		
Ophioglossum lusitanicum			x		
Orthrosanthus laxus var. gramineus		x			
Orthrosanthus multiflorus				x	
Orthrosanthus polystachyus	x				
Ozothamnus lepidophyllus		x			
Paracaleana dixonii ms		x			
Paracaleana triens ms		x			
Parsonsia diaphanophleba	x				
Patersonia maxwellii				x	
Pentapogon quadrifidus var. quadrifidus				x	
Pericalymma crassipes	x				
Persoonia graminea	x				
Persoonia quinquenervis		x			
Persoonia striata		x			
Persoonia sulcata	x				
Persoonia trinervis		x			
Petrophile brevifolia		x			
Petrophile drummondii		x			
Petrophile imbricata		x			
Petrophile latericola ms	x				
Petrophile macrostachya		x			

Table H.1 (Cont'd) Flora species-related values

Taxon name	Endemism	Range end	Relictual primitive	Disjuncture	Monotypic
Petrophile megalostegia		x			
Petrophile plumosa		x			
Petrophile scabriuscula		x			
Petrophile striata		x			
Phebalium rude subsp. rude		x			
Phylloglossum drummondii			x		x
Phyllota barbata		x			
Phymatocarpus porphyrocephalus		x			
Physopsis spicata		x			
Picris wagenitzii	x				
Pilularia novae-hollandiae			x		
Pimelea brevifolia subsp. brevifolia		x			
Pimelea brevistyla subsp. brevistyla	x				
Pimelea ciliata subsp. longituba	x				
Pimelea cracens subsp. glabra	x				
Pimelea erecta		x			
Pimelea imbricata var. major		x			
Pimelea lehmanniana subsp. lehmanniana		x			
Pimelea rara	x				
Pimelea tinctoria		x			
Pithocarpa achilleoides	x			x	
Pithocarpa corymbulosa	x				
Pithocarpa melanostigma	x				
Pityrodia dilatata	x	x			
Platysace cirrosa		x			
Platysace deflexa		x			
Platysace effusa		x			
Platysace ramosissima	x				
Platytheca juniperina		x		x	
Pleurophascum occidentale	x	x			
Pleurosorus rutifolius			x	x	
Pleurosorus subglandulosus			x	x	
Podocarpus drouynianus			x		
Podolepis canescens		x			
Podotheca gnaphalioides		x			
Praecoxanthus aphyllus ms					x
Prasophyllum ovale		x			
Pteridium esculentum			x		
Pteris vittata			x		
Pterostylis dilatata		x			
Pterostylis sanguinea		x			
Ptilotus declinatus		x			
Ptilotus esquamatus	x				
Ptilotus humilis subsp. humilis		x			
Ptilotus polystachyus var. polystachyus		x			
Pultenaea aspalathoides	x				
Pultenaea barbata		x			
Pultenaea conferta		x			
Pultenaea drummondii	x				
Pultenaea pauciflora	x				
Pultenaea pinifolia	x			x	
Pultenaea radiata	x				
Pultenaea skinneri	x				
Pultenaea tenuifolia		x			
Pultenaea vestita		x			
Quinetia urvillei					x
Reedia spathacea	x		x	x	x
Regelia inops		x			
Restio amblycoleus	x				
Restio chaunocoleus	x	x			
Restio confertospicatus		x			
Restio cracens ms	x				
Restio isomorphus	x				
Restio jacksonii ms	x				
Restio sinuosus ms	x				
Restio stenostachyus		x			
Restio ustulatus	x				
Rhacocarpus webbianus	x				
Rhodanthe humboldtiana		x			

Table H.1 (Cont'd) Flora species-related values

Taxon name	Endemism	Range end	Relictual primitive	Disjuncture	Monotypic
Rhodanthe laevis		x			
Rhodanthe pyrethrum	x				
Rhodanthe spicata		x			
Rinzia crassifolia		x			
Rinzia fumana		x			
Rinzia schollerifolia	x	x			
Rorippa dictyosperma				x	
Rulingia sp.Trigwell Bridge (R.Smith s.n. 20.6.89)	x				
Santalum acuminatum		x			
Scaevola auriculata				x	
Scaevola canescens		x			
Scaevola phlebopetala		x			
Scaevola striata var. arenaria		x			
Scaevola thesioides subsp. filifolia		x			
Schizaea fistulosa			x		
Schizaea rupestris			x	x	
Schoenolaena tenuior	x				
Schoenoplectus pungens				x	
Schoenus acuminatus		x			
Schoenus andrewsii		x			
Schoenus armeria		x			
Schoenus capillifolius	x				
Schoenus clandestinus		x			
Schoenus fluitans				x	
Schoenus indutus	x				
Schoenus minutulus		x		x	
Schoenus multiglumis	x				
Schoenus pleiostemoneus		x			
Schoenus rigens		x			
Schoenus sp. Waroona (GJ Keighery 12235)	x	x			
Schoenus sp.A2 Kulin (B.R.Briggs 7939)		x			
Schoenus sp.Bullsbrook (J.J.Alford 915)	x				
Schoenus sp.G Broad Sheath (K.L.Wilson 2633)		x			
Schoenus sp.Jindong (R.D.Royce 2485)	x				
Schoenus sp.Mt Barker (G.J.Keighery 9679)	x				
Schoenus subaphyllus				x	
Schoenus sublateralis	x				
Schoenus submicrostachyus		x			
Scholtzia ciliata		x			
Scholtzia involucrata		x			
Sebaea ovata		x			
Selaginella gracillima			x		
Selliera radicans	x				
Senecio gilbertii	x				
Solanum lasiophyllum		x			
Solanum oldfieldii		x			
Sollya drummondii	x	x			
Sowerbaea multicaulis				x	
Spartochloa scirpoidea		x			x
Sphaerolobium alatum	x				
Sphaerolobium fornicatum	x				
Sphaerolobium pubescens ms	x				
Sphaerolobium racemulosum				x	
Sphaerolobium rostratum ms	x				
Sphaeropteris cooperi			x		
Sphagnum molliculum	x				
Sphenotoma drummondii	x	x		x	
Sphenotoma parviflorum	x	x			
Sphenotoma sp.Stirling Range (P.G.Wilson 4235)	x	x		x	
Spiculaea ciliata		x			x
Spirogardnera rubescens	x	x			x
Sporadanthus rivularis ms	x				
Sporobolus mitchellii				x	

Table H.1 (Cont'd) Flora species-related values

Taxon name	Endemism	Range end	Relictual primitive	Disjuncture	Monotypic
Spyridium riparium	x				
Stachystemon axillaris		x			
Stachystemon vermicularis		x			
Stackhousia scoparia		x			
Stenanthemum coronatum		x			
Stenanthemum emarginatum				x	
Stenanthemum humile		x			
Stenanthemum intricatum		x			
Stenanthemum intropubens ms	x				
Stenanthemum nanum	x				
Stenanthemum pumilum				x	
Stenopa ramosissima ms			x		x
Stenopetalum filifolium		x			
Stirlingia abrotanoides		x			
Stirlingia divaricatissima	x				
Stirlingia seselifolia	x				
Stirlingia simplex		x			
Strangea stenocarpoides	x				
Stylidium adpressum var. patens		x			
Stylidium albolilacinum		x			
Stylidium articulatum				x	
Stylidium assimile		x			
Stylidium barleei	x				
Stylidium beaugleholei		x		x	
Stylidium corymbosum				x	
Stylidium cymiferum	x			x	
Stylidium diuroides subsp. diuroides		x			
Stylidium glabrifolium	x				
Stylidium glaucum subsp. angustifolium	x				
Stylidium hirsutum		x			
Stylidium laciniatum	x				
Stylidium leptophyllum		x			
Stylidium lowrieanum	x				
Stylidium marradongense ms	x				
Stylidium miniatum	x	x			
Stylidium obtusatum var. rubricalyx		x			
Stylidium pilosum				x	
Stylidium pritzelianum	x				
Stylidium pubigerum	x				
Stylidium pycnostachyum		x			
Stylidium pygmaeum		x			
Stylidium rhipidium				x	
Stylidium rigidifolium	x				
Stylidium roseo-alatum				x	
Stylidium scabridum		x			
Stylidium semaphorum ms	x	x			
Stylidium sp.Boulder Rock (A.H.Burbidge 2536)	x				
Stylidium spinulosum		x			
Stylidium tylosum				x	
Stylidium udusicola		x			
Stylidium utricularioides	x				
Stylidium yilgarnense		x			
Stylobasium australe		x			
Synaphea acutiloba	x				
Synaphea cuneata	x				
Synaphea damopsis	x				
Synaphea decumbens	x				
Synaphea favosa	x				
Synaphea flabelliformis	x				
Synaphea floribunda	x				
Synaphea grandis	x	x			
Synaphea hians	x				
Synaphea incurva	x				
Synaphea intricata	x				
Synaphea macrophylla	x				
Synaphea nexosa	x				
Synaphea odocoileops	x				
Synaphea otiostigma	x				

Table H.1(Cont'd) Flora species-related values

Taxon name	Endemism	Range end	Relictual primitive	Disjuncture	Monotypic
Synaphea panhesya	x				
Synaphea petiolaris subsp. simplex	x				
Synaphea petiolaris subsp. triloba	x				
Synaphea pinnata		x			
Synaphea polymorpha	x	x			
Synaphea preissii	x	x			
Synaphea stenoloba	x				
Synaphea whicherensis	x				
Taraxis glaucescens ms			x		x
Taraxis grossa ms			x		x
Tegicornia uniflora	x				x
Templetonia biloba		x			
Tetratheca filiformis	x				
Tetratheca nuda		x			
Tetratheca parvifolia	x				
Tetratheca pilifera	x				
Tetratheca similis	x				
Tetratheca sp.Granite (S.Patrick SP1224)	x				
Thelymitra dedmaniarum	x				
Thelymitra jacksonii ms	x				
Thelymitra macrophylla		x			
Thelymitra stellata		x			
Thomasia discolor	x	x			
Thomasia glutinosa var. glutinosa	x				
Thomasia macrocarpa				x	
Thomasia montana	x				
Thomasia quercifolia	x				
Thomasia solanacea	x				
Thomasia sp.Big Brook (M.Koch 2373)	x				
Thomasia stelligera		x			
Thomasia tremandroides		x			
Thomasia triloba	x				
Thryptomene australis		x			
Thysanotus anceps		x			
Thysanotus asper		x			
Thysanotus fastigiatus	x				
Thysanotus formosus	x				
Thysanotus glaucus	x				
Thysanotus isantherus	x				
Thysanotus pseudojunceus	x				
Thysanotus rectantherus		x			
Thysanotus scaber	x				
Trachymene cyanopetala		x			
Trachymene ornata		x			
Tremulina cracens ms	x				
Trichocline sp. Treeton (BJ Keighery & N Gibson 564)	x				
Tricoryne arenicola ms				x	
Tricostularia compressa		x			
Triglochin calcitrapum subsp. recurvum ms	x				
Tripterococcus brachylobus ms	x				
Tripterococcus sp.Cannington (A.S.George 16201)	x				
Trymalium ledifolium var. ledifolium		x			
Trymalium urceolare	x				
Trymalium venustum	x				
Tyrbastes glaucescens ms			x		x
Urodon dasyphyllus		x			
Utricularia australis				x	
Utricularia benthamii		x			
Utricularia simplex	x				
Velleia arguta		x			
Velleia cycnopotamica		x			
Velleia foliosa	x	x			
Velleia macrophylla	x				
Verreauxia reinwardtii		x			
Verreauxia verreauxii	x				
Verticordia apecta	x				

Table H.1 (Cont'd) Flora species-related values

Taxon name	Endemism	Range end	Relictual primitive	Disjuncture	Monotypic
Verticordia attenuata	x				
Verticordia bifimbriata	x				
Verticordia citrella	x				
Verticordia densiflora var. pedunculata	x				
Verticordia drummondii		x			
Verticordia endlicheriana var. angustifolia	x				
Verticordia endlicheriana var. endlicheriana		x			
Verticordia fimbrilepis subsp. australis	x				
Verticordia fimbrilepis subsp. fimbrilepis	x				
Verticordia grandiflora		x			
Verticordia huegelii var. stylosa		x			
Verticordia lehmannii	x				
Verticordia lindleyi subsp. purpurea		x			
Verticordia multiflora subsp. multiflora		x			
Verticordia nitens		x			
Verticordia nobilis		x			
Verticordia picta		x			
Verticordia plumosa var. ananeotes	x				
Verticordia plumosa var. pleiobotrya	x	x			
Verticordia plumosa var. vassensis	x				
Verticordia serrata var. ciliata		x			
Verticordia serrata var. linearis	x				
Verticordia serrata var. serrata		x			
Verticordia serrata var. Udumung (D:Hunter & B.Yarran 941006)	x				
Verticordia subulata	x	x			
Viminaria juncea					x
Waitzia acuminata var. acuminata		x			
Waitzia acuminata var. albicans		x			
Waitzia podolepis		x			
Waitzia suaveolens var. flava		x			
Wurmbea calcicola	x				
Wurmbea cernua		x			
Wurmbea drummondii		x			
Wurmbea sp.Cranbrook (A.R.Annels 3819)	x				
Xanthoparmelia darlingensis	x				
Xanthoparmelia hypoleia				x	
Xanthorrhoea acanthostachya		x		x	
Xanthorrhoea brunonis subsp. brunonis	x				
Xanthorrhoea brunonis subsp. semibarbata	x				
Xanthosia fruticulosa		x			
Xanthosia rotundifolia var. rotundifolia	x				
Xanthosia sp.Warren (A.R.Annels 1265)	x				
Xanthosia tomentosa		x			
Xyris gracillima	x				
Xyris inaequalis	x				
Xyris indivisa	x				
Xyris lanata	x				
Xyris laxiflora	x				
Xyris maxima	x				
Xyris roycei	x				

Appendix I Endemic and relictual fauna taxa

Table I.1 Endemic and relictual fauna taxa considered in the national estate assessment

Arachnid	*Wheenyoides cooki*
	Aturidae Gen. nov. "T" sp.
	Pseudohydryphantes doegi near carteri
	Tartarothyas sp.
	Sellnickiella biunguiculata
	Penemideopsis pusilla
	Tillia davisae
	Acercella poorginup
	Larri laffa
	Missulena torbayensis
	Chasmocephalon sp.
	Chasmocephalon flinders
	Chasmocephalon pemberton
	Chasmocephalon tingle
	Austrarchaea sp.
	Synothele harveyi
	Synothele longbottomi
	Synothele rastelloides
	Synothele rubripes
	Cyatholipidae Gen. nov. sp. nov.
	Arbanitis festivus
	Arbanitis inornatus
	Idiosoma hills sp. nov.
	Chenistonia boranup
	Chenistonia paludigena
	Stanwellia karri
	Tasmanoonops sp.
	Tasmanoonops australis
	Symphytognatha picta
	Cf. Pholcomma sp.
	Baalzebub sp.
	Hesperopilio mainae
	Calliuncus labyrinthus
	Dingupa glauerti
	Protochelifer sp.
	Pseudotyrannochthonius giganteus
	Pseudotyrannochthonius sp. nov.
	Tillia nov.
Chilopoda	*Cormocephalus michaelseni*
	Crustacea
	Paramelitidae sp. nov. 2
	Paramelitidae Et Sp. N. 1
	Paramelitidae Et Sp. N. 3
	Hurleya nov.
	Paramelitidae ?? Sp. Nov.
	Paramelitidae ? Et Sp. N. 4
	Perthia aff. acutitelson

Table I.1 (Cont'd) Endemic and relictual fauna taxa considered in the national estate assessment

Chilopoda (Cont'd)	*Perthia nov. 1*
	Isopoda new
	Janiridae Et Sp. N. 1
Diplopoda	*Cynotelopus notabilis*
Gastropoda	*Hydrobiidae (?) Et Sp. N.*
	Bothriembryon sp. nov augusta
	Bothriembryon sp. nov boddington
	Bothriembryon sp. nov denmark b
	Bothriembryon sp. nov manjimup
	Bothriembryon sp. nov nannup
	Bothriembryon sp. nov pt d'entrecasteaux
Insecta	*Castiarina elongata*
	Trichosternus relictus
	Adinolepis apodema
	Acantholophus cupreomicans
	Catasarcus laevior
	Catasarcus ustulatus
	Syndesus macleayi
	?Holjapyx sp. 1
	?Holjapyx sp. 2
	Myopias cf. Tasmaniensis
	Myrmecorhynchus
	Oligomyrmex ?
	Orectognathus clarki
	Armagomphus armiger
	Austrogomphus lateralis
	Hesperocordulia bethoudi
	Lathrocordulia metallica
	Petalura hesperia
	Archaeosynthemis cyanitincta
	Archaeosynthemis occidentalis
	Archaeosynthemis spiniger
Oligochaeta	*Fridericia cylindrica*
	Fridericia giniata
	Fridericia holmesa
	Pelodrilus darlingensis
Onychophora	*Occiperipatoides gilesii*
	Occiperipatoides occidentalis
	Turbellaria
	Alloeocoela
Vertebrata	*Geocrinia alba*
	Geocrinia vitellina
	Spicospina flammocaerulea

Note: ? = Probable affiliations for collected but taxonomically undescribed species.

Map 1. Natural landscapes, old-growth forest & wetlands

COMPREHENSIVE REGIONAL ASSESSMENT
SOUTH - WEST FOREST REGION

National Estate Values
Indicative Areas
Natural landscapes,
old-growth forest & wetlands

0 10 20 30 40 km
Projection: UTM (AMG Zone 50)

Legend
- Rare or depleted old-growth forest (criterion B.1)
- Aggregated old-growth forest (criterion A.2)
- Natural landscapes (criterion B.1)
- Wetlands of national importance (criterion A.2)

LOCALITY MAP
W.A.

DATA DICTIONARY
Data layer custodian: Australian Heritage Commission
Roads - CALM / DOLA
Hydrology - CALM / DOLA
June 1998

AUSTRALIAN HERITAGE COMMISSION

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DEPARTMENT OF CONSERVATION AND LAND MANAGEMENT

INDIAN OCEAN

SOUTHERN OCEAN

300000 350000 400000 450000 500000 550000

6550000 6500000 6450000 6400000 6350000 6300000 6250000 6200000 6150000 6100000

Lancelin
New Norcia
Gingin
Wanneroo
PERTH
Fremantle
Mundaring
Toodyay
Northam
York
Dowerin
Wyalkatchem
Goomalling
Cunderdin
Kellerber
Quairading
Beverley
Kelmscott
Brookton
Pingelly
Mandurah
Pinjarra
Dwellingup
Boddington
Waroona
Narrogin
Williams
Harvey
Wagin
Dumbl
Darkan
Bunbury
Collie
Capel
Donnybrook
Busselton
Katanning
Boyup Brook
Kojonup
Broomehill
Tambellup
Bridgetown
Margaret River
Nannup
Manjimup
Augusta
Pemberton
Mt Barker
Walpole
Denmark

Map 2. Refugia and endemic and relictual fauna

INDIAN OCEAN

SOUTHERN OCEAN

COMPREHENSIVE REGIONAL ASSESSMENT
SOUTH - WEST FOREST REGION

National Estate Values
Indicative Areas
Refugia and endemic and relictual fauna

0 10 20 30 40 km
Projection: UTM (AMG Zone 50)

Legend
- Known locations of relictual or narrowly endemic reptiles, fish and invertebrates (criterion A.1)
- Contemporary fauna refuges (criterion A.2)
- Refugia (criterion A.1)

LOCALITY MAP
W.A.

DATA DICTIONARY
Data layer custodian: Australian Heritage Commission
Roads - CALM / DOLA
Hydrology - CALM / DOLA
March 1998

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PERTH
Mandurah
Bunbury
Collie
Busselton
Nannup
Manjimup
Augusta
Pemberton
Walpole
Mt Barker
Denmark

300000 350000 400000 450000 500000 550000
6550000 6500000 6450000 6400000 6350000 6300000 6250000 6200000 6150000 6100000

Map 3. Endemic, relictual and disjunct flora

INDIAN OCEAN

SOUTHERN OCEAN

COMPREHENSIVE REGIONAL ASSESSMENT

SOUTH - WEST FOREST REGION

National Estate Values
Indicative Areas
Endemic, relictual and disjunct flora

0 10 20 30 40 km

Projection: UTM (AMG Zone 50)

Legend

Areas important as centres for

- Narrowly endemic plants (criterion A.1)
- Relict (primitive or Gondwanic) plants (criterion A.1)
- Plants with disjunct populations (criterion A.1)

LOCALITY MAP

W.A.

DATA DICTIONARY
Data layer custodian: Australian Heritage Commission
Roads - CALM / DOLA
Hydrology - CALM / DOLA
March 1998

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PERTH
Mandurah
Bunbury
Collie
Busselton
Nannup
Manjimup
Augusta
Pemberton
Mt Barker
Denmark
Walpole

300000 350000 400000 450000 500000 550000

6550000 6500000 6450000 6400000 6350000 6300000 6250000 6200000 6150000 6100000

Map 4. Rare, restricted and threatened communities

COMPREHENSIVE REGIONAL ASSESSMENT
SOUTH - WEST FOREST REGION

National Estate Values
Indicative Areas
Rare, restricted and
threatened communities

0 10 20 30 40 km
Projection: UTM (AMG Zone 50)

Legend
- Threatened ecological communities (criterion B.1)
- Rare forest ecosystems (criterion B.1)
- Rare, restricted and/or threatened vegetation complexes (criterion B.1)

LOCALITY MAP
W.A.

DATA DICTIONARY
Data layer custodian: Australian Heritage Commission
Roads - CALM / DOLA
Hydrology - CALM / DOLA
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INDIAN OCEAN

SOUTHERN OCEAN

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Manjimup
Augusta
Pemberton
Walpole
Denmark
Mt Barker

300000 350000 400000 450000 500000 550000
6550000 6500000 6450000 6400000 6350000 6300000 6250000 6200000 6150000 6100000

Map 5. Vegetation diversity and flora species richness

INDIAN OCEAN

SOUTHERN OCEAN

COMPREHENSIVE REGIONAL ASSESSMENT
SOUTH - WEST FOREST REGION

National Estate Values
Indicative Areas
Vegetation diversity and
flora species richness

0 10 20 30 40 km
Projection: UTM (AMG Zone 50)

Legend
- Areas with unusually high flora species richness (criterion A.3)
- Areas with unusually high diversity of vegetation complexes (criterion A.3)

LOCALITY MAP
W.A.

DATA DICTIONARY
Data layer custodian: Australian Heritage Commission
Roads - CALM / DOLA
Hydrology - CALM / DOLA
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Plot identifier: rfs_980211_032

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Busselton
Nannup
Manjimup
Augusta
Pemberton
Mt Barker
Denmark
Walpole

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6550000 6500000 6450000 6400000 6350000 6300000 6250000 6200000 6150000 6100000

Map 6. Social Value

INDIAN OCEAN

SOUTHERN OCEAN

COMPREHENSIVE REGIONAL ASSESSMENT
SOUTH - WEST FOREST REGION

National Estate Values
Indicative Areas
Social Value

0 10 20 30 40 km
Projection: UTM (AMG Zone 50)

Legend
- Social value (Criterion G.1)
- Social value - Aboriginal (Criterion G.1)

LOCALITY MAP

W.A.

DATA DICTIONARY
Data layer custodian: Australian Heritage Commission
Roads - CALM / DOLA
Hydrology - CALM / DOLA
June 1998

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Lancelin, New Norcia, Gingin, Dowerin, Wyalkatchem, Goomalling, Toodyay, Northam, Cunderdin, Kellerberrin, Wanneroo, Mundaring, York, PERTH, Fremantle, Quairading, Beverley, Kelmscott, Brookton, Mandurah, Pingelly, Pinjarra, Dwellingup, Boddington, Waroona, Narrogin, Williams, Harvey, Wagin, Dumbleyung, Bunbury, Collie, Darkan, Capel, Donnybrook, Busselton, Katanning, Boyup Brook, Kojonup, Broomehill, Margaret River, Nannup, Bridgetown, Tambellup, Manjimup, Augusta, Pemberton, Mt Barker, Walpole, Denmark

300000 350000 400000 450000 500000 550000
6550000 6500000 6450000 6400000 6350000 6300000 6250000 6200000 6150000 6100000

Map 7. Aesthetic Values

COMPREHENSIVE REGIONAL ASSESSMENT
SOUTH - WEST FOREST REGION

National Estate Values
Indicative Areas
Aesthetic Values

0 10 20 30 40 km
Projection: UTM (AMG Zone 50)

Legend
- Aesthetic Values (Criterion E.1)

LOCALITY MAP
W.A.

DATA DICTIONARY
Data layer custodian: Australian Heritage Commission
Roads - CALM / DOLA
Hydrology - CALM / DOLA
May 1998

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INDIAN OCEAN

SOUTHERN OCEAN

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6550000 6500000 6450000 6400000 6350000 6300000 6250000 6200000 6150000 6100000

New Norcia
Lancelin
Dowerin
Wyalkatchem
Goomalling
Gingin
Toodyay
Northam
Cunderdin
Kellerberg
Wanneroo
York
Mundaring
PERTH
Quairading
Fremantle
Beverley
Kelmscott
Brookton
Mandurah
Pingelly
Pinjarra
Dwellingup
Boddington
Waroona
Narrogin
Williams
Harvey
Wagin
Dumbl
Bunbury
Collie
Darkan
Capel
Donnybrook
Busselton
Katanning
Kojonup
Boyup Brook
Broomehill
Bridgetown
Margaret River
Nannup
Tambellup
Manjimup
Augusta
Pemberton
Mt Barker
Denmark
Walpole

Map 8 - Registered and Interim listed National Estate Places

INDIAN OCEAN

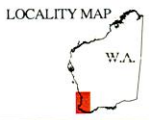
COMPREHENSIVE REGIONAL ASSESSMENT
SOUTH - WEST FOREST REGION

National Estate Values
Indicative Areas
Registered and Interim Listed
National Estate Places

0 10 20 30 40 km
Projection: UTM (AMG Zone 50)

Legend
- Registered Places
- Interim - listed Places

LOCALITY MAP



DATA DICTIONARY
Data layer custodian: CALM
Roads - CALM / DOLA
Hydrology - CALM / DOLA
April 1998

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Manjimup
Augusta
Pemberton
Mt Barker
Denmark
Walpole

SOUTHERN OCEAN

300000 350000 400000 450000 500000 550000

6550000 6500000 6450000 6400000 6350000 6300000 6250000 6200000 6150000 6100000

Map 9. Social Value - Aboriginal

COMPREHENSIVE REGIONAL ASSESSMENT
SOUTH - WEST FOREST REGION

Social Value - Aboriginal

0 10 20 30 40 km
Projection: UTM (AMG Zone 50)

Legend

Places of Aboriginal social value identified through community heritage workshops but not documented to the level required for listing in the Register of the National Estate.

LOCALITY MAP

W.A.

DATA DICTIONARY
Data layer custodian: Australian Heritage Commission
Roads - CALM / DOLA
Hydrology - CALM / DOLA
June 1998

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INDIAN OCEAN

SOUTHERN OCEAN

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6550000 6500000 6450000 6400000 6350000 6300000 6250000 6200000 6150000 6100000

New Norcia
Lancelin
Dowerin
Wyalkatchem
Goomalling
Gingin
Toodyay
Northam
Cunderdin
Kellerber
Wanneroo
Mundaring
York
PERTH
Fremantle
Quairading
Beverley
Kelmscott
Brookton
Pingelly
Mandurah
Pinjarra
Dwellingup
Boddington
Waroona
Narrogin
Williams
Harvey
Wagin
Dumbl
Bunbury
Collie
Darkan
Capel
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Katanning
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