Plant Species and Sites of Botanical Significance

in the Southern Bioregions

of the Northern Territory

Volume 2: Significant Sites
Part 1: Sites of Significance

Prepared By

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for the Arid Lands Environment Centre

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Volume 2: Significant Sites

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Front cover photograph: Ormiston Creek below Ormiston Gorge, with Mount Sonder in the background, by Bruce G. Thomson.

Forward from the Convenor of the Arid Lands Environment Centre

The Arid Lands Environment Centre is pleased to present this report on the current understanding of the status of rare and threatened plants in the southern NT, and a description of sites significant to their conservation, including waterholes. The work is the result of a productive collaboration between a community group and a government department (PWCNT), without whose co-operation such an extensive report would not have been possible. We would like to thank the Australian Heritage Commission for their provision of funding for the project, our consultant Matt White who undertook the work, and the Parks and Wildlife Commission of the Northern Territory for their extensive assistance with its execution.

It is our intention that the information in this report becomes widely available, not just to those with a specialist interest in plants or regional management of natural resources, but also to the land holders, managers and traditional owners of the sites broadly described in this report. It is our hope that in promoting the availability of this information we will increase the opportunities for constructive conversations between land holders and managers, government and conservation groups, and go some distance towards making up for past tensions between some of these groups. It is with this goal in mind that we commit to improving the accessibility of the information in this report, and to consulting with land-manager groups over the presentation of the information, and the protection of sites from access without land-holder permission.

Ms Melinda Hillery
Convenor of the Arid Lands Environment Centre

Forward from the Director of the Parks and Wildlife Commission of the Northern Territory

This report provides a benchmark for the conservation status of botanical values in the southern, predominantly arid part of the Northern Territory. It will have many and varied uses, providing information about conservation values to land holders and managers as well as government departments and conservation groups.

The report draws together into two volumes a tremendous amount of existing knowledge that was previously difficult to access, and includes information not formally recorded previously. Existing knowledge is patchy and for some places is very limited. Users of the report need to be aware that the conservation assessments of species and sites will change as knowledge improves over time. New information provided by users will inevitably require adjustment of the boundaries of many of the broad sites of botanical significance and new sites may be identified in areas about which there is currently inadequate botanical knowledge.

It is to be hoped that improved land management will increase the likelihood of survival of some of the species currently considered to be under threat.

A great deal of prior research and plant collecting by staff members of the Parks and Wildlife Commission of the Northern Territory underpins this report. The Northern Territory Herbarium has played a vital part in its collation. The Arid Lands Environment Centre (ALEC) is commended for the role it has played in bringing about this report, with financial assistance from the Australian Heritage Commission

Dr Bill Freeland
Director of the Parks and Wildlife Commission of the Northern Territory

Executive summary

This report, presented in two volumes, lists vascular plants of conservation significance and sites of importance for botanical conservation in the southern bioregions of the Northern Territory (NT). The study area encompasses those parts of the Northern Territory considered to have 'arid zone vegetation' but also includes the semi-arid Barkly Tablelands.

The report has largely been produced using existing knowledge on the distribution and conservation of rare plants. It is intended that it will be used as a source of information for land managers, owners and planners. By collating existing knowledge of botanical values those values can be better protected by land management and land-use planning. The report also includes recommendations for prioritising future botanical survey, research, and monitoring and threatened plant management.

The existing botanical information is very limited for some parts of the study area and as a consequence, it is likely that the status of many of the significant species and sites will be revised as more information on the distribution of plant species is collected. Some species may prove to be more common than current knowledge indicates, whilst others that are poorly known may be confirmed as rare. Likewise, the boundaries of some of the sites may be amended to take account of new information and new sites may be delineated. It is anticipated that this document will be updated from time to time to accommodate new information. As such, this report should be regarded as a first edition.

A significant limitation of the report is that the unsurpassed knowledge of the flora of central Australia retained by Aboriginal peoples has not been incorporated. This document has been researched and developed employing a perspective of the flora that has evolved through the 'western scientific' tradition and a western or European aesthetic. Unfortunately the values that Aboriginal people ascribe to the landscape and landscape elements such as plant communities and species have not been explored.

Volume one is an assessment of plant species of conservation significance and is presented in two parts. The first part describes the background to the report, the study area, data sources and methods. Part one also includes a description of the broad habitat types found in the study area and includes lists of the rare and threatened plants known to occur in each. Lists of taxa are given for each category of significance and significant taxa known from each bioregion are listed. Recommendations are made for further survey, research, monitoring and management tasks relevant to the conservation of rare, threatened and poorly known plant taxa.

Part two of volume one comprises an annotated list of all vascular plants of conservation significance in the southern bioregions of the NT (1,023 taxa). The terms taxa and taxon are used rather than species, because in some cases a significance rating only applies to one of several sub-species or varieties. Four broad levels of significance are identified: national (125 taxa), Northern Territory (399 taxa), southern NT (71 taxa) and bioregional (428 taxa). The categories of southern NT and bioregional significance are new categories devised for this report. They identify plant species that do not qualify as significant at the NT or national levels. Bioregionally significant taxa are only classified as significant in some bioregions or parts of bioregions in the study area and many are common in other bioregions.

The annotated list of significant taxa includes the conservation code, reservation status and geographic distribution of each taxon, with an accompanying map. For taxa that are nationally significant or significant in the NT, notes on habitat and lifeform are also provided. For southern NT and bioregionally significant taxa, generally only the nature of the significance is given.

Volume two describes sites and waterholes of botanical significance in the southern bioregions of the NT. The first part of volume two describes the concept of significant botanical sites, the methods used to define them and a summary of the sites themselves. The second part contains the descriptions of the sites and waterholes, arranged by bioregion and level of significance.

The sites of botanical significance are broadly defined and mostly cover large areas, with average size being 500 square kilometres. The sites are areas that are considered important for plant conservation generally and specifically for conserving the plant taxa listed in volume one. Sites are designated as either nationally significant (41 sites), bioregionally significant (79 sites) or of undetermined significance (33 sites). The assessment of degree of significance was based on the known botanical attributes of each site, in the context of the overall distribution of those attributes in the study area. The attributes of each site were assessed against criteria that were adapted from those used by the Australian Heritage Commission to assess natural places for inclusion on the Register for the National Estate. The criteria take account of the conservation of plant biodiversity, including populations and species of plants, the genetic

resources they harbour, the plant communities which they form and the range of ecological and evolutionary processes operating in the landscape. Site descriptions include maps, lists of significant vascular plant taxa and associated attributes such as endemism. The significance category 'undetermined' was included to record areas that were identified as significant on the basis of anecdotal information only. The sites of significance are described in the context of the bioregions within which they occur and a brief general description is given for each bioregion, including a summary of the sites identified within it.

Volume two also lists 38 permanent and semi-permanent waterholes and springs of botanical significance.

Notes on the authors

The preparation of this report was a large task involving several organisations and people. The principal author, Matt White, was engaged by the Arid Lands Environment Centre (ALEC) to carry out the work funded by two grants from the Australian Heritage Commission. Mary Hamilton was also funded through these grants. David Albrecht and Angus Duguid work for the Parks and Wildlife Commission of the Northern Territory and Peter Latz retired from that organisation during the life of the project. The Parks and Wildlife Commission had an integral role in the project, with most of the existing data about plant species and their distributions being held by the Commission. Also, there was a great deal of information held by Commission staff that had not been formally recorded prior to this report. By collaborating, ALEC and the Parks and Wildlife Commission have been able to produce a product that is far more comprehensive than would have been possible under the resources of the Heritage Commission Grants alone.

All of the authors contributed a great deal to various aspects of the project. Matt White had the lion's share, working full time on it for one year, while employed by ALEC, and for several months' spread over 1998, 1999 and 2000. David Albrecht, botanist at the Alice Springs Herbarium, contributed his knowledge of the flora, its taxonomy and its ecology. David also had a major role in assessing the conservation status of many of the species. Angus Duguid works on both threatened species management and plant ecology. His particular contribution was in the application of database technology and in the use of geographic information systems to analyse plant distributions and relationships as well as a major role in editing and compiling the final report. Peter Latz is one of the wise old men or Tjilpi of central Australian plant ecology. Peter contributed a massive proportion of the plant collections underlying this report and is still actively collecting specimens. Also, much of the information about the sites of botanical significance came from Peter's interpretations. Mary Hamilton digitised the sites of significance polygons and prepared the site maps. Mary also had a major role in preparing the final document.

Acknowledgements

In its first year the project was overseen by a Steering Committee, the members of which were Terry Mahney (ALEC Convenor), Georgie Stewart (ALEC co-ordinator), Karina Menkhorst and David Albrecht. Their vision and interest in the project is duly acknowledged.

The directors of CANB, BRI and PERTH are thanked for access to herbarium records.

The following people are gratefully acknowledged for their important and varied contributions: Jane Bowland, Tony Bowland, Joseph Breen, Suzanne Cawood, Hilary Coulson, Clyde Dunlop, Margaret Friedal, Nick Gambold, Russell Grant, Graham Griffin, Craig Hempel, Melinda Hillery, Peter Horsfall, Craig James, Deborah Lau, Bill Low, Jodie Mason, Des Nelson, Brenda Pitts, Mark Richardson, Peter Slater and Georgie Stewart. Darren Schunke assisted greatly by customising the ARCVIEW GIS software to speed up the process of creating the site maps. Partners and children of the authors sacrificed a great deal of family time and are duly acknowledged for their contribution.

Table of Contents - Part 1

List of Figures in Part 1

Note: individual site maps presented alongside site descriptions are not included in the list of figures.

List of Tables in Part 1

Part 1

1. Overview of Volume 2 – Sites of Significance

This is the second of two volumes and describes broad sites and waterholes of botanical significance in the southern bioregions of the Northern Territory and the methods used to delineate them.

The study area is the southern bioregions of the Northern Territory (Figures 1 & 2), defined according to Albrecht *et al.* (1997). The bioregion boundaries are generally those of the Interim Biogeographic Regionalisation for Australia (Thackway and Cresswell, 1995). The northern edge of the study area corresponds with the northern boundary of the Tanami bioregion and a modified northern boundary of the Mitchell Grass Downs bioregion. The 18° S line of latitude is a useful approximation of the northern boundary. The other boundaries of the study area are those of the Northern Territory border. A general description of the vast and mainly arid study area is given in volume one of this report, along with comprehensive descriptions of plant species of conservation significance. Volume one also contains a more complete introduction to the aims and background of this project.

This volume is divided into two main parts. Part one describes the methods and criteria used to delineate the sites. It includes a summary of the information presented in part two of this volume, with maps and tables for sites of national, bioregional and undetermined significance, plus a summary of waterholes of botanical significance. Part one also includes recommendations for further research and management of sites of botanical significance.

The second part of this volume contains detailed descriptions of sites of botanical significance in each bioregion. A section is devoted to each bioregion, and includes a brief general description of the bioregion, followed by a map of the bioregion showing sites of significance within it. Sites are assigned to one of three significance categories, and the site descriptions, with location maps, are ordered according to the significance category in the following sequence – national, bioregional, undetermined. Botanically significant waterholes are listed after the site descriptions within each bioregion section.

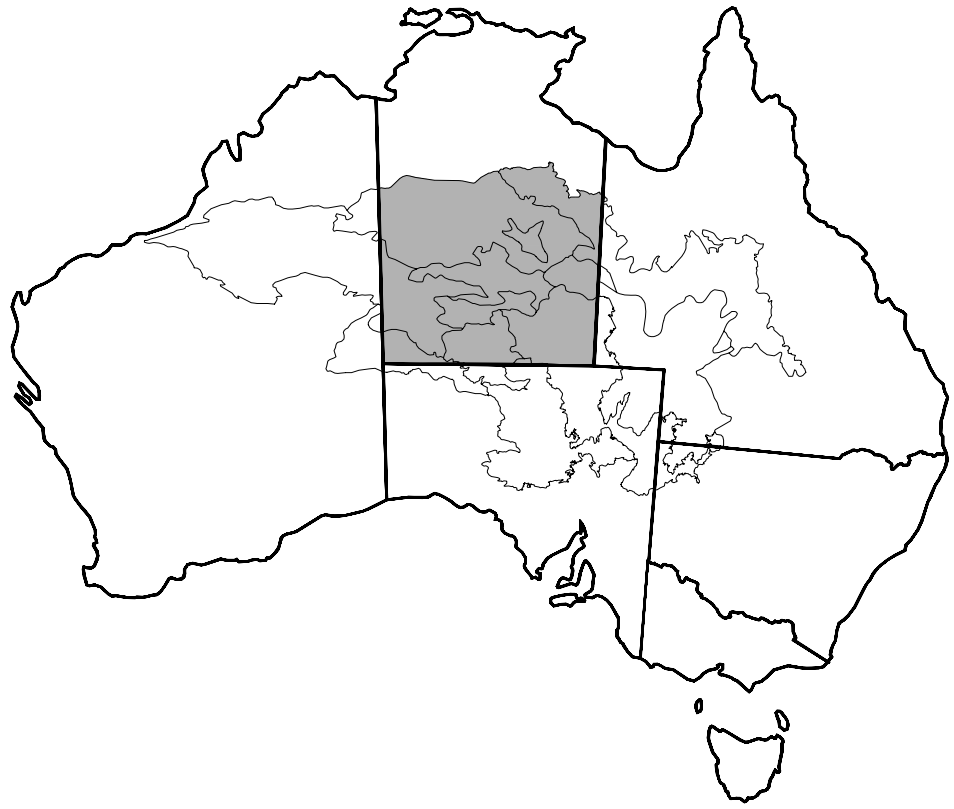

Figure 1: Map of Australia showing the study area, state borders and bioregion boundaries.

The study area is shaded, the state borders are depicted with thicker black lines and bioregion boundaries with thinner black lines. Those bioregions that extend from the study area into adjacent states are mapped across their entire extent.

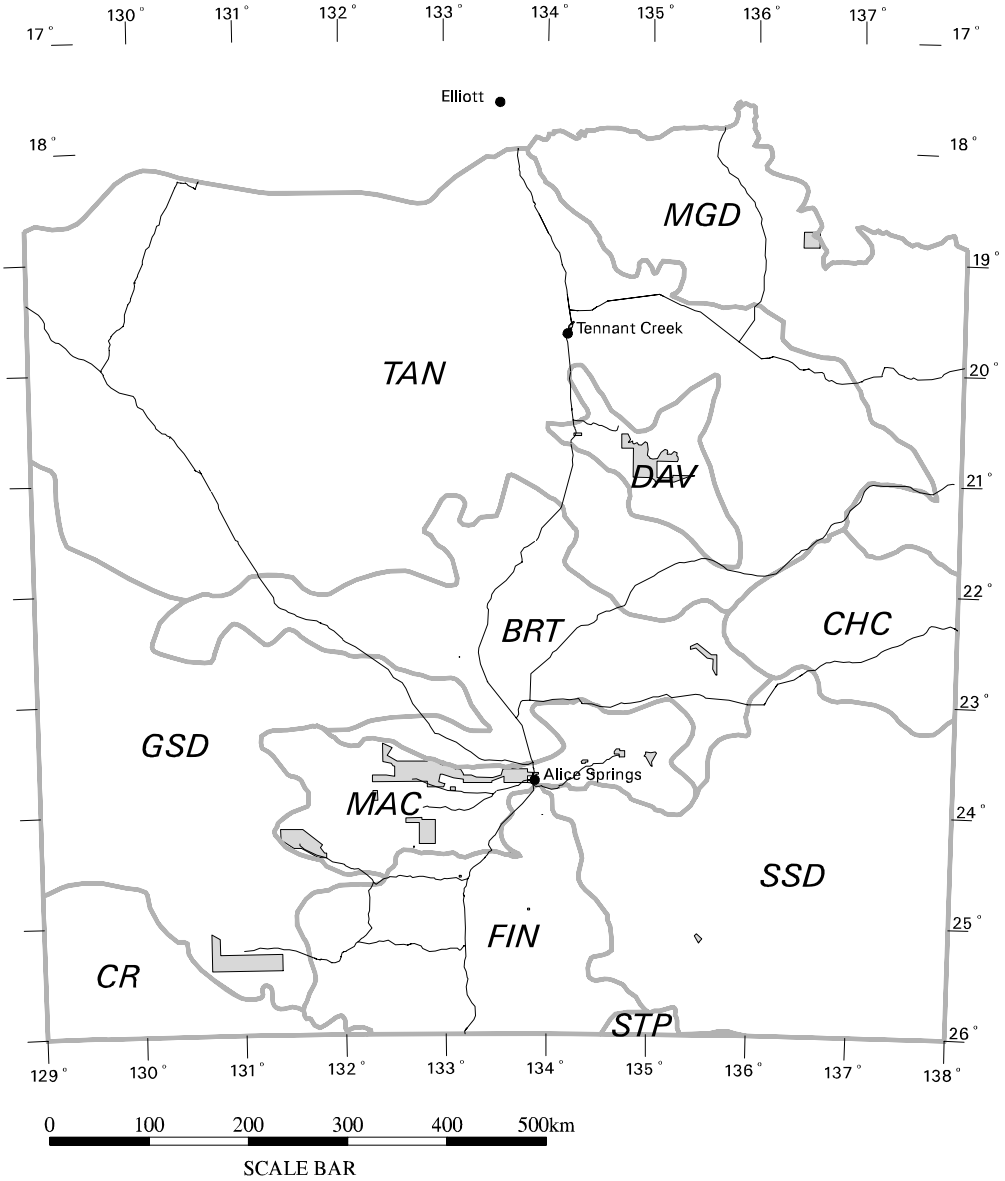

Figure 2: Map of the study area showing biogeographical regions.

Thin lines depict major roads and conservation reserves are shaded.

The bioregion names and associated abbreviations are:

- Burt Plain (BRT)
- Central Ranges (NT portion) (CR)
- Channel Country (NT portion) (CHC)
- Davenport Murchison Ranges (DAV)
- Finke (NT portion) (FIN)
- Great Sandy Desert (NT portion) (GSD)
- MacDonnell Ranges (MAC)
- Mitchell Grass Downs (NT portion) (MGD)
- Simpson-Strzelecki Dunefields (NT portion) (SSD)
- Stony Plains (NT portion) (STP)
- Tanami Desert (NT portion) (TAN)

It should be noted that the Davenport Murchison Ranges bioregion was delineated in preparation of the checklist of vascular plants of the study area (Albrecht *et al.*, 1997) and was adopted here for the same reasons as given with the checklist. A more complete discussion of the bioregions boundaries used in this study is given in volume one of this report and in Albrecht *et al.* (1997).

2. Introduction to Sites of Botanical Significance

Sites of botanical significance are defined here as areas that are important for plant conservation generally and specifically for conserving the plant taxa listed in volume one. The term 'significance' is used here to indicate a thing which is 'noteworthy or of considerable importance'. Thus, sites of botanical significance have botanical features that distinguish them from the surrounding landscape, and consequently the conservation of the vegetation should receive special attention at those sites. This does not mean that the surrounding areas are of no conservation value.

Specific criteria must be applied in determining the significance of a site so that the process is objective. The criteria used in this study are based on those used by the Australian Heritage Commission to assess natural places for inclusion on the Register for the National Estate (Table 1 & 2). The assessment of significance of each site is based on the known botanical attributes of the site, in the context of the overall distribution of those attributes in the study area. The criteria are independent of land-use classifications (e.g. conservation reserves) or land ownership (e.g. public land or freehold), instead being an assessment of the qualities of the flora in the context of its distribution, conservation status and integrity as currently understood.

Each broad site is ranked at one of three levels of significance: national, bioregional or undetermined. There are two components that define these levels: degree and scale. The assessment of *degree* of significance (e.g. high or moderate) is based on the values of the site in relation to the overall distribution, condition or importance of sites possessing these values - within the range delineated by the *scale* of reference, (i.e. national, state or territory, bioregional or local). Scale and degree are combined into levels of significance denoted by scale alone. Site significance was not assessed at the Northern Territory or study area level, in contrast to the assessment of taxa in volume one, where four levels of significance were assessed (national, Northern Territory, study area and bioregional). The third category used here, undetermined significance, is included to highlight areas where botanical values were strongly suspected, but are not confirmed by quantitative data. Most of these 'undetermined' sites emerged anecdotally through discussions with botanists and ecologists that have worked in the study area. Given the large 'gaps' in our knowledge of the distribution and conservation status of vascular plants across the study area, these sites of potential significance were documented to direct future fieldwork and exploration. It should not be assumed that these sites would inevitably be assessed as nationally or bioregionally significant following further work.

The sites of significance delineated are generally large, encompassing broad areas of similar terrain. They range in size from two square kilometres to three and a half thousand square kilometres with an average size of about five hundred square kilometres.

Waterholes of botanical significance are treated separately from the broad sites because of their particular importance in the arid zone. Many of the significant waterholes are contained within the broader sites of botanical significance. Waterholes were assessed as being of either national or bioregional significance, in the same way as the broader sites.

The predominant factor influencing the level of significance of the sites is the conservation significance of the plant taxa known to occur there. The reliance on the use of available knowledge is emphasised. Current knowledge of the flora within the study area is far from comprehensive. Some areas have been rarely visited by botanists, as indicated by Figure 3, which shows the numbers of specimens collected from quarter degree grid cells across the study area. Consequently, site boundaries and the level of significance attributed to each site may be reassessed in the future with new information about species distributions. Similarly, new areas of botanical significance may be identified.

This report does not make detailed recommendations about land use planning or land management for the protection of botanical values. At some sites, land use has been relatively constant over several decades and the existing botanical values may be assumed to be compatible with the land use. However, throughout the study area there are many ongoing and potential changes, such as changes to fire regimes and the invasion of competitive introduced species, that may threaten botanical values.

It is hoped that this report will assist landholders and organisations to identify sites of botanical significance under their control and will encourage them to implement management practices that maintain the known botanical values of the sites.

It is important that land managers and land use planners be aware that areas outside of the defined sites of significance may also have botanical values worth protecting. Representative samples of all vegetation types in the study area should be protected for the general conservation of biodiversity. Protection of both defined sites of significance and representative samples of vegetation types may be achieved in a number of ways besides reserving land in national parks.

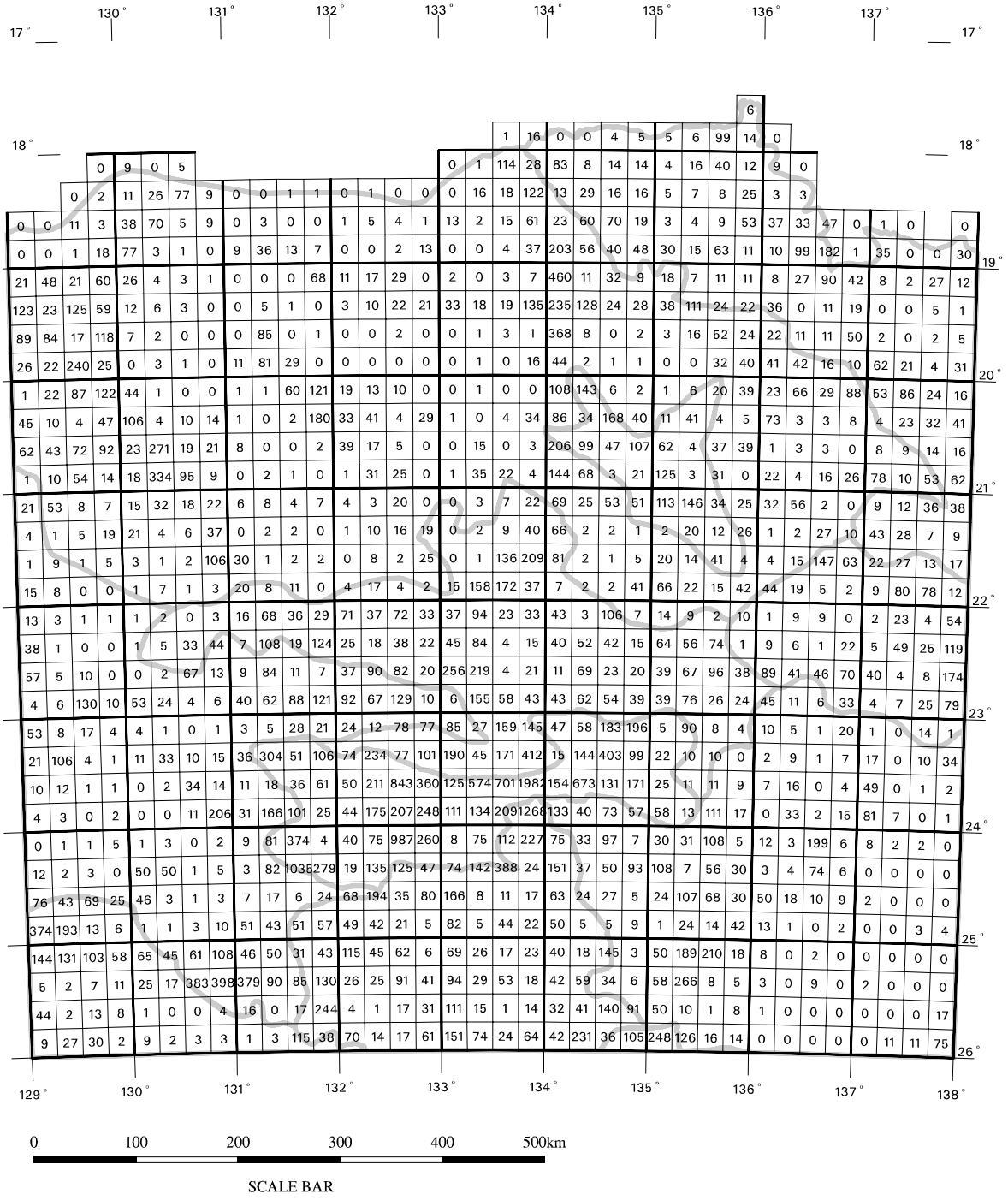

Figure 3: Map of study area showing the collecting intensity across the study area.

Collecting intensity as determined by the number of plant specimens lodged at the NT Herbarium at February 2000 for each quarter degree grid square (updated from Albrecht *et al*, 1997). All latitudes and longitudes were assumed to be in the AGDGG datum.

3. Methods

3.1 OVERVIEW OF BOTANICAL ATTRIBUTES THAT CONTRIBUTE TO THE BOTANICAL SIGNIFICANCE OF AN AREA

Many botanical attributes have the potential to be used in the assessment of botanical significance. The attributes that are used most frequently in such assessments are the presence of significant plant taxa, the presence of significant plant communities, the presence of species type localities, the integrity of the ecosystems present and the diversity of plant taxa and plant communities present. In this study it was not possible to consider many of these botanical attributes due to a lack of detailed data. For example, our current knowledge of significant plant communities in the study area is insufficiently developed to enable us to confidently use this information in the assessment of significant sites. The only botanical attributes that could be used consistently throughout the assessment are the presence of significant plant taxa and the presence of type locations. Type localities are places from which the specimen/s used to describe a new taxon were collected in the wild. Type localities are important as taxonomic reference places and it is desirable from this perspective that the vegetation remains intact.

The data compiled for volume one of this report, which includes the determination of significant plant taxa and type locations, formed the basis for the assessment of sites of significance presented in volume 2. The methodology for determining taxa of significance is described in volume one.

3.2 DATA SOURCES

Data on the distribution and abundance of plant taxa was acquired from a range of sources including herbarium databases and collections, published taxonomic literature, published and unpublished survey literature and personal discussions with field workers based in Alice Springs.

3.2.1 Databased herbarium records

Much of the data used in this project has been taken directly from the Northern Territory Herbarium Database (Holtze) which is maintained by the Parks and Wildlife Commission of the Northern Territory (PWCNT). This extensive data set includes records of all botanical collections lodged at the Northern Territory Herbarium (NT & DNA). Collections from the study area housed at interstate herbaria were scrutinised to corroborate and augment vascular plant records from 'Holtze'. Databased records of herbarium specimens lodged at the Australian National Herbarium (CANB), the Western Australian Herbarium (PERTH) and the Queensland Herbarium (BRI) were obtained and included in the analysis.

3.2.2 Taxonomic literature

Taxonomic literature provided further distributional and ecological material. Information was collated from regional and state based floras, the flora of Australia series described in George (1981) and major Australian taxonomic journals (including *Nuytsia, Telopea, Muelleria, Austrobaileya, Journal of the Adelaide Botanic Gardens, Australian Systematic Botany, Brunonia and Australian Journal of Botany*), and where relevant international journals such as the *Kew Bulletin*. Type locations for species described prior to 1990 were extracted from sources referenced in the Australian Plant Name Index (Chapman 1991). Taxonomic references consulted are included in the list of references in section 7.2.

3.2.3 Survey reports

Numerous reports include useful descriptive information on the flora and/or vegetation of the study area. Some reports include information on the relationship between physical site characteristics, such as geology, and vegetation patterns and composition. Survey literature consulted usually falls within one of the following six categories:

- floristic vegetation survey reports and land unit surveys, such as those carried out by Wilson *et al.* (1990), Albrecht & Pitts (in press), Pitts (1994) and Pitts *et al.* (1995);
- rapid broad-scale descriptive reports focusing on specific pastoral leases (e.g. Low *et al.* 1987);
- rapid site specific surveys carried out by Parks and Wildlife Commission of the Northern Territory (PWCNT) staff;
- maps and explanatory reports produced as part of the 1:250,000 geological map series for the Northern Territory;
- research reports and publications; and
- short (unpublished) reports and species lists.

Most of the unpublished reports consulted were from the PWCNT library at Alice Springs and the Alice Springs Herbarium library. Survey reports consulted are included in the list of references in section 7.2.

3.2.4 Anecdotal information

Anecdotal sources of information were also used, including field observations of the authors. Lengthy discussions were held with the following individuals with an intimate knowledge of the study area and/or with key plant species or assemblages: Clyde Dunlop, Margaret Friedal, Nick Gambold, Russell Grant, Graham Griffin, Bill Low, Des Nelson, and Brenda Pitts.

3.3 CRITERIA USED FOR DETERMINING AND RANKING SITES OF BOTANICAL SIGNIFICANCE

The Australian Heritage Commission (AHC) has developed a set of criteria by which places are assessed for inclusion on the Register for the National Estate. A sub-set of these criteria are used for the appraisal of places of natural significance (Table 1) and these were adapted for use in determining botanical significance across the study area. These criteria relate to plant biodiversity values, including populations and species of plants, the genetic resources they harbour, the plant communities that they form, and the range of ecological and evolutionary processes operating in the landscape.

Table 1: Criteria developed by the Australian Heritage Commission, used in the evaluation of places of natural significance (source: AHC web-site).

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

It is important to note that these criteria are not ranked and values demonstrated by each criterion are not directly comparable. As such, an area which is recognised as nationally significant for the presence of a rare plant species (i.e. criterion B.1) is not necessarily more important than another area which may be recognised as nationally significant for the presence of a suite of plant taxa at the edge of their continental range (i.e. criterion A1).

AHC criteria for the assessment of natural values are associated with a subset of 'National Estate guidelines', which refer to potentially important attributes to be considered under each criterion (Table 2). These have been modified here to highlight botanical values rather than general natural values. Only vascular plants were considered in this report.

Thresholds were defined at both the national and bioregional scale and were employed to quantify these guidelines and further refine particular National Estate criteria (Table 2). The suite of criteria used to assess attributes was effectively hierarchical, loosely conforming to the following sequence:

- National Estate criteria – consideration of broad criteria;
- National Estate guideline – definition of attribute to be assessed; and
- project criteria – botanical attributes assessed against thresholds.

The ranking or scale of significance is based on the attribute thresholds in Table 2. Sites were ranked as nationally or bioregionally significant. If the botanical values of a site were strongly suspected, but are not confirmed by quantitative data, the site was categorised as of undetermined significance. A site of national significance is one where the occurrence of an attribute (e.g. a population of a significant taxon) or attributes contributes substantially to the presence of that attribute or set of attributes in Australia. Accordingly a site of bioregional significance is one where the occurrence of an attribute or set of attributes contributes substantially to the presence of that attribute or attributes in the relevant bioregion but not necessarily across the continent.

Table 2: Criteria for assessing botanical significance of sites in the southern bioregions of the NT. (based on Table 1 but modified to highlight botanical values at national and bioregional levels of significance)

A. Ecological			
AHC Criteria	**AHC Guidelines**	**Project criteria**	
		National significance attribute thresholds	**Bioregional significance attribute thresholds**
1. Importance in the evolution of Australian flora, fauna, landscape or climate	**a.** Species on the edge of their geographic range or in atypical locations	**i)** Site is of national bio-geographical importance - with 10 or more taxa reaching the edge of their continental distribution.	**ii)** site supports three or more plant taxa at the edge of their continental distribution
	b. Geographically and/or ecologically disjunct populations	**i)** Site is of national phytogeographic importance – with 10 or more taxa with geographically and/or ecologically disjunct populations.	**ii)** Site supports three or more taxa with geographically and/or ecologically disjunct populations.
	c. Relict plant taxa or communities	**i)** Site is of national phytogeographical and ecological importance – supporting 10 or more potentially relict plant taxa.	**ii)** Site supports populations of three or more potentially relict plant taxa.
	d. Endemic plant taxa	**i)** Site is of national phytogeographical and evolutionary importance – supporting locally endemic plant taxa.	

Table 2 Continued

A. Ecological (continued)			
AHC Criteria	**AHC Guidelines**	**National significance attribute thresholds**	**Bioregional significance attribute thresholds**
2. Importance in maintaining existing processes at the regional or national scale	**a.** Important sites along migratory routes	Not applicable to project.	Not applicable to project.
	b. Important gene pools	Not assessed as insufficient available data.	Not assessed as insufficient available data.
	c. Establishment of biota after major environmental disturbance by natural agents	**i)** Not specifically assessed, attributes noted where they co-occur with other values.	**ii)** Not specifically assessed; attributes noted where they co-occur with other values.
	e. Refuges	**i)** Not specifically assessed, attributes noted where they co-occur with other values.	**ii)** Not specifically assessed; attributes noted where they co-occur with other values.
	f. Intact ecosystems, particularly undisturbed whole catchments	**i)** Not specifically assessed, attributes noted where they co-occur with other values.	**ii)** Not specifically assessed; attributes noted where they co-occur with other values.
	g. Places of high biological/ecological integrity of viable size	**i)** Not specifically assessed, attributes noted where they co-occur with other values.	**ii)** Not specifically assessed; attributes noted where they co-occur with other values.
	h. Places where processes are demonstrable in a significant manner e.g. important breeding areas	**i)** Not specifically assessed, attributes noted where they co-occur with other values.	**ii)** Not specifically assessed; attributes noted where they co-occur with other values.
3. Diversity/Richness: Importance in exhibiting unusual richness or diversity of species, communities, landscape and physical features.	**a.** Species-rich communities of their type.	**i)** Not specifically assessed, attributes noted where they were considered unusual in the context of the study area and co-occurred with other values.	**ii)** Not specifically assessed; attributes noted where they were considered unusual in the context of the bioregion and co-occurred with other values.
	b. Diversity of plant communities or associations	**i)** Not specifically assessed, attributes noted where they were considered unusual in the context of the study area and co-occurred with other values.	**ii)** Not specifically assessed; attributes noted where they were considered unusual in the context of the bioregion and co-occurred with other values.
	c. Diversity of flora species	**i)** Not specifically assessed, attributes noted where they were considered unusual in the context of the study area and co-occurred with other values.	**ii)** Not specifically assessed; attributes noted where they were considered unusual in the context of the study area and co-occurred with other values.
	d. Abundance of a particular species	Not assessed insufficient available data.	Not assessed as insufficient available data.

Table 2 Continued

B. Rarity			
AHC Criteria	**AHC Guidelines**	**National significance attribute thresholds**	**Bioregional significance attribute thresholds**
1. Importance for rare, endangered or uncommon flora, fauna, communities, ecosystems, natural landscape or phenomena	**a.** Biological/ Ecological	Not applicable to project.	Not applicable to project.
	b1. Rare or threatened plant taxa	**i)** Site supports populations of plant taxa that are nationally rare or threatened (i.e. endangered, vulnerable, rare and poorly known taxa) or taxa that are threatened in the Northern Territory (i.e. endangered and vulnerable taxa) and the occurrence of these populations is considered critical to the conservation of the species in Australia or the Northern Territory respectively. Or the site supports 3 or more taxa, which are considered to be poorly known Nationally.	**ii)** Sites support populations of plant taxa that are rare or threatened in the bioregion and the occurrence of the populations are considered critical to the conservation of the taxon in that bioregion.
	b2. Rare or threatened plant communities	**i)** Not specifically assessed due to insufficient detailed data, attributes were noted where they were considered unusual in the context of the study area and co-occurred with other values.	**ii)** Not specifically assessed due to insufficient detailed data; attributes were noted where they were considered unusual in the context of the bioregion and co-occurred with other values.
C. Importance			
AHC Criteria	**AHC Guidelines**	**National significance attribute thresholds**	**Bioregional significance attribute thresholds**
1. Importance for information contributing to a wider understanding of Australian natural history, by virtue of its use as a research site type locality, reference or benchmark site	**a.** Places where the monitoring process is likely to add to knowledge of the processes	**i)** Not specifically assessed, attributes noted where they were considered important in the context of the study area and co-occurred with other values.	**ii)** Not specifically assessed; attributes noted where they were considered important in the context of the study area and co-occurred with other values.
	b. Significant botanical type localities	**i)** Site is of national taxonomic importance – containing more than 5 type localities.	**ii)** Site contains two or more type localities.
	c. Habitats of rare or endangered plants.		
D. Characteristics			
AHC Criteria	**AHC Guidelines**	**National significance attribute thresholds**	**Bioregional significance attribute thresholds**
1. Importance in demonstrating the principle characteristics of a range of landscapes, environments or ecosystems, the attributes of which identify them as being characteristic of their class.	**a.** Places that are good examples of vegetation asso-ciations/communities with their range of understories (if appropriate) and including the range of geology and soil types on which they occur	**i)** Not specifically assessed, attributes noted where they were considered important in the context of the study area and co-occurred with other values.	**ii)** Not specifically assessed; attributes noted where they were considered important in the context of the study area and co-occurred with other values.

3.4 DELINEATION OF SITES

Point locations for Herbarium specimens of significant taxa were plotted on transparent overlay sheets for each of the 1:250,000 scale topographic maps sheets that cover the study area. A spatial index to these map sheets is given in Figure 4.

Sites of botanical significance were circumscribed by identifying and bounding spatial aggregations of point records of significant populations of plant taxa. These notional sites were then assessed against the National Estate criteria and the identified thresholds (Table 2) in a regional and/or national context, and further sub-divided where necessary on the basis of level of significance. The final delineation of sites involved including all geographically related attributes, which featured at the same level of significance. Theoretically site boundaries were designed to protect 'viable' populations of significant plant taxa. Given that the ecological requirements and genetic characteristics of most native plants are poorly understood, the delineation of sites is a subjective process. In practice, a precautionary approach was adopted and site boundaries comfortably enclosed all values and were fitted to 'ecological boundaries' such as catchments or where relevant mapping was available, the margins of geological, physiographic or vegetation units. In most cases a site is delineated by a single irregular polygon. In a few cases, several polygons delineate a single site, usually where the site is closely aligned with an easily mapped and desegregated landform feature, such as a scattered group of claypans.

The level of significance within identified sites can be broadly assumed to be consistent across the site. Where this is not the case and values have been extrapolated on the basis of consistent landscape features, this has been noted in the accompanying text.

Sites of undetermined significance are not all delineated by a bounding polygon. Some are recorded only as a point location denoted by a triangle marker on the maps in this report (more details on map layouts are given below). For those sites of undetermined significance that are delineated by a bounding polygon, the boundary attempts to enclose the features of interest, but since by definition these are poorly known, the boundaries are somewhat arbitrary.

All sites were hand digitised from line-work drawn onto 1:250,000 scale stable base maps. The Parks and Wildlife Commission of the Northern Territory hold the digital data.

Sites are numbered by a three part numbering system based on a grid of 1:250,000 scale map sheets of the study area. For example the site called "Bush Potato site" is number 22-4-1. The first pair of digits is the latitude of the northern edge of the relevant map sheet. Where sites straddle the north-south boundary of map sheets, the number may be the northern latitude of either sheet. The second number is based on the columns of the grid of 1:250,000 scale map sheets of the study area. The furthest west column of sheets is -1- and the furthest east column is -6-. Within each map sheet sites were numbered in the order in which they were first defined. Sites of undetermined significance have the initials of the principal informant for the site preceding the last number. Site numbers can be related to standard map sheet numbers using Figure 4.

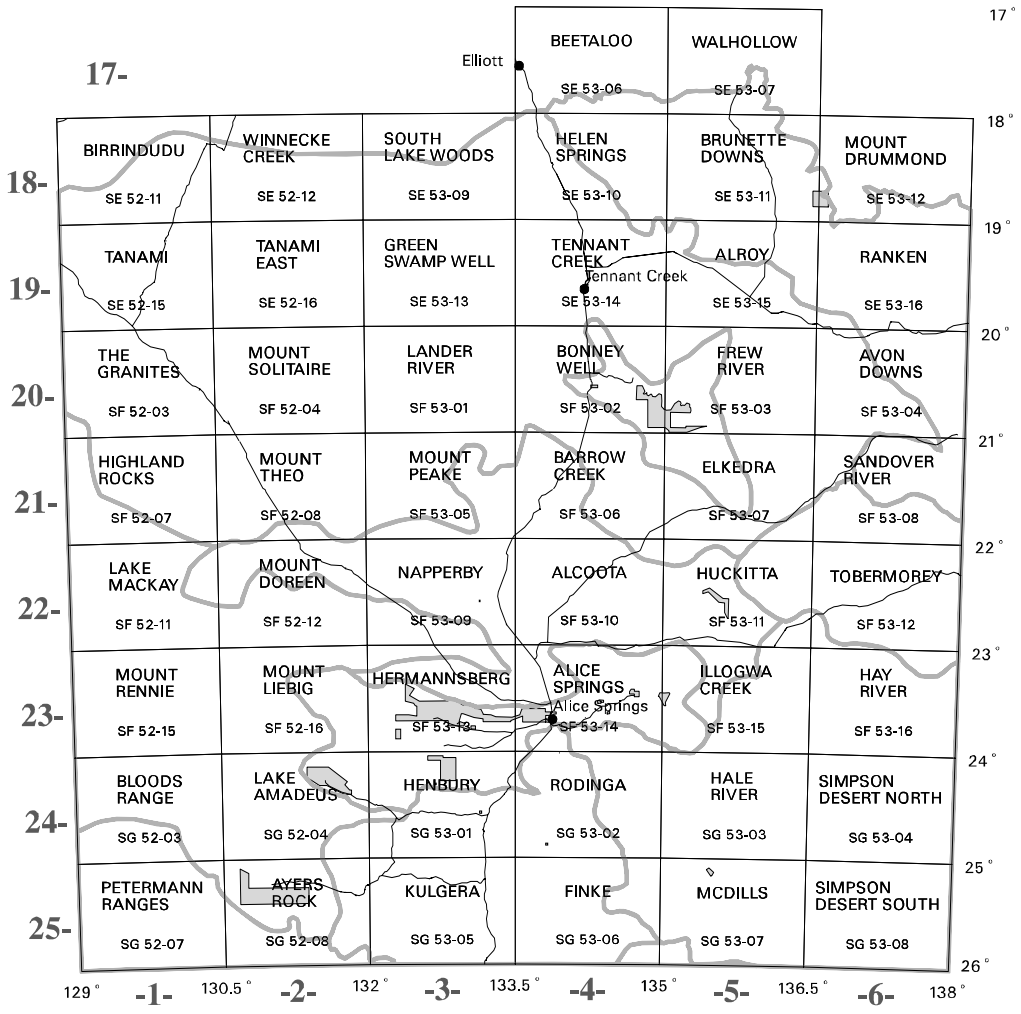

Figure 4: Spatial index to 1:250,000 scale topographic maps of the study area.

Large numbers on the left and lower edges of the figure are from the site numbering system (see text). The degrees of longitude and latitude of the map sheet edges are shown on the lower and right hand sides of the figure.

3.5 DATABASE OF SITES OF SIGNIFICANCE

Descriptions of the sites of botanical significance were compiled in a database. The primary copy of the database is stored on the Parks and Wildlife Commission's computer network and the intention is to update it periodically with new information. The database is available from the Parks and Wildlife Commission or the Arid Lands Environment Centre, however it does not currently have a customised interface to assist in the use and interpretation of the data. Site descriptions were largely from data delineated using a geographic information system (GIS) following the digitising of site boundaries.

4. Summary of Sites Across the Whole Study Area

Across the study area 41 sites were assessed as being of national significance, 79 sites were assessed as being of bioregional significance and 33 sites were assessed as being of undetermined significance. Table 3 includes this information and some spatial data.

Table 3: Numbers and areas of significant sites by significance category.

Significance	Number of sites	Smallest site	Largest site	Total area (nearest 000 km^2)	% of study area
National	41	25 km^2	2,568 km^2	28,000 km^2	3.2%
Bioregional	79	2 km^2	3,567 km^2	34,000 km^2	4.2 %
total of national and bioregional	120			63,000 km^2	7.7 %
Undetermined	33	*	*	9000 km^2 *	*

(* Note that not all the undetermined sites were mapped with bounding polygons)

An overview of sites of national, bioregional and undetermined significance and waterholes of significance is presented in the following sections. Sites are listed with spatial information and grouped by the principal bioregion to which they belong. Three maps of the study area are provided showing sites of national significance, sites of bioregional significance and sites of undetermined significance.

The total area of all sites of national, bioregional and undetermined significance is about 72,000 km^2, covering about 10% of the study area (approximately 805,000 km^2). The figure of 10% should be interpreted cautiously. Many of the sites are very broadly defined and it may be possible to more tightly define them in the future as botanical knowledge increases, thereby reducing the overall size of the sites of significance. Conversely, some poorly surveyed parts of the study area may harbour unknown significant botanical values that may justify the delineation of new sites of significance in the future.

There is a strong association between the sites defined here, and areas that are botanically relatively well known. Of the 50,268 identified vascular plant specimens housed in the NT Herbarium from the study area, more than half (27,320) have been collected from the 10% of the study area circumscribed as sites of national, bioregional or undetermined significance. There are several possible factors underlying this strong association. In some places, high collecting intensity is a reflection of a particularly rich or interesting flora. Similarly, low collecting intensity may reflect widespread, uniform vegetation comprising common and widespread species. Both these factors would indicate that our delineation of sites genuinely identifies areas with greater botanical significance than the surrounding countryside. However, it is possible that some of the sites or at least some of the boundaries are an artifact of the general low level of botanical knowledge. For example, an area that has been well collected surrounded by poorly collected areas might appear to be more significant than it really is. This can only be determined by further botanical survey. Many areas of low collecting intensity are in harsh, remote terrain and are seldom if ever visted by botanists. It is invalid to infer a lack of significant botanical conservation values at such places, even though there are currently no sites of significance delineated there.

4.1 SUMMARY OF SITES OF NATIONAL SIGNIFICANCE

Figure 5 and Table 4 provides summary information on all sites of national significance within the study area.

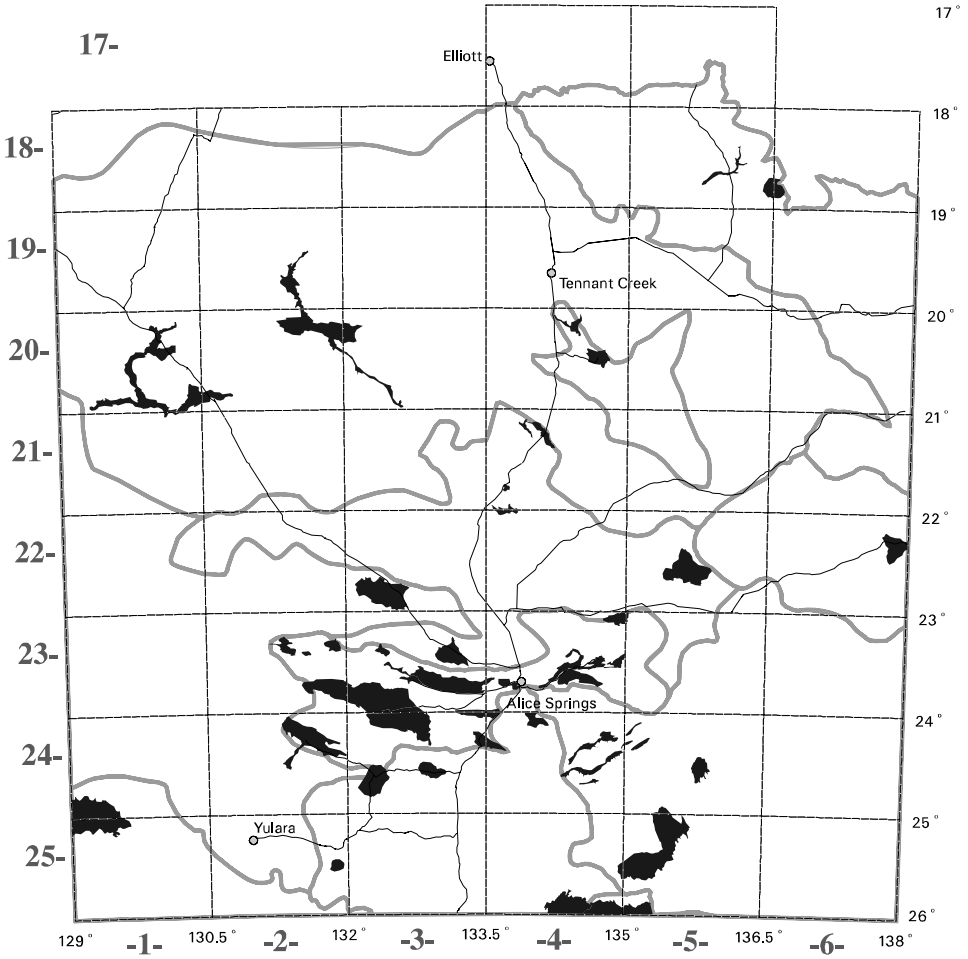

Figure 5: Map of nationally significant sites across the study area

Sites are shaded black, bioregion boundaries are represented by broad grey lines, main roads by thin black lines and map sheet boundaries by dashed black lines. The large numbers on the left and lower sides of the figure refer to the site numbering system. The degrees of longitude and latitude of the map sheet edges are on the lower and right sides of the figure. The map is in a transverse mercator projection centred on 133.5 degrees east.

Table 4: Summary information on sites of national significance.

Principal Bioregion **Site Number and Site Name**	**Area**	**Proportion in each bioregion** **(where more than one bioregion)**
Principal Bioregion: Burt Plain		
21-4-1 Osborne and Crawford Ranges	290 km^2	BRT 85.4% & TAN 14.6%
21-4-7 Stirling Swamp	41 km^2	
22-4-1 Bush Potato Site	164 km^2	
22-5-2 Dulcie Ranges	1,117 km^2	
23-3-3 Mount Hay	562 km^2	
Principal Bioregion: Central Ranges		
24-1-2 Petermann Ranges	1,905 km^2	
Principal Bioregion: Channel Country		
22-6-4 Illungnara	523 km^2	

Table 4 Continued: Summary information on sites of national significance.

Principal Bioregion Site Number and Site Name	Area	Proportion in each bioregion (where more than one bioregion)
Principal Bioregion: Davenport Murchison Ranges		
20-4-3 Kurundi Creek	334 km^2	DAV 92.9% & TAN 7.1%
20-4-4 Gosse River and Edinburgh Creek	187 km^2	DAV 85.8% & TAN 14.2%
Principal Bioregion: Finke		
24-3-2 Wolluga Dunefields	758 km^2	FIN 69.8% & GSD 23.8% & MAC 6.4%
24-3-3 Bacon Ranges	352 km^2	
24-4-4 Ooraminna	253 km^2	
25-2-3 Mount Conner	163 km^2	
25-4-1 Beddome Range	853 km^2	FIN 95.5% & STP 4.5%
Principal Bioregion: Great Sandy Desert		
22-3-2 Lake Lewis	1,326 km^2	
Principal Bioregion: MacDonnell Ranges		
23-2-1 Mount Edward	171 km^2	MAC 92.6% & BRT 7.4%
23-2-3 Talipata/Mount Liebig	262 km^2	MAC 99.4% & GSD 0.6%
23-3-1 Mount Zeil	104 km^2	MAC 97.1% & BRT 2.9%
23-3-2 Missionary Plain	2,568 km^2	MAC 96.6% & GSD 3.4%
23-3-5 Chewings Range	1,299 km^2	
23-3-7 Glen Helen	107 km^2	
23-4-14 Simpsons Gap	94 km^2	
23-4-16 Ilparpa	61 km^2	
23-4-5 Trephina	563 km^2	MAC 99.3% & SSD 0.7%
23-4-6 N'Dhala	484 km^2	
23-4-7 Amarata Range	144 km^2	
23-4-9 Harts Range	273 km^2	MAC 71.6% & BRT 28.4%
24-2-1 Watarrka	1,243 km^2	MAC 87.3% & GSD 12.7%
24-3-1 Waterhouse Range	320 km^2	
24-3-5 Palm Valley	1,575 km^2	
24-4-5 Rainbow Valley	319 km^2	MAC 97.1% & FIN 2.9%
Principal Bioregion: Mitchell Grass Downs		
18-5-1 Brunette Creek Waterholes	209 km^2	
18-6-1 Connells Lagoon	387 km^2	
Principal Bioregion: Simpson-Strzelecki Dunefields		
24-4-1 Rodinga	787 km^2	SSD 99.3% & FIN 0.7%
24-5-1 Allitra Tablelands	348 km^2	
24-5-2 Arookara Range	84 km^2	
25-5-1 Andado	2,455 km^2	
Principal Bioregion: Stony Plains		
25-5-2 Wilyunpa Tablelands	892 km^2	STP 99.9% & SSD slither
Principal Bioregion: Tanami		
20-1-3 Western Tanami Paleodrainage Systems	2,383 km^2	
20-2-1 Lake Surprise and the Lander River Floodout	2,021 km^2	
20-3-2 Upper Lander River	261 km^2	

4.2 SUMMARY OF SITES OF BIOREGIONAL SIGNIFICANCE

Figure 6 and Table 5 provides summary information on all sites of bioregional significance within the study area.

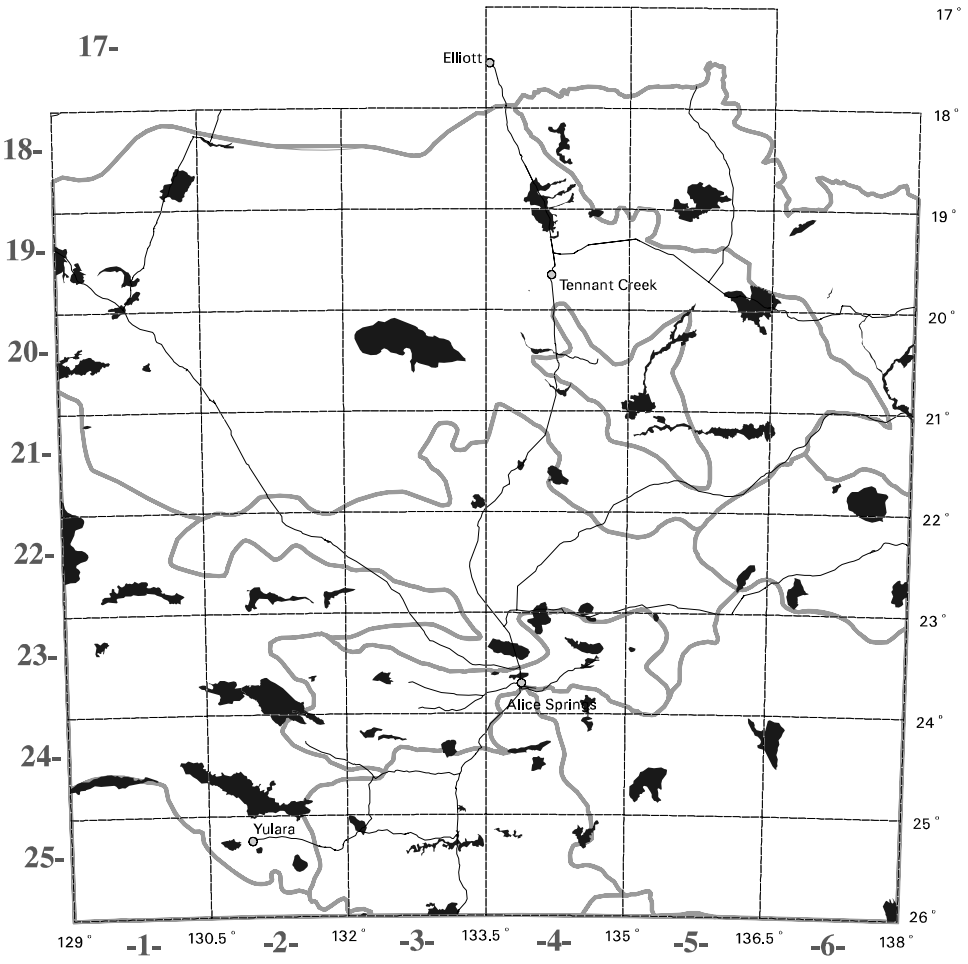

Figure 6: Map of bioregionally significant sites across the study area

Sites are shaded black, bioregion boundaries are represented by broad grey lines, main roads by thin black lines and map sheet boundaries by dashed black lines. The large numbers on the left and lower sides of the figure refer to the site numbering system. The degrees of longitude and latitude of the map sheet edges are on the lower and right sides of the figure. The map is in a transverse mercator projection centred on 133.5 degrees east.

Table 5: Summary information on sites of bioregional significance.

Principal Bioregion **Site Number and Site Name**	**Area**	**Proportion in each bioregion (where more than one bioregion)**
Principal Bioregion: Burt Plain		
21-3-2 Central Mount Stuart	169 km^2	
21-4-3 Barrow Creek	67 km^2	
22-2-3 Yuendumu South	13 km^2	
22-4-3 Upper Plenty River	176 km^2	
23-4-17 Everard Scrub	597 km^2	

Table 5 Continued: Summary information on sites of bioregional significance.

Principal Bioregion **Site Number and Site Name**	**Area**	**Proportion in each bioregion** **(where more than one bioregion)**
Principal Bioregion: Central Ranges		
24-1-1 Bloods Range	777 km^2	CR 81.7% & GSD 18.3%
25-3-3 Mount Cuthbert	15 km^2	CR 99.5% & FIN 0.5%
21-6-1 Manners Creek Gidgee	1,275 km^2	
21-6-2 Lake Nash - No. One Dam	62 km^2	
22-5-1 Jervois Range	274 km^2	CHC 95.3% & BRT 3.4% & SSD 1.3%
22-6-1 Tarlton Ranges	398 km^2	
22-6-2 Toko Range	388 km^2	
22-6-3 Querinya	11 km^2	
Principal Bioregion: Davenport Murchison Ranges		
20-5-1 Lower Frew River and Floodout	535 km^2	DAV 74.4% & TAN 25.6%
20-5-2 Upper Frew River	702 km^2	
21-5-2 Upper Elkedra River	273 km^2	
Principal Bioregion: Finke		
24-3-7 Fox Salt lakes	37 km^2	
24-4-3 James Range East	239 km^2	
24-4-6 Camel Creek	175 km^2	
25-3-1 Karinga Creek	502 km^2	
25-3-2 Ayres Range	347 km^2	
25-3-5 Kernot Range	209 km^2	
25-4-2 Rumbalara	323 km^2	FIN 77.2% & SSD 22.8%
25-4-3 Poona	105 km^2	
Principal Bioregion: Great Sandy Desert		
22-1-1 Lake MacKay	1,394 km^2	
22-1-2 Kalipima	913 km^2	
22-2-1 Lake Bennett	539 km^2	
22-2-2 Central Mount Wedge	232 km^2	
23-1-1 Kintore Range	134 km^2	
23-2-5 Cleland Hills	702 km^2	
23-2-6 Lay Cock's Sandplain	1,854 km^2	GSD 93.7% & MAC 6.3%
24-2-2 Lake Amadeus	2,756 km^2	GSD 96.6% & FIN 3.4%
25-2-1 Uluru	37 km^2	
25-2-2 Kata Tjuta	165 km^2	
25-2-4 *Acacia ammobia* Shrublands	205 km^2	
Principal Bioregion: MacDonnell Ranges		
22-4-2 Mueller Creek Catchment	490 km^2	MAC 74.4% & BRT 25.6%
23-2-4 Mereenie	160 km^2	MAC 92.9% & GSD 7.1%
23-2-8 Idirriki	31 km^2	
23-3-6 Goyder Pass	180 km^2	
23-4-10 Hale and Paddys Plains	491 km^2	
23-4-11 Mount Riddock	47 km^2	BRT 98% & MAC 2%
23-4-12 New Well	27 km^2	
23-4-13 Emily Gap	25 km^2	MAC 96.5% & SSD 3.2% & FIN 0.3%
23-4-15 Charles and Todd Rivers	109 km^2	
23-5-2 Mount Ruby	31 km^2	
23-5-4 Mount Long/Mount Mary	42 km^2	BRT 59.8% & MAC 40.2%
24-3-4 Illawilla	240 km^2	MAC 74.6% & FIN 25.4%
24-3-6 Wild Eagle Plains	101 km^2	
24-3-8 Bowson	143 km^2	

Table 5 Continued: Summary information on sites of bioregional significance.

Principal Bioregion **Site Number and Site Name**	**Area**	**Proportion in each bioregion (where more than one bioregion)**
Principal Bioregion: Mitchell Grass Downs		
18-4-5 Nilly	393 km^2	
18-5-2 Lake Sylvester	1,361 km^2	
19-4-4 Headwaters of Brunchilly Creek	111 km^2	MGD 60.5% & TAN 39.5%
19-6-1 Buchanan Rises	180 km^2	
19-6-2 Lorne Creek Waterholes	13 km^2	
20-6-1 Georgina River	532 km^2	
20-6-2 James River Waterholes	69 km^2	
Principal Bioregion: Simpson-Strzelecki Dunefields		
23-4-8 Wyeecha	169 km^2	
24-4-2 Mount Capitor	118 km^2	
24-5-3 Old Todd River Floodout	948 km^2	
24-6-1 Prior floodout of the Plenty River	923 km^2	
25-6-1 Lake Poeppel	291 km^2	
Principal Bioregion: Tanami		
18-1-1 Winnecke Hills	774 km^2	
18-2-1 Hooker Creek and Floodout	117 km^2	
18-4-1 Whittington and Short Ranges	1,169 km^2	
19-1-1 Gardiner Range	353 km^2	
19-1-2 Pargee	230 km^2	
19-1-3 Coomarie	300 km^2	
19-1-4 Range	282 km^2	
19-4-2 Short Range Waterholes	28 km^2	
19-4-3 Little Lake Surprise Ngwrratiji	2 km^2	
20-1-2 Dead Bullock Soak	55 km^2	
20-1-4 Mongrel Downs	758 km^2	
20-3-1 Paleo-Lander River	3,567 km^2	
20-4-1 Thring Swamp	102 km^2	TAN 98% & DAV 2%
20-4-2 Algoolgoora Swamp	117 km^2	TAN 99.9% & DAV slither
20-5-4 Wonarah Beds	1,431 km^2	TAN 98.5% & MGD 1.5%
21-1-1 False Mount Russell	23 km^2	TAN 99.7% & GSD 0.3%
21-4-4 Watt Range Floodouts and Fringing Sandplains	303 km^2	TAN 76% & BRT 24%
21-5-3 Elkedra River Floodout	834 km^2	

4.3 SUMMARY OF SITES OF UNDETERMINED SIGNIFICANCE

Figure 7 and Table 6 provide summary information on all sites of undetermined significance within the study area.

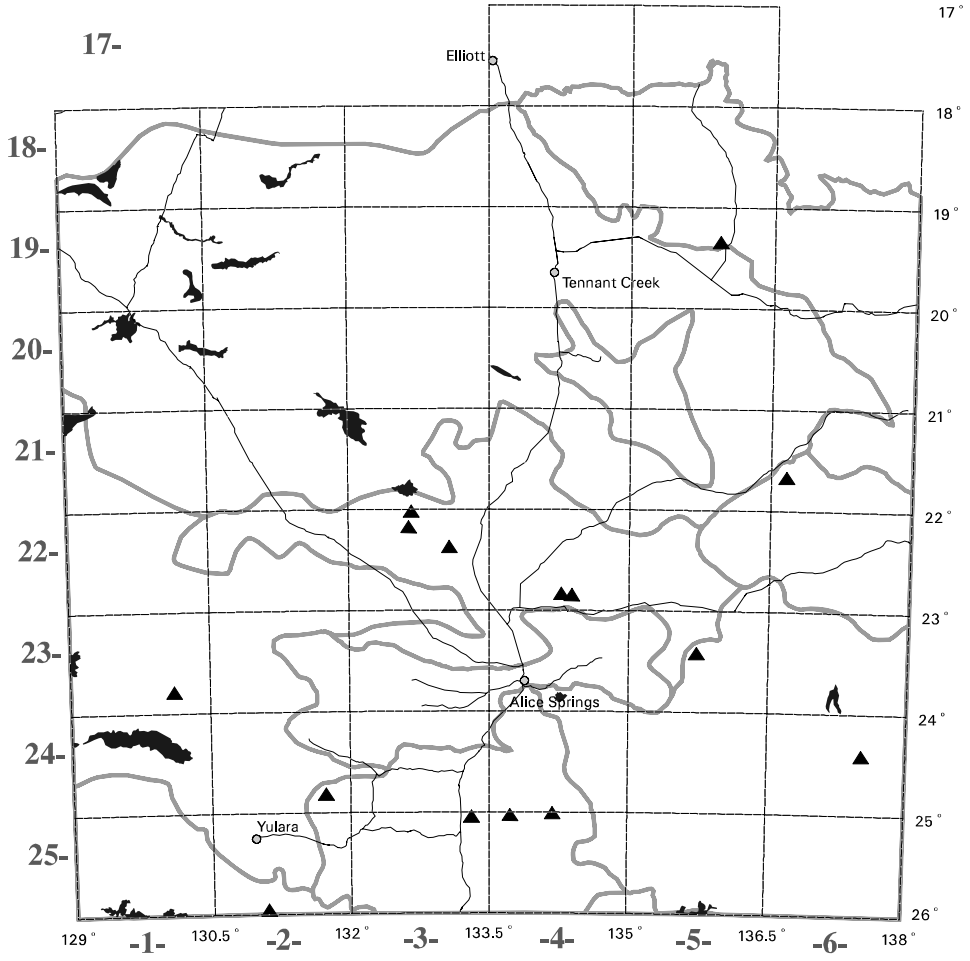

Figure 7: Map of sites of undetermined significance across the study area

Sites where a perimeter has been mapped are shaded black and others are represented by black triangles. Bioregion boundaries are represented by broad grey lines; main roads by thin black lines and map sheet boundaries by dashed black lines. The large numbers on the left and lower sides of the figure refer to the site numbering system. The degrees of longitude and latitude of the map sheet edges are shown on the lower and right sides of the figure. The map is in a transverse mercator projection centred on 133.5 degrees east.

Table 6: Summary information on sites of undetermined significance.

Principal Bioregion **Site Number and Site Name**	**Area**	**Proportion in each bioregion (where more than one bioregion)**
Principal Bioregion: Burt Plain		
21-3-PL2 Nanga Range	271 km^2	TAN 61% & BRT 39%
22-3-PL1 Yunderbulu		
22-3-PL2 Mount Gardiner		
22-3-PL3 Warimbi Hills		
22-4-PL1 Mount Beechmore Mulga		
22-4-PL2 The Twins		
Principal Bioregion: Central Ranges		
25-1-PL1 Northern Mann Ranges	514 km^2	
25-2-AD1 Northern Musgrave Range		
Principal Bioregion: Channel Country		
21-6-PL2 Sandover River Floodout		
Principal Bioregion: Finke		
24-2-DN1 Golden Valley		
25-3-PL1 Mount Sunday		
25-4-PL1 Reticulate Dunes on the		
25-4-PL2 Confluence of and Hugh Rivers		
Principal Bioregion: Great Sandy Desert		
20-1-PL3 Lake White	441 km^2	GSD 78% & TAN 22%
23-1-PL1 Yingurrdu		
23-1-PL2 Lake Macdonald	205 km^2	
24-1-PL1 Lake Neale	1,876 km^2	
Principal Bioregion: Mitchell Grass Downs		
23-4-PL1 Santa Teresa	93 km^2	
23-5-PL1 Gidgee Bore		
23-6-PL1 Lake Caroline	251 km^2	
24-6-PL1 Hay River Floodout		
Principal Bioregion: Stony Plains		
25-5-PL1 Dakota	236 km^2	SSD 64.5% & STP 35.5%
Principal Bioregion: Tanami		
18-1-PL1 Browns Range	559 km^2	
18-1-PL2 Birrindudu Range	365 km^2	
18-2-PL1 Winneke Floodout	420 km^2	
19-1-PL1 Lake Buck	324 km^2	
19-2-PL1 Central Paleodrainage Depression	514 km^2	
19-2-PL2 Wilson Creek and Floodout	216 km^2	
20-1-PL1 Bluebush Hills	683 km^2	
20-1-PL2 Paleodrainage System Extension	360 km^2	
20-4-PL1 Numagalong Dunes	149 km^2	

4.4 SUMMARY OF WATERHOLES OF BOTANICAL SIGNIFICANCE

A number of sites of botanical significance include permanent and semi-permanent waterholes where botanical values are concentrated at a point location. These sites have been noted in addition to the larger sites within which they occur. There are 38 waterhole sites of known botanical significance. Of these, 13 support botanical values of national significance, 23 support botanical values of bioregional significance and two have unconfirmed botanical conservation values. Table 7 (next page) lists all waterhole sites for each bioregion. Note that the Finke, Stony Plains and Simpson-Strzelecki Dunefields bioregions do not have waterholes of known botanical significance.

Table 7: Summary information on waterholes of botanical significance.

Waterholes of National Significance		
Principal bioregion	**Waterhole Site Name**	**Included in Site (name and code)**
Burt Plain	-	-
Central Ranges	-	-
Channel Country	Nora Waterhole	Toko Range, 22-6-2
Davenport Murchison Ranges	Pingelly waterhole	Kurundi Creek, 20-4-3
	Annie Loch Rockhole	Gosse River and Edinburgh Creek, 20-4-4
Finke	-	-
Great Sandy Desert	-	-
MacDonnell Ranges	Giles Spring	Chewings Range, 23-3-5
	Kings Canyon waterholes	Watarrka, 24-2-1
	Mt. Pfitzner Spring	Mueller Creek Catchment, 22-4-2
	Palm Valley springs	Palm Valley, 24-3-5
	Penny Springs	Watarrka, 24-2-1
	Reedy Creek rockholes	Watarrka, 24-2-1
	Talipata Springs	Talipata/Mount Liebig, 23-2-3
	Wallaby Gorge waterholes	Watarrka, 24-2-1
Mitchell Grass Downs	Brunette Downs Homestead Waterhole	Brunette Creek Waterholes, 18-5-1
Simpson-Strzelecki Dunefields	-	-
Stony Plains	-	-
Tanami	Mallopan Waterhole	Lake Surprise and the Lander River Floodout, 20-2-1
Waterholes of Bioregional Significance		
Principal bioregion	**Waterhole Site Name**	**Included in Site (name and code)**
Burt Plain	Picton Springs	Dulcie Ranges, 22-5-2
	Dulcie Gorge	Dulcie Ranges, 22-5-2
Central Ranges	Wankarily Waterhole	Petermann, 24-1-2
Davenport Murchison Ranges	-	-
Finke	-	-
Great Sandy Desert	Maggie Springs	Uluru, 25-2-1
MacDonnell Ranges	Bagot Springs Waterholes	Watarrka, 24-2-1
	Ellery Creek gorge	Chewings Range, 23-3-5
	Fringe Lily Gorge	Chewings Range, 23-3-5
	Gas well spring	Palm Valley, 24-3-5
	Giles Spring no. 3	Chewings Range, 23-3-5
	Giles Yard Spring	Chewings Range, 23-3-5
	Illara Waterhole	
	Illbilla springs	Palm Valley, 24-3-5
	Kathleen Spring waterhole	Watarrka, 24-2-1
	Running Waters	Palm Valley, 24-3-5
	Stokes Creek Springs	Watarrka, 24-2-1
Mitchell Grass Downs	James River Waterhole	James River Waterholes, 20-6-2
	Lake Nash Waterhole	Georgina River, 20-6-1
	Lily Woodcutter Waterhole	Brunette Creek Waterholes, 18-5-1
	Lorne Waterhole	Lorne Creek Waterholes, 19-6-2
	Split Lagoon	James River Waterholes, 20-6-2
Simpson-Strzelecki Dunefields	-	-
Stony Plains	-	-
Tanami	Coodna Waterhole	Short Range Waterholes, 19-4-2
	Curlew Waterhole	Upper Lander River, 20-3-2
	Dingo Waterhole	Upper Lander River, 20-3-2
Waterholes of Undetermined Significance		
Principal bioregion	**Waterhole Site Name**	**Included in Site (name and code)**
MacDonnell Ranges	Petermann Creek	
	Walker Creek	

5. Information Provided for Each Site

5.1 ORDER OF PRESENTATION OF SITES

Each site and waterhole of botanical significance is individually described in part two of this volume. Site descriptions are arranged bioregionally, with a section for each bioregion. Where a site crosses the boundary between two or more bioregions, the site is allocated to the bioregion with which it has the greatest affinity and this is referred to as the principal bioregion. Within each bioregional section, sites of national significance are presented first, followed by those of bioregional significance, then those of undetermined significance and finally waterholes of botanical significance. Within these significance groups, sites are arranged by site number.

A brief description of the geomorphological and biological features of each bioregion and a map showing all sites of botanical significance within it precedes the individual site descriptions. A table listing sites in that bioregion, their significance and the page on which they are described accompanies the map, to assist with finding the description for particular sites. An index at the back of part 2 also gives page numbers for sites and species.

5.2 LAYOUT OF INFORMATION PROVIDED FOR EACH SITE

The following information is included in the site descriptions:

- level of significance (national, bioregional or undetermined);
- location, including the latitude and longitude of a reference point and a brief description;
- area in square kilometres;
- standard map sheet(s) on which it occurs (1:250,000 scale);
- bioregion(s) in which it occurs and the proportion of the site in each, where more than one;
- land tenure;
- general description, which may include landform, geology, an explanation of the boundaries of the site and a summary of the botanical values;
- additional notes on significant botanical values are included where relevant;
- significance criteria that the site has satisfied (Table 2).
- lists of all significant plant taxa occurring within the bounds of the site, including significant attributes such as endemism and whether or not taxa are at or near the edge of their known range;
- a list of other (non-significant) taxa which on the basis of herbarium collections are only known in the principal bioregion from the site;
- a list of any species for which a type specimen was collected from the site; and
- a list of all vegetation map units mapped as occurring at the site on the 1: 1 million scale vegetation map of the NT (Wilson *et al.*, 1990). Note that due to the coarse scale of mapping, the vegetation types listed for a site may not correspond with the vegetation types actually present.

Significant taxa known from each site are presented in four lists, one for each level of species significance: national, Northern Territory, study area and bioregional. The source of these lists is predominantly the NT Herbarium database. Significance codes are given in curly brackets following the species names. Taxa with national and NT significance have significance codes based on the ROTAP system, as explained in volume 1 of this report. For example:

Spartothamnella puberula {3rC-}.

Taxa that are significant at the study area level have the nature of the significance in brackets: threatened, rare, apparently rare or disjunct. For example:

Chrislella dentata {(threatened)}

Bioregionally significant taxa have a significance code consisting of an abbreviation of the name of the bioregion/s in which they are significant, and the nature of the significance in standard (round) brackets.

Only those bioregions that include all or part of the site of significance are included within the code. For example:

Eucalyptus orbifolia subsp. orbifolia {MAC (disjunct)}.

Where a taxon is at or near (within 6 minutes of) the edge of its known longitudinal or latitudinal range in a site this is indicated by the capital letter for the relevant cardinal compass points in brackets, following the taxon name and the significance code. The compass points are in square brackets, for example:

Eremophila ovata {3k [N,E]}.

Some taxa are listed as bioregionally significant because they are at the edge of their known range in a bioregion. In the following example *Lechenaultia filiformis* is at the southern edge of its range at the relevant site of significance:

Lechenaultia filiformis {TAN (southern range limit) [S]}

Additional distribution information is given where a site encompasses the only NT Herbarium records of a taxon in one of four categories:

- endemic to/only known from this site;
- only known in study area from this site;
- only known in NT from this site; and
- only known in bioregion from this site.

In these cases the above text follows the significance code and any edge of range code, inside the curly brackets. For example:

Acacia dolichophylla {2RC- [N, S, E, W] endemic to/only known from this site}

Taxa that are restricted to the general area of the site, but are not endemic to it, will have [N, S, E, W] after the significance code.

The category 'only known in study area from this site' applies to taxa with distributions that include the northern bioregions of the NT, while the category 'only known in NT from this site' applies to taxa for which all NT records are in the study area.

It should be noted that the distribution categories are derived from NT Herbarium specimen data only and caution is advised in interpreting the importance of this distribution data. It should also be noted that the term “only known in REG* from this site”, where REG is one of the eleven bioregion abbreviations (e.g. TAN) refers to the NT portion of those bioregions that extend beyond the study area.

5.3 LAYOUT AND LEGEND OF SITE MAPS

A site locality map is provided with the description of each of the sites of national or bioregional significance. The maps are based on features from the 1:250,000 topographic maps and are designed for use in conjunction with them. Most maps show drainage features, roads and grid references to assist in locating sites on the 1:250,000 scale topographic maps. In some instances, drainage lines were not included, as the drainage networks were so dense as to obscure all other features. Neighbouring sites also appear on many of the site maps. Where sites are contiguous, darker shading indicates the site being described. A legend for all site locality maps is provided in Figure 8.

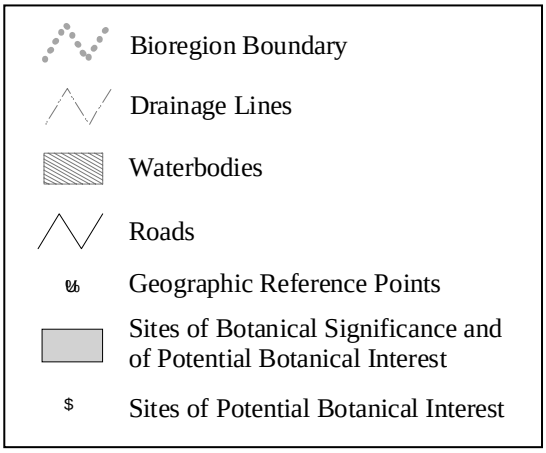

Figure 8: Legend for site locality maps

Drainage lines, roads and waterbodies are from AUSLIG 1:250,000 scale topographic maps (digital Topo 250 K Geodata).

5.4 INFORMATION PROVIDED ON WATERHOLES OF BOTANICAL SIGNIFICANCE

Permanent and semi-permanent waterholes of botanical significance are briefly described at the end of the section for each bioregion. These significant waterholes invariably form part of larger sites of significance, but for the purposes of reporting have been described separately in this document. Some approximate location details are given and the larger site into which they have been incorporated noted. For example the Kathleen Springs Waterhole was deemed to be of bioregional botanical significance in the context of the MacDonnell Ranges Bioregion. This small area forms part of the much larger Watarrka site of significance, site number 24-2-1. The following example illustrates the type of information provided:

Kathleen Spring waterhole

Included within Watarrka site of significance, site no. 24-2-1

Reference coordinates (decimal degrees of latitude and longitude): -24.3º , 131.68333º

Significant plant taxa: *Centipeda A92472 Toko Range* {3kC-}, *Cyclosorus interruptus* {sthn NT (disjunct)}, *Juncus continuus* {3rC-}, *Phragmites australis* {sthn NT (disjunct & apparently rare)}, *Schoenus falcatus* {sthn NT (disjunct & apparently rare)}, *Stylidium inaequipetalum* {3RCa}

6. Future Directions for Research and Management of Sites of Botanical Significance

6.1 DATA COLLECTION AND REASSESSMENT OF THE STATUS OF SITES OF BOTANICAL SIGNIFICANCE

As new data are collected the status of some sites of significance will need to be reviewed; particularly those presently assessed as of undetermined significance. This task will also involve the maintenance of the sites of significance database. New data could come from various sources as discussed below.

6.1.1 New Data on Significant Taxa

As the determination of significant sites in this report is heavily based on the occurrence of significant taxa, any future changes to the conservation status of taxa may have a bearing on the status of the sites in which they occur. Changes to the conservation status of taxa may result from taxonomic revision, new insights into threatening processes (including the intensification or abatement of a particular threat), or improved knowledge of the distribution and ecological amplitude of taxa. Taxon-specific targeted surveys (see Vol. 1, section 7.2), general collecting in previously poorly collected areas and systematic bioregional vegetation surveys are all likely to yield information on the distribution of taxa, habitat specificity and threats. A major benefit of such work will be the resolution of those taxa here classified as poorly known (K and k). The production of user-friendly bioregional identification guides for poorly known taxa could broaden the pool of people collecting data on these taxa.

6.1.2 Surveys of Sites of Undetermined Significance

In this document 33 sites are identified as being potentially significant. Although this is not a definitive list of all potentially significant sites in the southern NT, it is the first step towards prioritising those areas requiring investigation. Whenever botanical work is being undertaken within a bioregion, efforts should be made to visit and survey those sites of undetermined significance. Some of the undetermined sites in the Finke and Burt Plain bioregions were visited during the final preparation of this report (Winter/Spring 2000). As a result the status of some sites may be upgraded from undetermined to bioregionally or nationally significant, while others may not warrant listing as nationally or bioregionally significant. These assessments will be incorporated into the sites of significance database.

6.1.3 Incorporation of Botanical Attributes Not Previously Included in the Assessment of Sites of Significance

Ideally, a larger suite of botanical attributes than that used in this document would be available for assessing the botanical significance of areas. Botanical attributes of particular value in the assessment of sites of significance for which we presently have little data include:

- the presence of significant plant communities;
- vegetation quality (degree of disturbance and weed invasion);
- and the diversity of species and communities present within the area of interest.

The collection of these data for the whole study area is a long term goal, however these data may be forthcoming in the short term for specific bioregions that are subject to systematic survey for the purposes of bioregional conservation plans. A bioregional conservation plan is presently being prepared for the Finke bioregion by PWCNT and this will be the first attempt in the southern NT to incorporate some additional botanical attributes in the assessment of significant botanical areas at the bioregional scale.

Considerable fieldwork needs to be undertaken across the study area to acquire floristic data. A quadrat based floristic survey approach is the preferred methodology, as the data can be analysed to define floristic communities, and determine relative weediness and relative species richness of areas sampled. Some quadrat based floristic data were collected to describe and map the vegetation of the Northern Territory at 1:1,000,000 scale (Wilson *et al.*, 1990). While this synthesis has been enormously useful, it is

axiomatic that such a broad study would be unable to define all vegetation communities occurring in the southern NT or identify restricted, uncommon or rare communities. Quadrat data has been collected on a limited number of survey and mapping projects, including Pitts (1994), Pitts *et al.* (1995) and Albrecht & Pitts (in press). These studies have identified restricted and potentially threatened plant communities, however in some cases further detailed vegetation mapping and survey at 1:250,000 scale (or larger) is required to verify the status of these plant communities across the study area. The Alice Springs Herbarium has an ongoing program of opportunistically collecting quadrat data throughout the study area. Quadrat data will also be collected in the course of bioregional surveys and habitat-specific surveys such as the current PWCNT survey of wetlands in arid NT. In the absence of a specifically funded project dedicated to the description and mapping of vegetation communities in the study area, data will largely continue to be collected opportunistically and will be spatially disjunct. If the classification of vegetation communities and identification of rare or threatened communities in the study area attracts funding, it will be essential that data sets from various government bodies such as PWCNT, Department of Lands Planning and Environment (DLPE), Department of Primary Industries and Fisheries (DPIF), Central Land Council (CLC) and CSIRO are examined.

Although there is little quantitative data available, several vegetation types in the study area appear to be geographically restricted. Further targeted survey work is required to determine the distribution of, threats to and variation within the following vegetation types:

- shrublands with *Dodonaea microzyga* present;
- *Atriplex nummularia* subsp. *omissa* dominated shrublands;
- mesic spring-fed vegetation in gorges;
- *Callitris glaucophylla* dominated communities;
- *Brachychiton gregorii* dominated plant communities;
- perched dunefields and sandplains (with *Xanthorrhoea thorntonii*);
- *Acacia stowardii* dominated shrubland;
- *Acacia cyperophylla* dominated shrublands;
- *Acacia ammobia* dominated shrublands;
- tussock grasslands dominated by *Astrebla* sp. (outside the Mitchell Grass Downs Bioregion and the Channel Country Bioregion);
- long unburned vegetation in gorges and ranges;
- *Eucalyptus gongylocarpa* (Marble Gum) dominated woodlands;
- mound spring vegetation;
- vegetation with *Pachycornia triandra* present; and
- vegetation of 'breakaways' and other eroding areas, including those with *Cratystylis A36062 Glen Helen* or *Eucalyptus thozetiana*.

6.2 THREATENING PROCESSES

The scale, nature and relative importance of threats to plant species and communities occurring at sites of significance in the study area requires detailed study. A number of broadscale processes which potentially threaten plant taxa and plant communities are operating in the southern bioregions of the NT, including grazing (by both stock and feral animals), fire, weed invasion or combinations of these potential threats. Processes of acute concern with respect to sites of significance are described below.

Ongoing invasion of introduced plant species

Highly competitive perennial grasses such as *Cenchrus ciliaris* (Buffel Grass), *Cynodon dactylon* (Couch Grass) and *Dichanthium annulatum* (Sheda Grass) are of particular concern. Some of these species continue to be deliberately sown for their perceived pasture value or for erosion control. It is imperative that these species are not deliberately sown in or near sites of botanical significance as in many cases at least one of these species will spread beyond the points of introduction, directly or indirectly (by causing changes in fire regimes) altering vegetation structure and floristics. Preliminary studies have been undertaken to quantify the impact of *Cenchrus ciliaris* on plant biodiversity and examine the efficacy of several control options (Pitts and Albrecht, 2000).

Impact of feral animals and stock

The long-term impact of feral animals and stock can be hard to quantify. Impacts are generally more acute near areas of permanent or temporary water.

Unfavourable fire regimes

Unfavourable fire regimes are of concern in areas supporting fire sensitive plant species. Fire regimes have undoubtedly changed over the past century with changing landuse and changes to vegetation, including the spread of *Cenchrus ciliaris* (Buffel Grass) and *Cynodon dactylon* (Couch Grass). Latz *et al.* (1989) describe a threatening process in which frequent fires in hilly terrain promote the expansion of spinifex grasses at the expense of fire sensitive plants species of conservation significance, such as *Acacia undoolyana*. The relationship between fire and spinifex in hilly terrain requires further study and is included in a current Phd study by Catherine Nano.

6.3 SITE MANAGEMENT

For some sites of significance sufficient information is at hand to begin to address threatening processes such as weed invasion, visitor pressure and unfavourable fire regimes. Ideally management plans would be drawn up for each site of significance, outlining the management issues and providing a framework for management inputs. Currently the only sites of botanical significance that have various management-related plans and strategies are those occurring within areas managed by PWCNT. In reality, the task of developing management plans for the remaining sites is unlikely to be undertaken unless it attracts specific funding. A viable alternative could be to involve students from environmental management courses. Students could not only develop management plans for specific sites, but also liase with stakeholders, investigate funding options, undertake additional survey work and establish monitoring programs.

Management input is urgently required at some sites. For example, small populations of highly invasive weeds could be eradicated from some sites if undertaken soon. The creation of fire breaks is also urgently required in some areas where fire sensitive species and communities are present and fuel loads are high. Failure to undertake this work will severely compromise the values of some sites in the long term.

There is a great need to prioritise sites of significance on the basis of management urgency. In the absence of carefully considered prioritisation, sites of national significance should be given priority over sites of bioregional significance. Given the trend towards bioregionalism, it may be advisable to prioritise sites within each separate bioregion. Funding for management activities at sites of significance on pastoral and Aboriginal land could be investigated by land holders/managers, Aboriginal communities and landcare groups in collaboration with government agencies.

The results of implementing management measures must be carefully evaluated through detailed monitoring.

6.4 MONITORING

Monitoring activities should be undertaken at sites of significance to gauge the impact of existing threats and anticipate potential threats. Such threats may include new or expanding weed infestations, increasing numbers of feral animals, unfavourable stocking rates and high fuel loads. Threats may operate at the scale of individual populations of rare and threatened plant taxa or the site as a whole. Monitoring is also important for assessing the efficacy of various management actions such as weed control, fuel reduction burning and feral animal control. Given the scarce resources, monitoring programs should be designed to collect useful data rapidly. Monitoring should be maintained over extended periods of time and should be intensified following unique or unusual environmental events such as fire, protracted drought or heavy rainfalls.

7. References

The references section is divided into two sections. Section 7.1 details all literature cited in both volumes of the report and section 7.2 details a general list of references used in the development of the annotations accompanying species (volume 1 part 2) and site descriptions (volume 2 part 2).

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