Vegetation Retention Plans for Darwin, Marrakai and Katherine/Mataranka regions

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Executive summary

1. The intact nature of the Northern Territory landscape provides for the conservation of its biodiversity and maintains the workings of its ecological processes. Such healthy and extensive natural landscapes underpin most land use and the livelihoods of Territorians. Due to a growing economy there is increasing pressure to clear land for a range of industries. The need for improved management and planning for vegetation management was recognised in the Integrated Natural Resource Management Plan for the Northern Territory (2005). This project was commissioned to address this issue in the Darwin, Marrakai and Katherine/Mataranka regions.

2. The management of native vegetation in other Australian jurisdictions is strictly regulated. Most states prohibit clearing of native vegetation and have established thresholds for retention of vegetation types at a state and regional levels. The Northern Territory currently has no set limits on the extent to which any vegetation type or other environmental unit may be subjected to clearance. Any land clearing greater than 1 ha is regulated by the Northern Territory Government and all applications are assessed using Land Clearing Guidelines (2006). Under these guidelines, clearing of certain vegetation types (e.g. rainforest, wetland, mangrove and riparian) and watercourses is prohibited, along with other restrictions relating to land capability.

3. A vegetation retention threshold set at 70% of the pre-European extent for each vegetation type defined at 1:1,000,000 scale is suggested. This would still cater for the protection of biodiversity and ecosystems services. This threshold should operate at both whole of the Northern Territory and regional levels (e.g. catchments). There may be some particular environments in particular regions that have such significant biodiversity values and/or role in sustaining ecological processes that they may also merit complete retention. Further, because retention targets directed only at vegetation types or land units may provide a poor match for the distributional patterns of some species, and because protection directed only at vegetation types or land units may allow excessive clearing (with resultant detrimental impacts on hydrological values) within some catchments, we propose a cap on clearing extent to 50% for every sub-catchment, where sub-catchments are defined as relating to any well-defined watercourse.

4. The extent of land clearing in the Darwin, Marrakai and Katherine/Mataranka regions is currently 13%, 6% and 6%, respectively. We used a range of spatial data to map vegetation in each of these three regions. Clearing in a number of mapping units has already exceeded the thresholds suggested above, notably eucalypt woodland and forest on deep soils.

5. We estimate that the current NT land clearing guidelines retain 56% of native vegetation in the Darwin region, 60% of native vegetation in the Marrakai region and 30% of native vegetation in the Katherine region. We applied a range of retention thresholds to this minimum baseline in each of the three project areas. The adequacy of each threshold in preserving each vegetation type in the project areas varied, but a 70% threshold adequately represented all vegetation types.

6. Management of remnant vegetation is required to avoid degradation. Land owners should consider the protection and enhancement of remnant vegetation following clearing. Uniform mapping of vegetation types at a scale of 1:250,000 or finer will improve planning for vegetation retention in the Northern Territory.
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Chapter 1. Background and Aims

Land clearing is one of the main threatening processes to the conservation of biodiversity in Australia and overseas. Land clearing results in the loss of habitat for plant and animal species and has been one of the main causes of extinction for a large number of plant and animal species. In 1992, Commonwealth, State and Territory Governments formulated the National Forests Policy Statement to provide a blueprint for the future use of public and private forests. The conservation goal in the statement is:

“...to maintain an extensive and permanent native forest estate in Australia and to manage that estate in an ecologically sustainable manner so as to conserve the full suite of values that forests can provide for current and future generations. These values include biological diversity, and heritage, Aboriginal and other cultural values.”

In comparison to the rest of Australia, the amount of land clearing in the Northern Territory is relatively small, and focussed on the main population centres of Darwin and Katherine. The future growth of the Northern Territory economy is dependent on the availability of suitable land for industries such as pastoralism, horticulture and mining. In response to these growing pressures for more land to be cleared for economic development and the threat that this may pose to the conservation of biodiversity, the Northern Territory Integrated Natural Resource Management Plan (2005) established the following Management Action Target:

“MAT3-5 In areas subject to most intense development pressures, regional vegetation management plans that provide for the retention of sufficient cover of all environments to meet ecological and community targets set by MA3-16 are collaboratively developed and enacted by 2008.”

The goal of this project is to develop vegetation retention plans for Darwin, Katherine/ Mataranka and Marrakai (Figure 1.1). The project has the following aims:

1. Critically review the adequacy and efficacy of retention thresholds developed in other Australian jurisdictions, and elsewhere
2. Review the threats to vegetation retention in Litchfield Shire, Marrakai and the Katherine/Mataranka regions.
3. Identify priority vegetation types within each key region, with a focus on vegetation types not readily retained under current land clearing guidelines and controls, such as vegetation types within prime agricultural land.
4. Determine and document overall proposed thresholds for retention of every priority vegetation type at an appropriate scale.
5. For each priority vegetation type use ecological theory and relevant data from the NT and elsewhere to assess the risk to biodiversity conservation across a gradient of possible thresholds to retain vegetation based on sound scientific principles.
6. Produce management guidelines on vegetation retention to assist landowners to retain biodiversity and mitigate threats or minimise impact of threats.

This document aims to provide practical guidance to stakeholders who are seeking information relating to the retention of native vegetation in the Northern Territory. This document has no statutory authority and has not been developed with public consultation.
Figure 1.1. Location of the Darwin, Katherine/ Mataranka and Marrakai regions in the Top End of the Northern Territory
This chapter describes the key features of land clearing regulations in the Northern Territory and reviews management of native vegetation in other jurisdictions of Australia.

Current vegetation clearing regulations in the Northern Territory

Native vegetation clearing has been subject to regulatory controls on pastoral land and within the Litchfield Shire for many years. In December 2002, the NT Government introduced native vegetation clearing controls to the remaining freehold and crown land, outside of the existing planning control areas (Darwin, Palmerston, Litchfield Shire, Katherine, Alice Springs), through Interim Development Control Order No. 12 (IDCO no.12). Following a two year period of consultation and development the IDCO was replaced by a permanent amendment to the NT Planning Scheme on 24 November 2004 and updated on 1 February 2007.

Clearing on land in planning control areas or on freehold or Crown land anywhere in the Territory is controlled by the Planning Act 2005. Clearing on pastoral leases is regulated under the Pastoral Land Act. Clearing on mining leases is guided primarily through environmental management plans under the Mines Management Act.

Under the Planning Act controls, landholders are required to get a permit to clear any more than one hectare of native vegetation. Where a hectare or more has already been cleared on a property, a permit is required for any additional clearing. All clearing of native vegetation in land zoned as for conservation requires consent. Clearing in areas zoned as "Restricted Rural Residential" must not exceed that reasonably necessary for the construction of a dwelling and uses ancillary to that dwelling.

These clearing regulations are designed to avoid impacts on environmentally significant or sensitive vegetation; to be based on land capability and suitability for the intended use; to avoid impacts on drainage areas, wetlands and waterways; to minimise habitat fragmentation and impacts on native wildlife corridors; and to avoid impacts on highly erodible soils. Each application for the clearing of native vegetation is required to demonstrate consideration of the following:

a) the Land Clearing Guidelines (as amended from time to time) by the Department of Natural Resources, Environment and the Arts;

b) the presence of threatened wildlife as declared under the Territory Parks and Wildlife Conservation Act;

c) the presence of sensitive or significant vegetation communities such as rainforest, vine thicket, closed forest or riparian vegetation;

d) the presence of essential habitats, within the meaning of the Territory Parks and Wildlife Conservation Act;

e) the impact of the clearing on regional biodiversity;

f) whether the clearing is necessary for the intended use;

g) whether there is sufficient water for the intended use;

h) whether the soils are suitable for the intended use;
i) whether the slope is suitable for the intended use;

j) the presence of permanent and seasonal water features such as billabongs and swamps;

k) the retention of native vegetation adjacent to waterways, wetlands and rainforests;

l) the retention of native vegetation buffers along boundaries;

m) the retention of native vegetation corridors between remnant native vegetation;

n) the presence of declared heritage places or archaeological sites within the meaning of the *Heritage Conservation Act*; and

o) the presence of any sacred sites within the meaning of the *NT Aboriginal Sacred Sites Act*.

Clearing of vegetation without consent is permissible where it is required under any other Act in force in the NT, or is for the purpose of (a) a firebreak up to 5 m wide along the boundary of a lot having an area of 8 ha or less, unless otherwise specified by a Regional Fire Control Committee; or (b) a firebreak up to 10 m wide along the boundary of a lot having an area greater than 8 ha, unless otherwise specified by a Regional Fire Control Committee; or (c) an internal fence line up to 10 m wide on a lot having an area greater than 8 ha.

Review of interstate thresholds and regulation for clearing native vegetation

Broad scale land clearing is no longer permitted in any Australian State and Territory apart from the Northern Territory. Nonetheless, clearing of native vegetation in these jurisdictions continues. Based on data contained in the State of the Environment Report (Beeton et al. 2006) a substantial net loss of vegetation is still occurring despite considerable revegetation in the last 24 years. Revegetation programs and natural regrowth in Australia have had a positive effect but at no time since 1973 has woody regrowth exceeded clearing of woody vegetation, mainly due to the high clearing rates in Queensland.

Legislation regulating the clearing of native vegetation is undergoing rapid changes in Australian jurisdictions at present. The last three years have seen all states adopt new legislation and/ or make significant amendments to existing land clearing legislation. A summary of the relevant government policies and legislation for other jurisdictions in Australia is provided in Appendix 1. Key features of native vegetation management regulations for Australian states are summarised in Table 2.1.

A common feature among the states is the use of retention thresholds at which the restrictions on clearing become tighter. For example, most jurisdictions use terms like “endangered”, “over-cleared” or “of concern” to denote vegetation types which have been cleared beyond a particular extent, and have more stringent protection measures for these vegetation types. Most states have set this threshold at 30% of the extent of the vegetation type prior to European settlement, with some states offering further protection when less than 10% remains. A number of states have adopted principles of “no net loss” or “net gain”, which means that to receive approval to clear, other areas of native vegetation must be set aside or restored for conservation. Permits to clear native vegetation are required in all jurisdictions. While every state allows exemptions in exceptional circumstances, all states restrict clearing in significant habitat, over-cleared vegetation types, and where clearing would contribute to soil erosion or deterioration in water quality.
Table 2.1. Summary of key features of native vegetation clearing regulations in Australian jurisdictions. [*See Appendix I for more details. Vegetation condition caveats apply in many jurisdictions (i.e. thresholds are higher if remaining vegetation is in degraded condition).

<table>
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<th>Feature</th>
<th>NT</th>
<th>NSW</th>
<th>Qld</th>
<th>SA</th>
<th>Tas</th>
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<td>Need permit to clear native vegetation</td>
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<td>✓</td>
<td>✓</td>
<td>✓</td>
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<td>✓</td>
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<tr>
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<tr>
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</tbody>
</table>

There is a growing trend among Australian jurisdictions to plan for connectivity at the landscape scale and trialling of market based incentives schemes. For example, the Queensland Government has identified state wildlife corridors and other attributes of significance for biodiversity that local government and other planning authorities can incorporate into their planning schemes. In South Australia, five landscape-scale biodiversity corridors ("naturelinks") are being planned that will comprise a comprehensive system of core protected areas, buffered and linked by areas of land and sea managed for conservation. Three corridors have been identified so far and details are being clarified through planning processes involving local communities and stakeholders. While primarily relying on core areas of public land managed for conservation, private landholders will also be encouraged to manage their land in a way that contributes to biodiversity conservation. The Victorian government has been developing a market based incentive scheme to manage remnant vegetation called “Bush Broker”. The scheme, managed by the Department of Sustainability and Environment, will administer the property rights through a set of covenants and management agreements. The department will provide information to enable matching of the quality and other characteristics of native vegetation between development sites and offset localities to ensure the offset criteria applied to clearing of native vegetation in Victoria are met. The department itself will not be involved in trading native vegetation credits; rather it will act as a quasi-clearinghouse, essentially to facilitate potential trades between buyers and sellers or their agents. In this capacity, it will develop rules and standards for the creation of credits, exchange of rights and the use of credits to meet offset requirements (DSE 2006).
**Chapter 3. Vegetation retention, the impact of clearing on biodiversity and thresholds**

Introduction

Unlike most Australian jurisdictions, currently in the Northern Territory there are generally no set limits on the extent to which any vegetation type or other environmental unit may be subjected to clearance.

This major deficiency in the natural resource management and regulatory framework for the Territory was explicitly recognised in the *Integrated Natural Resource Management Plan for the Northern Territory* (LCNT 2005) ["the NT NRM Plan"], where a series of Management Activities was developed to address the issue:

- **MA3-1.** Determine acceptable levels for the retention of each vegetation type (as identified at 1:1,000,000 scale) and vegetation condition by 2006.
- **MA3-2.** Monitor and adaptively manage the cumulative impacts on the broad scale extent and condition of vegetation and ecosystems in accordance with the limits identified in MA3-1.
- **MA3-15.** Continue to develop and implement overall targets for retention (i.e. not necessarily reservation) of every vegetation type at appropriate scales (i.e. greater detail than current 1:1,000,000), with particular emphasis on environments in those regions with high current or projected resource use or development pressures (e.g. Darwin surrounds, Daly Basin, Tiwi Islands).

The NT NRM Plan also included the Resource Condition Targets:

- **RCT3-1.** By 2020 the extent, condition and functionality of all native Territory environments will be maintained at levels to be set by 2006.
- **RCT 3-2.** By 2020 a comprehensive, adequate and representative protected area system will have been developed (through successful negotiation with landholders) and be cooperatively managed, that includes:
  a) at least 15% of the extent of all vegetation types (at 1:1,000,000 scale).

Notwithstanding the timeline indicated for this activity in the NT NRM Plan, these retention thresholds have not yet been established, and it would be inappropriate to use this report to establish them. However, here we review some relevant considerations, from ecological studies and policies and legislation elsewhere, and develop some recommended options that may inform the process of setting such limits.

Considerations

*Vegetation clearance is the primary cause of biodiversity decline and extinction worldwide.*

There is a settled consensus amongst environmental scientists that vegetation clearance has been the major factor driving contemporary high rates of extinction (e.g. Fischer and Lindenmayer 2007). Current vegetation clearance and the legacy of previous clearing events have caused and continue to cause substantial declines in biodiversity across the...
The clearance of native vegetation reduces the population of many native species, and fragments or isolates that remaining in retained bushland. Both of these factors may lead to reductions in the viability of the overall population of any species, and hence increase its likelihood of extinction.

As explicit recognition of its adverse impacts on Australia’s biodiversity, *land clearing* is listed as a key threatening process under the *Environment Protection and Biodiversity Conservation Act*.

In a recent review, the Prime Minister’s Science, Engineering and Innovation Council advised that unequivocally the single most important, and economically efficient, priority for sustaining our nation’s natural systems and biodiversity was the cessation of vegetation clearance (Morton et al. 2002).

**Deforestation is a major contributor to global climate change.**

The world’s climatic patterns are changing, at a rapid and probably accelerating rate. Such global climate change will increasingly have substantial, perhaps catastrophic, impacts on biodiversity - and possibly on human societies.

Deforestation is one of the main factors contributing to global climate change. Throughout their life, trees capture and store carbon, and, through photosynthesis, release oxygen. Recent analyses suggest that about 1 tonne of carbon per hectare per year is sequestered in Top End forests (Chen et al. 2003), with this value increasing if vegetation is unburnt.

Not only is this ongoing carbon accumulation lost or jeopardised with clearance of native forests and woodlands, but there may also be a one-off substantial spike in greenhouse gas emissions if felled timber is subsequently burnt.

At a time when many of the more developed regions in the world are attempting major tree-planting and reforestation schemes as a means towards forestalling or ameliorating global climate change and its impacts, it may be viewed as perverse to sanction continuing broad-scale vegetation clearance.

**The fundamental environmental value of the Northern Territory is in its essentially intact natural state.**

The Northern Territory has some particular sites of outstanding environmental value, most notably including the sandstone plateau of western Arnhem Land, the northern floodplain systems, the MacDonnell Ranges and the Tiwi Islands. But of more global significance is the naturalness of the landscape as a whole. Recent analyses demonstrate that northern Australia has by far the largest and most intact tropical savanna systems in the world (Woinarski et al. 2007a). This is an international asset that could be readily compromised by excessive clearing.

This intact nature of the Territory landscape provides for the conservation of its biodiversity and maintains the workings of its ecological processes. Such healthy and extensive natural landscapes underpin most land use and the livelihoods of Territorians. Extensive natural landscapes also define the essence of the Northern Territory.

**Vegetation clearance affects hydrological patterning and processes, and hence may have consequential impacts well beyond the clearing site.**

The removal of native vegetation may have complex impacts on hydrological processes. The structure and composition of vegetation affects the extent of water use, interception of
rainfall, the extent and intensity of run-off (and hence soil erosion) and ground temperature. Hence clearing and transformation of native vegetation may affect water availability and quality beyond the site of clearing: that is, detrimental effects may be suffered by neighbours or stakeholders distant from the point of clearing. In the strongly seasonal environment of the Northern Territory, water availability may be a critical factor in at least parts of the year, so such perturbations in the hydrological system may have substantial impacts.

**Almost any vegetation clearing will affect biodiversity.**

Any clearing event will result in losses of some individuals of many plant and animal species. In a study focusing particularly on Queensland, (Cogger et al. 2003) collated available information to derive density for plants and animals, and hence the number that would be killed in a clearing event. For environments similar to those of the Top End, they predicted that, for any hectare cleared, between 1.4 and 3.5 native mammals, 26-31 birds, 200 reptiles and 466 trees would be killed, with substantially greater loss of understorey plants and invertebrates.

The conservation consequences of such losses are variable - depending upon the total range and abundance of any given species relative to the clearing event; the total extent and dispersion of the environments subject to clearing; and the extent of previous clearing affecting these environments and species. At one extreme, some species (such as some plants and invertebrates) may be highly restricted (e.g. <10 ha in total extent), and their ongoing survival may be particularly susceptible to even very limited clearing episodes. Because of their small ranges, such species are typically not or imperfectly detected in broad-scale biodiversity inventories.

**There is a substantial ecological literature relating vegetation clearance to biodiversity decline, but there is no consensus about the form of the relationship between the extent of clearing and biodiversity response, nor about the positioning, if any, of a threshold of “acceptable” clearing.**

Research around the world has found that species are lost very rapidly from highly fragmented landscapes (e.g. Andren 1994, Sodhi et al. 2004). In the Top End of the Northern Territory, Rankmore and Price (2004) studied the consequences of habitat fragmentation in the Darwin region and found that 40% of vertebrate species were less common within woodland fragments than in similar continuous woodlands. They also predicted that many species would be lost from a landscape with less than 30% vegetation retention.

**The scale of environmental mapping that is appropriate for regional planning and establishment of vegetation clearance thresholds, and for monitoring of clearing extent, is 1:250,000 or finer.**

Environmental mapping, primarily based on vegetation types, is a widely used methodology in Australia and overseas for planning of conservation management initiatives. The spatial scale at which environmental features are mapped influences the amount of information represented in the map, and therefore the basis for planning decisions. Environmental mapping at a broad scale (> 1:1,000,000) is far more generalised and less able to delineate between complex vegetation than at the 1:100,000 scale. Note that the National Forests Policy Statement stipulates that consideration of land-use and clearing should be predicated on mapping at 1:250,000 or finer.
The distributions of some species will not be well represented by vegetation mapping.

Environmental mapping provides a largely objective procedure for spatially symbolising and simplifying the complex variability in natural systems. In the context of management and monitoring of vegetation clearance, an environmental mapping scheme is necessary to ensure that some sample of whole assemblages of plants and animals is retained rather than unwittingly eliminated, and to provide the planning tools that will show geographic options for clearing and retention.

However, there will always be some elements of biodiversity whose distribution is uncorrelated with any particular environmental mapping scheme. Hence designing a conservation plan or vegetation retention plan based solely on one environmental mapping scheme will provide little safeguard for some species. This deficiency can be addressed partly through ensuring that retention thresholds are set conservatively, partly through using more than one environmental mapping scheme (where available), partly through ensuring some level of geographic representation in the planning, and partly through using information on species’ distributions.

How to deal with landscape connectivity?

Connectivity is a key component of vegetation retention planning because it links individual populations of plants and animals, which in turn increases genetic diversity and reduces extinction risk. A number of studies show that it is important not just to maintain connections among elements of the same habitat, but that different habitat types that support wildlife at different times in their life cycles or in different seasons must also remain connected if populations are to persist (Talley et al. 2006). Mathematical models and simulations indicate that in a landscape comprising two “habitat” types, one representing favourable habitat and the other unfavourable, direct connection among the elements of favourable habitat will break down rapidly if more than 40% of the cells are cleared (e.g. With and Crist 1995). Therefore, it is important to maintain connectivity in landscapes. However, current understanding of the level of connectivity in tropical savannas is limited and further research in is required to establish optimal configuration of corridors and patch size.

In the highly seasonal climate of the Northern Territory, many species may need to disperse widely across the landscape.

In some geographic areas, most species will be relatively sedentary, and such resident populations may be likely to persist in retained bushland fragments. However, for the persistence of species that need to disperse widely over the course of a year, or between years, much larger areas of bushland and/or substantial bushland connections between retained patches may be needed. Largely because the highly seasonal environment of northern Australia imposes marked variation in resources at any one locality, very many species in northern Australia need to disperse widely across the landscape to survive over the course of a year (Woinarski et al. 2005, Woinarski et al. 2007a). For this reason, it may be more important to retain a higher proportion of native vegetation in the landscape than for a less seasonal environment.

Should thresholds also apply at regional levels?

A review of the global literature suggested that when clearing of forests exceeds 70%, birds and mammals are increasingly lost from the entire landscape (Andren 1994). Others reviewing the same information have concluded that such generalisation of a threshold is risky and that losses often occur at substantially lower levels of clearing (Mönkkönen and Reunanen 1999). Local studies of fragmented landscapes show that significant declines in abundance of a number of species are observed when clearing exceeds 35% of the area.
within a radius of 4 km, the threatened Northern Quoll will be lost entirely when clearing exceeds 50%, and increasing numbers of species will be lost when clearing exceeds 70% (Rankmore and Price 2004). Therefore, thresholds need to be applied at a range of spatial scales to conserve biodiversity. Further research in the Northern Territory is required to establish thresholds at different spatial scales.

**Some vegetation types, or environmental units, are more important (or susceptible) than others.**

The existing land clearing guidelines recognise that some environments have such important ecological roles and/or contain such important biodiversity values, that they should be protected entirely from clearing. The environments listed in the existing guidelines are rainforests, riparian areas and wetlands.

Rainforests are important as they typically contain high species richness within relatively small areas, and many species that are dependent upon them. For example, rainforest patches comprise about 0.2% of the area of the Northern Territory yet are the primary habitat of about 13% of the Territory’s plant species. Rainforest patches form a natural archipelago, each with different plant and animal species composition, and recent research suggests that the loss of any one patch may have more pervasive impacts across the rainforest system as a whole (Price et al. 1999). Many plant and animal species occur only in rainforests, and the ranges of many are restricted to very few patches.

Riparian areas (“frontages” or riverside zones) are functionally important, for maintaining savanna and stream biodiversity, stream channel morphology and water quality. They typically have greater species richness than surrounding areas, they provide pathways that allow biota to move from one area to another, acting as natural corridors, and they provide critical habitat in an otherwise inhospitable environment (Woinarski et al. 2000). Many species are restricted to watercourse frontages. Vegetation is essential in maintaining bank stability, reducing nutrient runoff reaching rivers, reducing erosion and overland water flow, and regulating light and temperature on the water surface.

Wetlands are essential habitat for all fish, crustacean, aquatic plant and most frog species, yet occupy only about 1% of a catchment area. Mobile species such as magpie geese need a network of wetlands to provide resources at critical times of the year. For this reason, the loss of a particular wetland may produce a gap in resources that some species cannot overcome.

**Some rock-bottom limits to vegetation retention thresholds can be informed by commitments given for the establishment of a comprehensive adequate and representative reserve network, and from the categorisation elsewhere of what constitutes a threatened ecological community or regional ecosystem.**

Through the Parks and Conservation Masterplan (NRETA 2005) and a range of national strategies, the Territory Government has committed to the establishment of a comprehensive adequate and representative conservation reserve system. Such a system requires inclusion within protected areas of adequate amounts of every environmental unit defined at appropriate scale. Consistent with international best practice, the INRM Plan (RCT3-2) parameterises this as 15% of the extent of every vegetation type; although it relates this typology to a scale (1:1,000,000) generally recognised as too coarse for regional planning. This target provides a rock-bottom limit to the extent of retention of 15% (and hence maximum upper clearing limit of 85%): else, the reserve network would never meet the objective of comprehensiveness and adequacy.

A converse way of identifying rock-bottom limits to vegetation retention is to use thresholds developed elsewhere to categorise environmental units as threatened that is with a high risk of extinction. In Queensland, any regional ecosystem is regarded as **endangered** if less
than 10% of its pre-European extent remains, and of concern if 10-30% remains. For listing nationally as threatened communities under the EPBC Act, the criteria are indicative and contextualised by a range of other factors, but a terrestrial vegetation community meets the criteria for critically endangered if it has less than 5% of its extent remaining, endangered if less than 10%, and vulnerable if less than 30%. These standards suggest that clearing extents of over 70% are recognised as compromising the viability of any vegetation type or ecological community to such an extent that it would be threatened with extinction and may be listed nationally as a threatened ecological community.

In general, the current cumulative amount of clearing in the Northern Territory is relatively limited, hence thresholds could be set conservatively.

Of the 112 vegetation types defined at 1:1,000,000 scale for the Northern Territory by Wilson et al. (1990):

82 of the 112 (=73%) vegetation types have had no (or negligible = <0.001% of their extent) clearing;

- a further 18 vegetation types (=16%) have had <1% of their extent cleared;
- a further 9 vegetation types (=8%) have had 1-5% of their extent cleared; and
- the remaining three vegetation types have had more than 5% of their extent cleared.

The three most cleared vegetation types are:

- Type 48 (*Livistona humilis* tall open shrubland) for which 13.9% of the original extent is already cleared [most of that clearing being in the Litchfield-Finniss-Dundee area]
- Type 47 (*Acacia* open shrubland with *Sorghum* understorey) of which 10.0% of the original extent is already cleared [most of that clearing being on Melville Island]; and
- Type 9 (*Eucalyptus tetrodonta-E.miniata-Corymbia bleeseri* woodland with *Sorghum* understorey) of which 5.8% of the original extent is already cleared [mostly in the Darwin greater rural area].

These tallies suggest that there is opportunity to set conservative clearing thresholds, which would still allow for substantial development.

Suggested vegetation retention thresholds

The Territory’s intactness, and hence value, will be diminished by ongoing clearing. But for a range of economic and social reasons, there will continue to be pressure to expand development. As the modification and clearing of our native environments expands, its conservation values decline. Where is the balance? Frankly, there is no threshold that optimises these competing values: no single figure that flips from a guarantee of maintenance of biodiversity conservation to erosion of that biodiversity. A range of candidate values are presented in Table 3.1 below, along with their likely consequences for biodiversity and development.
Table 3.1. Plausible retention thresholds (for all vegetation types) and their likely consequences for environment and development.

<table>
<thead>
<tr>
<th>Vegetation retention threshold</th>
<th>Likely consequences for the environment</th>
<th>Likely consequences for development</th>
</tr>
</thead>
<tbody>
<tr>
<td>90%</td>
<td>All species will maintain viable populations; all ecosystem processes remain intact and country healthy; the character of the Territory retained</td>
<td>Some clearing would still be allowable in most (109 of the recognised 112) environments; but would need to be very tightly and strategically regulated</td>
</tr>
<tr>
<td>70%</td>
<td>All species likely to retain viable populations; ecosystem processes likely to be maintained; the character of the Territory largely maintained.</td>
<td>Substantial clearing allowable but within a context of retaining the landscape as mostly natural.</td>
</tr>
<tr>
<td>50%</td>
<td>Some regional extinctions possible; impact on ecological processes uncertain; the landscape would become a blend of natural and artificial; some substantial adverse contributions to climate change.</td>
<td>Substantial clearing allowable, and large areas transformed to intensive use.</td>
</tr>
<tr>
<td>30%</td>
<td>Regional extinctions likely; ecosystems likely to become recognised as threatened; the character of the Territory irredeemably changed; major adverse national contribution to climate change</td>
<td>Major broad-scale clearing for intensive use; transformation of the Territory</td>
</tr>
</tbody>
</table>

We consider the issues discussed above can best be addressed by setting a reasonably cautious limit, to ensure that all environments are maintained in a functioning manner. We note that prudence is reasonable as it is far easier to adjust, in the future, the threshold downwards (to allow more clearing) if it can be shown to have been initially set over-conservatively, than to attempt to restore native environments if subsequent evidence shows that the thresholds were initially set too low.

Based on plausible retention thresholds noted in Table 3.1, we suggest that the threshold be 70% retention of the pre-European extent for each vegetation type defined at 1:1,000,000 scale to maximise the protection of biodiversity and ecosystems services. This threshold should operate at both whole of Territory and regional levels (e.g. catchments). Following the existing NT land clearing guidelines, exceptions are made for rainforests, riparian areas and wetlands, where the retention level is set at 100%. Additionally, there may be some particular environments in particular regions that have such significant biodiversity values and/or role in sustaining ecological processes that they may also merit such complete retention.

Further, because retention targets directed only at vegetation types may provide a poor match for the distributional patterns of some species, and because protection directed only at vegetation types may allow excessive clearing (with resultant detrimental impacts on hydrological values) within some catchments, we propose a cap on clearing extent to 50% for every sub-catchment, where sub-catchments are defined as relating to any well-defined watercourse, including stream order 1.

These suggested thresholds should complement and/or add to existing guidelines that constrain clearing from steeper slopes, unsuitable soils and within specified buffers of watercourses.

In chapters to follow, we explore a variety of vegetation retention scenarios in the Darwin (Chapter 5), Katherine/ Mataranka (Chapter 6) and Marrakai regions (Chapter 7). We contrast the threshold we recommend here with a range of other possible thresholds.
Chapter 4. Spatial data and protocols for vegetation retention mapping

This chapter summarises the spatial data used and protocols adopted to develop vegetation retention scenarios.

Spatial data

A Geographic Information System (GIS) was assembled to include available spatial data and satellite imagery for the three project areas. The mapping exercise was limited by the extent and quality of spatial data, with varying coverage and spatial scales available. There was no uniform spatial data set available that adequately represented vegetation in the three project areas. The NT vegetation map (Wilson et al. 1990) is produced at a scale of 1:1,000,000, which was considered to be too coarse for vegetation retention planning in the Darwin and Marrakai regions. Therefore, we relied upon three different spatial data sets representing vegetation in each project area: Marrakai – land units mapped at 1:25,000; Darwin – vegetation cover mapped at 1:100,000; Katherine/Mataranka – Land systems mapped at 1:250,000.

Protocols

All vegetation retention scenarios are illustrative only. They do not represent any form of legally binding regulation of land clearing. Instead, they reflect planning principles for the retention of native vegetation, and how the application of these principles and possible thresholds might play out in terms of on-ground consequences and outcomes. The scenarios were produced in two stages.

The first stage (“baseline retention”) consisted of retaining vegetation based on the current Northern Territory Government Land Clearing Guidelines (NRETA 2006). Specifically, this included retaining all vegetation that was associated with:

1. Drainage lines, watercourses, wetlands or seepage zones and recommended buffers;
2. Sensitive vegetation (rainforests, vine thicket or closed forest);
3. Waterlogging and seasonal inundation; and
4. Slopes greater than 5%.

The second stage consisted of introducing a number of alternative thresholds to the baseline map established in Stage 1 using the relevant mapping unit (i.e. land unit, vegetation type or land system). Mapping unit thresholds were set to illustrate the potential vegetation retention scenarios in the region. In each project area, we developed three vegetation retention scenarios as described below:

1. Scenario 1 - Baseline retention + 50% of each mapping unit
2. Scenario 2 - Baseline retention + 70% of each mapping unit + 50% of each property
3. Scenario 3 - Baseline retention + 90% of each mapping unit + 70% of each sub-catchment
Where there were choices of areas which could be selected to reach these retention thresholds, areas were selected that maximised connectivity between baseline retained vegetation (e.g. linked isolated fragments; closed gaps in corridors of vegetation), that kept vegetation in as large a block as possible, and which were preferably located away from areas that had already been cleared.

Table 4.1. Information layers used in GIS to design vegetation retention scenarios.

<table>
<thead>
<tr>
<th>Category</th>
<th>Dataset</th>
<th>Scale</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vegetation / land classification</td>
<td>NT Native Vegetation Clearing</td>
<td>1:100,000</td>
<td>NRETA</td>
</tr>
<tr>
<td></td>
<td>Daly Basin Land units</td>
<td>1:50,000</td>
<td>NRETA</td>
</tr>
<tr>
<td></td>
<td>Marrakai Land units</td>
<td>1:25,000</td>
<td>NRETA</td>
</tr>
<tr>
<td></td>
<td>NT Rainforest</td>
<td>1:100,000 – 1:250,000</td>
<td>NRETA</td>
</tr>
<tr>
<td></td>
<td>NT Wetlands</td>
<td>1:100,000</td>
<td>NRETA</td>
</tr>
<tr>
<td></td>
<td>NT Melaleuca</td>
<td>1:100,000</td>
<td>NRETA</td>
</tr>
<tr>
<td></td>
<td>Top End Land systems</td>
<td>1:250,000</td>
<td>NRETA</td>
</tr>
<tr>
<td></td>
<td>Katherine Sinkholes</td>
<td></td>
<td>NRETA</td>
</tr>
<tr>
<td>Biodiversity</td>
<td>NT Fauna Atlas (including threatened species)</td>
<td>varied</td>
<td>NRETA</td>
</tr>
<tr>
<td></td>
<td>NT Flora Atlas (including threatened species)</td>
<td>varied</td>
<td>NRETA</td>
</tr>
<tr>
<td>Land boundaries</td>
<td>NT Cadastre (and Tenure type)</td>
<td>1:50,000</td>
<td>DPI</td>
</tr>
<tr>
<td></td>
<td>NT Planning Zones</td>
<td>1:50,000</td>
<td>DPI</td>
</tr>
<tr>
<td></td>
<td>NT Parks and Reserves</td>
<td>1:50,000</td>
<td>NRETA</td>
</tr>
<tr>
<td></td>
<td>Land Use Mapping of NT</td>
<td>1:25,000-1:100,000</td>
<td>NRETA</td>
</tr>
<tr>
<td>Water</td>
<td>Rivers and creeks</td>
<td>1:250,000, supplemented with 1:50,000</td>
<td>GA</td>
</tr>
<tr>
<td>Relief</td>
<td>Elevation and slope</td>
<td>1:100,000</td>
<td>SRTM</td>
</tr>
<tr>
<td>Infrastructure</td>
<td>Roads and railways</td>
<td>1:100,000</td>
<td>DPI</td>
</tr>
<tr>
<td>Satellite Imagery</td>
<td>Landsat TM, varied years</td>
<td>30 m resolution</td>
<td>AGO</td>
</tr>
<tr>
<td></td>
<td>SPOT (Katherine)</td>
<td>2.5 m resolution</td>
<td>AGO</td>
</tr>
<tr>
<td></td>
<td>Quickbird (Katherine and Darwin)</td>
<td>2.5 m resolution</td>
<td>AGO</td>
</tr>
</tbody>
</table>

[AGO = Australian Greenhouse Office; DPI = NT Dept Planning and Infrastructure; GA = Geoscience Australia; STRM = Shuttle Radar Topography Mission]
Chapter 5. Darwin Region vegetation retention plan

Description of Darwin region

The Darwin region, as defined in this strategy includes Darwin and Palmerston, Litchfield Shire, the Cox Peninsula and the Coomalie and Finniss Sub-regions (Figure 5.1). It has a total area of 7605 km² or about 0.6% of the entire NT. The majority of the area lies within the Darwin Coastal bioregion (60.4%), and the remainder in the Pine Creek bioregion. The area represents the most developed part of the Northern Territory, including large urban and peri-urban residential areas, industrial facilities and diverse agricultural developments. The region has a population of over 100,000 people. A small strip of land on the eastern edge of Litchfield Shire (265.9 km²) and Coomalie Sub-region (56.5 km²) is not included in the region, because it was outside the swath of the Landsat satellite imagery that was used to derive the vegetation map. Almost all of these excluded areas are on the floodplain of the Adelaide River.

Several Government land use planning documents cover the Darwin region. These include the Litchfield Planning Concepts and Land Use Objectives (Anon. 2002b), the Litchfield Area Plan (Anon. 2004), Proposed Coomalie Planning Concepts and Land Use Objectives (Anon. 1998), and Finniss Planning Concepts and Land Use Objectives (Anon. 2002a). These plans addressed the issue of land use allocation, including mapping areas for primarily conservation management. They frame the broad context in which retention of native vegetation may occur. For example, they highlight priority areas for future peri-urban and agricultural expansion and areas with high conservation priority. Together, these documents identify 1699 km² of land (22% of the region) as Open Space or Water Management, in addition to the existing formal reserves (Figure 5.2).

Tenure and land use

A range of land tenures cover the Darwin region (Figure 5.1; Table 5.1). Freehold tenure is the most common in the region, covering 34%. Crown lease in perpetuity covers 16% of the region. Land use is diversified in the Darwin region (Figure 5.2). In the northern areas, land use is dominated by a mixture of urban and rural residential, agriculture, defence and conservation. In the southern areas, grazing, water catchment and other agricultural industries are more prevalent.

There are 21 protected areas managed by the Northern Territory Government in the Darwin region, comprising 875 km² (11.3% of the region) (Figure 5.3; Table 5.2). About half of the protected area is in Djukbinj National Park and the northern section of Litchfield National Park (most of Litchfield National Park is outside the region). In addition to this, the Litchfield Shire Council owns 45 small reserves, with a combined area of 11.9 km². They are almost all wetlands and riparian buffers, acquired as an excision from a residential development.

There are a number of river catchments in the Darwin region (Figure 5.4). River catchments draining to the north coast include the Darwin, Blackmore Howard, Elizabeth and Howard Rivers, while the Finniss River drains to the west coast. Part of the Adelaide River catchment is contained in the region as well.
### Table 5.1. Summary of land tenure in the Darwin region.

<table>
<thead>
<tr>
<th>Tenure</th>
<th>Area (km²)</th>
<th>% of project area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aboriginal Freehold (Commonwealth)</td>
<td>531</td>
<td>7</td>
</tr>
<tr>
<td>Aboriginal Land (NT Freehold)</td>
<td>254</td>
<td>4</td>
</tr>
<tr>
<td>Crown Lease in Perpetuity</td>
<td>1107</td>
<td>16</td>
</tr>
<tr>
<td>Crown Lease Term</td>
<td>405</td>
<td>6</td>
</tr>
<tr>
<td>Estate in Fee Simple (Freehold)</td>
<td>2404</td>
<td>34</td>
</tr>
<tr>
<td>Government Set Aside</td>
<td>92</td>
<td>1</td>
</tr>
<tr>
<td>Occupational Licence</td>
<td>9</td>
<td>&lt;0.1</td>
</tr>
<tr>
<td>Perpetual Pastoral Lease Reserve</td>
<td>887</td>
<td>13</td>
</tr>
<tr>
<td>Right to a Freehold Title</td>
<td>48</td>
<td>1</td>
</tr>
<tr>
<td>Special Purposes Lease</td>
<td>23</td>
<td>&lt;0.1</td>
</tr>
<tr>
<td>Vacant Crown Land</td>
<td>1201</td>
<td>17</td>
</tr>
</tbody>
</table>

### Table 5.2. Summary of conservation reserves managed by the Northern Territory Government in the Darwin region.

<table>
<thead>
<tr>
<th>No.</th>
<th>Name</th>
<th>Area (km²)</th>
<th>No. of land cover types</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Djukbinj National Park (eastern section)</td>
<td>238.0</td>
<td>13</td>
</tr>
<tr>
<td>2</td>
<td>Litchfield National Park (northern section)</td>
<td>200.0</td>
<td>6</td>
</tr>
<tr>
<td>3</td>
<td>Shoal Bay Coastal Reserve</td>
<td>121.7</td>
<td>14</td>
</tr>
<tr>
<td>4</td>
<td>Manton Dam Recreation Area</td>
<td>116.6</td>
<td>9</td>
</tr>
<tr>
<td>4</td>
<td>Black Jungle / Lambells Lagoon Conservation Reserve</td>
<td>40.5</td>
<td>10</td>
</tr>
<tr>
<td>5</td>
<td>Vernon Islands Conservation Reserve</td>
<td>33.3</td>
<td>7</td>
</tr>
<tr>
<td>6</td>
<td>Indian Island Conservation Area</td>
<td>24.2</td>
<td>9</td>
</tr>
<tr>
<td>7</td>
<td>Melacca Swamp Conservation Area</td>
<td>22.9</td>
<td>12</td>
</tr>
<tr>
<td>8</td>
<td>Fogg Dam Conservation Reserve</td>
<td>18.1</td>
<td>9</td>
</tr>
<tr>
<td>10</td>
<td>Howard Springs Hunting Reserve</td>
<td>16.1</td>
<td>10</td>
</tr>
<tr>
<td>11</td>
<td>Charles Darwin National Park</td>
<td>10.6</td>
<td>10</td>
</tr>
<tr>
<td>12</td>
<td>Territory Wildlife Park / Berry Springs Nature Park</td>
<td>8.1</td>
<td>9</td>
</tr>
<tr>
<td>13</td>
<td>Blackmore River Conservation Reserve</td>
<td>5.5</td>
<td>7</td>
</tr>
<tr>
<td>14</td>
<td>Tree Point Conservation Area</td>
<td>4.5</td>
<td>8</td>
</tr>
<tr>
<td>15</td>
<td>Casuarina Coastal Reserve</td>
<td>3.4</td>
<td>5</td>
</tr>
<tr>
<td>16</td>
<td>Howard Springs Nature Park</td>
<td>2.8</td>
<td>7</td>
</tr>
<tr>
<td>17</td>
<td>Holmes Jungle Nature Park</td>
<td>2.5</td>
<td>7</td>
</tr>
<tr>
<td>18</td>
<td>Adelaide River Foreshore Conservation Area</td>
<td>2.2</td>
<td>1</td>
</tr>
<tr>
<td>19</td>
<td>Harrison Dam Conservation Area</td>
<td>1.9</td>
<td>5</td>
</tr>
<tr>
<td>20</td>
<td>Knuckey Lagoons Conservation Reserve</td>
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<td>2</td>
</tr>
<tr>
<td>21</td>
<td>Channel Island Conservation Reserve</td>
<td>1.0</td>
<td>2</td>
</tr>
</tbody>
</table>
Figure 5.1. Distribution of land tenure in the Darwin region.
Figure 5.2. Distribution of land use in the Darwin region.
Figure 5.3. Distribution of conservation reserves in the Darwin region.
Figure 5.4. Distribution of rivers and associated sub-catchments in the Darwin region.
Vegetation mapping

There have been seven mapping projects relevant to describing vegetation in the Darwin region. The first was Land Unit mapping, which was derived at a scale of 1:25,000 from aerial photography and field data from hundreds of sites (van Cuylenburg and Czachorowski 1984). At present, it covers the entire region except Coomalie Sub-region and Cox Peninsula. The second was the remnant vegetation mapping of Darwin and Litchfield Shire by Greening Australia in the early 1990s at a scale of 1:25,000 (Brock 1995). There are also four maps of specific vegetation types. These are mangrove communities in Darwin Harbour (Brocklehurst and Edmeades 1996); paperbark communities across the NT (DIPE, unpublished data); rainforest patches across the NT (DIPE, unpublished data); and wetlands across the NT identified from 1:100,000 topographic maps (used in the Coastal Resource Atlas, unpublished data). The seventh was a 1:100,000 scale map of land cover was derived from Landsat satellite imagery (Hempel 2003).

For this report, we used the 2003 Land Cover map combined with specific vegetation types maps for rainforest and wetlands. The definition we used for wetland was any area mapped as such in at least two of the maps (Land Cover, CRA wetlands, Land Units and Paperbark Communities). The riparian class in the Land Cover map is not strictly a riparian forest type, but a mix of open to closed forest, including some riparian areas, but also the most dense eucalypt forests, *Acacia auriculiformis* forest and the more open rainforests. To identify strictly riparian vegetation, we instead use the river and creek network from 1:25,000 topographic maps. Overall, this resulted in 12 vegetation types (Figure 5.5).

Description of vegetation types

*Eucalypt woodland and open forests* (Area = 59.2% of the Darwin region). Positioned along a spectrum of soil fertility and depth, with the open woodland occurring on the shallowest, rocky or drainage impeded soils and the open forest on the deepest and more fertile soils. The plant species overlap considerably, but the open forest canopy is dominated by *Eucalyptus tetrodonta* and *E. miniata*, while the open woodland has a higher proportion of *Corymbia polycarpa* and *C. latifolia*. Open forests are the core habitat for cycads (*Cycas armstrongii*), have a dense understorey (including vines) and large trees.

*Drainage open woodlands* (Area = 6.6%) - occur in seasonally inundated areas with impeded drainage. They may have a variety of dominant tree species, including *Lophostemon lactifluus*, *Pandanus spiralis*, *Melaleuca viridiflora* or *M. nervosa*.

*Riparian open forest* (Area = 5.4%) - includes several forest communities that are not all riparian, but contain similar species. In many cases, this is the margins of rainforest patches or mangroves, where they intergrade with eucalypt woodlands. Common tree species include *Acacia auriculiformis*, *Pandanus spiralis*, *Canarium australianum*, *Lophostemon lactifluus* and *Melaleuca cajuputi*.

*Rainforest* (Area = 2%) – This unit occurs in a wide range of conditions including margins of wetlands, floodplains open forest. It is composed of numerous small (typically <10 ha) patches, and has very high plant species diversity.
*Melaleuca swamps* (Area = 1%) - seasonally inundated swamps, and usually comprise a forest of *Melaleuca viridiflora*.

*Heathland* (Area = 0.7%) - occur where a layer of sand overlies an impermeable deposit of clay. They are usually dominated by *Grevillea pteridifolia* and *Banksia dentata* and are also the habitat for almost all of the *Utricularia* species (bladderwort herbs) found in the Darwin region.

*Grassy swamp* (Area = 0.8%) - perennial grass or sedgelands with scattered trees occurring on black soil. Common species include *Xyris complanata*, *Pseudoraphis spinescens* (both sedges), *Eriachne burkittii* and *Ischaemum australe* (perennial grasses).

*Floodplain* (Area = 4.2%) – occur in seasonally inundated coastal plains and contain grass or sedgelands with very scattered trees. The dominant species are *Eleocharis dulcis*, *E. spiralis*, and *Oryza rufipogon*.

Mangrove forest (Area = 3%) - occur in coastal zones from landward to seaward. Species include *Sonneratia alba*, *Rhizophora stylosa*, *Ceriops tagal* and *Avicennia marina*.

*Samphire* (Area = 2%) - hypersaline mudflats either devoid of vegetation or containing sparse salt-tolerant shrubs, such as *Baltis argillicola*. 
Figure 5.5. Distribution of vegetation types in the Darwin region. Mapping is based on Hempel (2003).
Priority vegetation and threatened species in Darwin region

The Darwin region contains substantial amounts of vegetation types classified as ‘sensitive’ under the Land Clearing Guidelines (NRETA 2006). In total, sensitive vegetation types comprise approximately 1824 km² of the Darwin region (Figure 5.6). Rainforest vegetation covers 131 km² of the Darwin region and is concentrated on the edge of the Adelaide River floodplain. Extensive wetlands occur throughout the area, covering 161 km². Riparian vegetation occurs along the main river channels and associated streams, covering 414 km². Other sensitive vegetation types include samphire (137 km²), floodplains (327 km²) and mangrove (677 km²).

Heathlands is a rare vegetation type present in the Darwin region but not covered under the NT Land Clearing Guidelines (NRETA 2006). In the Darwin region, heathlands cover 56 km². Sand sheets associated with Heathlands are also the habitat of the recently discovered Howard River Toadlet (*Uperoleia daviesae*) that is known only from the Darwin region. The extent of Heathlands in the Darwin region has been diminished by mining for sand used in the local construction industry. Melaleuca swamps and Grassy swamps are of limited extent in the Darwin region (Figure 5.6).

The Darwin region contains 40 flora species that are listed as of conservation significance under Northern Territory and/or Commonwealth legislation (Table 5.3; Figure 5.7). Eleven of these are listed as threatened under the *Territory Parks and Wildlife Conservation Act 2001* and/or the *Environment Protection and Biodiversity Conservation Act 1999*, while a further 29 are listed as Near Threatened in the NT. Fourteen plant species from the Darwin region have a very restricted range (less than 10,000 km²), which means that conservation within the Darwin region is a high priority (Table 5.3).

There are 114 vertebrate species of conservation significance in the Darwin region (Table 5.4; Figure 5.7). Sixteen species are listed as threatened under the *Territory Parks and Wildlife Conservation Act 2001* and/or the *Environment Protection and Biodiversity Conservation Act 1999* (Table 5.4; Figure 5.7). A further 22 species are listed as Near Threatened in the NT. Most of these species need large areas to maintain populations, and since most have been recorded from the Darwin River catchment, this area provides their most important protection within the hinterland of Darwin. Eighty-one species that occur in the Darwin region are recognised under international migratory species treaties (Table 5.4).

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NT – Near Threatened, VU – Vulnerable, EN – Endangered

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</tr>
<tr>
<td>Pacific Golden Plover</td>
<td><em>Pluvialis fulva</em></td>
<td>Bird</td>
<td>+</td>
<td>158</td>
<td>44</td>
</tr>
<tr>
<td>Grey Plover</td>
<td><em>Pluvialis squatarola</em></td>
<td>Bird</td>
<td>+</td>
<td>193</td>
<td>35</td>
</tr>
<tr>
<td>Ringed Plover</td>
<td><em>Charadrius hiaticula</em></td>
<td>Bird</td>
<td>+</td>
<td>3</td>
<td>100</td>
</tr>
<tr>
<td>Little Ringed Plover</td>
<td><em>Charadrius dubius</em></td>
<td>Bird</td>
<td>+</td>
<td>83</td>
<td>89</td>
</tr>
<tr>
<td>Lesser Sand Plover</td>
<td><em>Charadrius mongolus</em></td>
<td>Bird</td>
<td>+</td>
<td>162</td>
<td>38</td>
</tr>
<tr>
<td>Greater Sand Plover</td>
<td><em>Charadrius leschenaultii</em></td>
<td>Bird</td>
<td>+</td>
<td>286</td>
<td>47</td>
</tr>
<tr>
<td>Caspian Plover</td>
<td><em>Charadrius asiaticus</em></td>
<td>Bird</td>
<td>+</td>
<td>3</td>
<td>43</td>
</tr>
<tr>
<td>Oriental Plover</td>
<td><em>Charadrius veredus</em></td>
<td>Bird</td>
<td>+</td>
<td>28</td>
<td>15</td>
</tr>
<tr>
<td>Oriental Pratincole</td>
<td><em>Glareola maldivarum</em></td>
<td>Bird</td>
<td>+</td>
<td>30</td>
<td>20</td>
</tr>
<tr>
<td>Pomarine Jaeger</td>
<td><em>Stercorarius pomarinus</em></td>
<td>Bird</td>
<td>+</td>
<td>2</td>
<td>17</td>
</tr>
<tr>
<td>Long-tailed Jaeger</td>
<td><em>Stercorarius longicaudatus</em></td>
<td>Bird</td>
<td>+</td>
<td>2</td>
<td>67</td>
</tr>
<tr>
<td>Caspian Tern</td>
<td><em>Sterna caspia</em></td>
<td>Bird</td>
<td>+</td>
<td>187</td>
<td>25</td>
</tr>
<tr>
<td>Lesser Crested Tern</td>
<td><em>Sterna bengalensis</em></td>
<td>Bird</td>
<td>+</td>
<td>129</td>
<td>37</td>
</tr>
<tr>
<td>Black-naped Tern</td>
<td><em>Sterna sumatranas</em></td>
<td>Bird</td>
<td>+</td>
<td>1</td>
<td>0.2</td>
</tr>
<tr>
<td>Common Tern</td>
<td><em>Sterna hirundo</em></td>
<td>Bird</td>
<td>+</td>
<td>31</td>
<td>23</td>
</tr>
<tr>
<td>Little Tern</td>
<td><em>Sterna albifrons</em></td>
<td>Bird</td>
<td>+</td>
<td>89</td>
<td>14</td>
</tr>
<tr>
<td>Bridled Tern</td>
<td><em>Sterna anaethetus</em></td>
<td>Bird</td>
<td>+</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>White-winged Black Tern</td>
<td><em>Chlidonias leucopterus</em></td>
<td>Bird</td>
<td>+</td>
<td>316</td>
<td>48</td>
</tr>
<tr>
<td>Common Noddy</td>
<td><em>Anous stolidus</em></td>
<td>Bird</td>
<td>+</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>Flock Bronzewing</td>
<td><em>Phaps histrionica</em></td>
<td>Bird</td>
<td>NT</td>
<td>24</td>
<td>9</td>
</tr>
<tr>
<td>Partridge Pigeon</td>
<td><em>Geophaps smithii</em></td>
<td>Bird</td>
<td>VU (VU)</td>
<td>1077</td>
<td>20</td>
</tr>
<tr>
<td>Oriental Cuckoo</td>
<td><em>Cuculus saturatus</em></td>
<td>Bird</td>
<td>+</td>
<td>53</td>
<td>38</td>
</tr>
<tr>
<td>Grass Owl</td>
<td><em>Tyto capensis</em></td>
<td>Bird</td>
<td>NT</td>
<td>3</td>
<td>21</td>
</tr>
<tr>
<td>White-throated Needletail</td>
<td><em>Hirundapus caudacutus</em></td>
<td>Bird</td>
<td>+</td>
<td>1</td>
<td>9</td>
</tr>
<tr>
<td>Fork-tailed Swift</td>
<td><em>Apus pacificus</em></td>
<td>Bird</td>
<td>+</td>
<td>77</td>
<td>29</td>
</tr>
<tr>
<td>Rainbow Bee-eater</td>
<td><em>Merops oratus</em></td>
<td>Bird</td>
<td>+</td>
<td>1635</td>
<td>17</td>
</tr>
<tr>
<td>White-browed Bee-eater</td>
<td><em>Poeicidryas superciliosa</em></td>
<td>Bird</td>
<td>NT</td>
<td>24</td>
<td>7</td>
</tr>
<tr>
<td>Leaden Flycatcher</td>
<td><em>Myiagra rubecula</em></td>
<td>Bird</td>
<td>+</td>
<td>417</td>
<td>17</td>
</tr>
<tr>
<td>Restless Flycatcher</td>
<td><em>Myiagra inquieta</em></td>
<td>Bird</td>
<td>+</td>
<td>220</td>
<td>12</td>
</tr>
<tr>
<td>Arafura Fantail</td>
<td><em>Rhipidura dryas</em></td>
<td>Bird</td>
<td>+</td>
<td>84</td>
<td>21</td>
</tr>
<tr>
<td>Yellow Wagtail</td>
<td><em>Motacilla flava</em></td>
<td>Bird</td>
<td>+</td>
<td>191</td>
<td>94</td>
</tr>
<tr>
<td>Grey Wagtail</td>
<td><em>Motacilla cinerea</em></td>
<td>Bird</td>
<td>+</td>
<td>11</td>
<td>65</td>
</tr>
<tr>
<td>Common name</td>
<td>Scientific name</td>
<td>Group</td>
<td>TPWCA (EPBCA) status</td>
<td>CJB*</td>
<td>Records in Darwin</td>
</tr>
<tr>
<td>--------------------------</td>
<td>-------------------------</td>
<td>-----------</td>
<td>----------------------</td>
<td>------</td>
<td>-------------------</td>
</tr>
<tr>
<td>White Wagtail</td>
<td>Motacilla alba</td>
<td>Bird</td>
<td></td>
<td></td>
<td>22</td>
</tr>
<tr>
<td>Star Finch</td>
<td>Neochmia ruficauda</td>
<td>Bird</td>
<td>NT</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Yellow-rumped Mannikin</td>
<td>Lonchura flavipryrna</td>
<td>Bird</td>
<td>NT</td>
<td>26</td>
<td>29</td>
</tr>
<tr>
<td>Gouldian Finch</td>
<td>Erythura gouldiae</td>
<td>Bird</td>
<td>EN (EN)</td>
<td>27</td>
<td>1</td>
</tr>
<tr>
<td>Barn Swallow</td>
<td>Hirundo rustica</td>
<td>Bird</td>
<td>+</td>
<td>31</td>
<td>84</td>
</tr>
<tr>
<td>Clamorous Reed-Warbler</td>
<td>Acrocephalus australis</td>
<td>Bird</td>
<td>NT</td>
<td>88</td>
<td>9</td>
</tr>
<tr>
<td>Oriental Reed-Warbler</td>
<td>Acrocephalus orientalis</td>
<td>Bird</td>
<td>+</td>
<td>3</td>
<td>43</td>
</tr>
<tr>
<td>Northern Quoll</td>
<td>Dasyurus hallucatus</td>
<td>Mammal</td>
<td>CR (EN)</td>
<td>424</td>
<td>19</td>
</tr>
<tr>
<td>Northern Brush-tailed Phascogale</td>
<td>Phascogale pirata</td>
<td>Mammal</td>
<td>VU</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Bare-rumped Sheath-tail Bat</td>
<td>Saccoleimus saccolaimus</td>
<td>Mammal</td>
<td>(CR)</td>
<td>1</td>
<td>17</td>
</tr>
<tr>
<td>Arnhem Sheath-tail-Bat</td>
<td>Taphozous kapalensis</td>
<td>Mammal</td>
<td>NT</td>
<td>4</td>
<td>24</td>
</tr>
<tr>
<td>Ghost Bat</td>
<td>Macroderma gigas</td>
<td>Mammal</td>
<td>NT</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>Orange Leaf-nosed bat</td>
<td>Rhinonicteris aurantia</td>
<td>Mammal</td>
<td>NT</td>
<td>12</td>
<td>7</td>
</tr>
<tr>
<td>Black-footed Tree-rat</td>
<td>Mesembrionys gouldii</td>
<td>Mammal</td>
<td>NT</td>
<td>87</td>
<td>25</td>
</tr>
<tr>
<td>Kakadu Pebble-mound Mouse</td>
<td>Pseudomys calabyi</td>
<td>Mammal</td>
<td>NT</td>
<td>13</td>
<td>15</td>
</tr>
<tr>
<td>Western Chestnut Mouse</td>
<td>Pseudomys nanus</td>
<td>Mammal</td>
<td>NT</td>
<td>25</td>
<td>4</td>
</tr>
<tr>
<td>Pale Field-rat</td>
<td>Rattus tunneyi</td>
<td>Mammal</td>
<td>NT</td>
<td>50</td>
<td>5</td>
</tr>
<tr>
<td>Long-beaked Bottlenose Dolphin</td>
<td>Tursiops aduncus</td>
<td>Mammal</td>
<td></td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Blue Whale</td>
<td>Balaenoptera musculus</td>
<td>Mammal</td>
<td>(EN)</td>
<td>1</td>
<td>50</td>
</tr>
<tr>
<td>Dugong</td>
<td>Dugong dugon</td>
<td>Mammal</td>
<td>NT</td>
<td>8</td>
<td>2</td>
</tr>
<tr>
<td>Howard Springs Toadlet</td>
<td>Uperoleia daviesae</td>
<td>Frog</td>
<td>VU</td>
<td>19</td>
<td>95</td>
</tr>
<tr>
<td>Northern Death Adder</td>
<td>Acanthophis praelongus</td>
<td>Reptile</td>
<td>NT</td>
<td>34</td>
<td>30</td>
</tr>
<tr>
<td>Green Turtle</td>
<td>Chelonia mydas</td>
<td>Reptile</td>
<td>(VU)</td>
<td>+</td>
<td>12</td>
</tr>
<tr>
<td>Chameleon Dragon</td>
<td>Chelosania brunnea</td>
<td>Reptile</td>
<td>NT</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Saltwater Crocodile</td>
<td>Crocodylus porosus</td>
<td>Reptile</td>
<td></td>
<td>+</td>
<td>1624</td>
</tr>
<tr>
<td>Hawksbill Turtle</td>
<td>Eretmochelys imbricata</td>
<td>Reptile</td>
<td>(VU)</td>
<td>+</td>
<td>6</td>
</tr>
<tr>
<td>Olive Ridley</td>
<td>Lepidochelys olivacea</td>
<td>Reptile</td>
<td>(EN)</td>
<td>+</td>
<td>3</td>
</tr>
<tr>
<td>Flatback Turtle</td>
<td>Nator depressus</td>
<td>Reptile</td>
<td>(VU)</td>
<td>+</td>
<td>27</td>
</tr>
<tr>
<td>Mangrove Monitor</td>
<td>Varanus indicus</td>
<td>Reptile</td>
<td>NT</td>
<td>2</td>
<td>11</td>
</tr>
<tr>
<td>Merten's Water Monitor</td>
<td>Varanus mertensi</td>
<td>Reptile</td>
<td>VU</td>
<td>68</td>
<td>12</td>
</tr>
<tr>
<td>Floodplain Monitor</td>
<td>Varanus panoptes</td>
<td>Reptile</td>
<td>VU</td>
<td>135</td>
<td>25</td>
</tr>
<tr>
<td>Northern Ridge-tailed Monitor</td>
<td>Varanus primordius</td>
<td>Reptile</td>
<td>NT</td>
<td>13</td>
<td>39</td>
</tr>
</tbody>
</table>

Figure 5.6. Distribution of vegetation classed as “sensitive” and associated buffers under current NT Land clearing guidelines (NRETA 2006).
Figure 5.7. Distribution of records of flora and fauna species listed under Northern Territory (Territory Parks and Wildlife Conservation Act 2001) and Commonwealth legislation (Environment Protection and Biodiversity Conservation Act 1999) in the Darwin region.
Historical land clearing in the Darwin region

Based on spatial mapping, 1018 km² of land has been cleared in the Darwin region (Figure 5.8). This equates to 13% of the project area. Table 5.5 shows a breakdown of the proportion of each vegetation type that has been cleared since 2001. Data were not available to determine how much of each vegetation type had been cleared prior to 2001. Eucalypt open forests and woodlands have been cleared the most, principally because they grow on deep soils suited for agriculture and residential developments. Table 5.6 shows the amount of sensitive vegetation that has been cleared in the Darwin region.

Table 5.5. Amount of each vegetation type cleared within the Darwin region since the extent of each vegetation types was mapped in 2001. *Data are not available as to the breakdown of vegetation types cleared prior to 2001.

<table>
<thead>
<tr>
<th>Vegetation type</th>
<th>Area in region (ha)</th>
<th>Land cleared (ha)</th>
<th>% land cleared</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drainage open woodland</td>
<td>511</td>
<td>43</td>
<td>8</td>
</tr>
<tr>
<td>Dry Rainforest</td>
<td>34</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Eucalypt open forest</td>
<td>801</td>
<td>45</td>
<td>6</td>
</tr>
<tr>
<td>Eucalypt open woodland</td>
<td>1507</td>
<td>222</td>
<td>15</td>
</tr>
<tr>
<td>Eucalypt woodland</td>
<td>2262</td>
<td>101</td>
<td>4</td>
</tr>
<tr>
<td>Floodplain</td>
<td>327</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>Grassy swamp</td>
<td>60</td>
<td>8</td>
<td>13</td>
</tr>
<tr>
<td>Heath</td>
<td>56</td>
<td>12</td>
<td>21</td>
</tr>
<tr>
<td>Mangrove forest</td>
<td>677</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Melaleuca swamp</td>
<td>78</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Riparian open forest</td>
<td>414</td>
<td>14</td>
<td>3</td>
</tr>
<tr>
<td>Samphire</td>
<td>137</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Spring rainforest</td>
<td>13</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Cleared pre-2001, unspecified*</td>
<td>557</td>
<td>557</td>
<td>100</td>
</tr>
<tr>
<td>TOTAL</td>
<td>7578</td>
<td>1018</td>
<td>13</td>
</tr>
</tbody>
</table>

Table 5.6. Amount of land clearing of sensitive vegetation (as defined under the NT Land Clearing Guidelines NRETA 2006) in the Darwin region.

<table>
<thead>
<tr>
<th>Sensitive vegetation</th>
<th>Area in region (ha)</th>
<th>Cleared (ha)</th>
<th>Cleared (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rainforest:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spring</td>
<td>1896</td>
<td>88</td>
<td>5</td>
</tr>
<tr>
<td>Dry</td>
<td>8505</td>
<td>293</td>
<td>3</td>
</tr>
<tr>
<td>Riparian</td>
<td>1483</td>
<td>56</td>
<td>4</td>
</tr>
<tr>
<td>500 m rainforest buffer</td>
<td>155173</td>
<td>12599</td>
<td>8</td>
</tr>
<tr>
<td>Wetlands</td>
<td>150001</td>
<td>8524</td>
<td>6</td>
</tr>
<tr>
<td>200m wetland buffer</td>
<td>240878</td>
<td>20609</td>
<td>9</td>
</tr>
</tbody>
</table>
Figure 5.8. Historical land clearing in the Darwin region.
Vegetation retention scenarios in the Darwin region

All vegetation retention scenarios presented below are illustrative only. They do not represent any form of legally binding regulation of land clearing. Instead, they reflect planning principles for the retention of native vegetation. The scenarios were produced in two stages. For the Darwin region, vegetation retention thresholds were based on vegetation type mapped at a scale of 1:100,000 (Hempel 2003).

Stage 1 - Baseline retention
The first stage consisted of identifying vegetation that should already be excluded from clearing under the current Northern Territory Government Land Clearing Guidelines (NRETA 2006). Specifically, this included retaining all vegetation that was associated with:

- Drainage lines, watercourses, wetlands or seepage zones and recommended buffers
- Sensitive vegetation (rainforests, vine thicket or closed forest)
- Waterlogging and seasonal inundation
- Slopes greater than 0.5%

Areas which had already been cleared were also identified in this stage, as these are no longer available for vegetation retention.

Stage 2 - Scenarios
The second stage consisted of introducing a number of different planning thresholds to the baseline vegetation map established in Stage 1. Vegetation type and sub-catchment thresholds were set to illustrate the potential vegetation retention scenarios in the region.

Three scenarios are described below:

Scenario 1 - Baseline retention + 50% of each vegetation type
Scenario 2 - Baseline retention + 70% of each vegetation type + 50% of each property greater than 150 ha in size
Scenario 3 - Baseline retention + 90% of vegetation + 70% of each sub-catchment
**Baseline vegetation retention in the Darwin region**

A map of the baseline vegetation that is retained under current NT land clearing guidelines (NRETA 2006) is presented in Figure 5.9. The guidelines retain a total of 54% (4121 km²) of the native vegetation in the Darwin region (Table 5.7). Sensitive habitats and seasonally inundated areas contributed the most to the total, due to the Adelaide River floodplain and associated wetlands in the region.

Table 5.7. Summary of amount of vegetation retained in the Darwin region under current NT land clearing guidelines (NRETA 2006).

<table>
<thead>
<tr>
<th>Baseline categories</th>
<th>Area km²</th>
<th>Proportion of region retained (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slope &gt; 5%</td>
<td>405</td>
<td>5</td>
</tr>
<tr>
<td>Sensitive Habitat</td>
<td>2,526</td>
<td>33</td>
</tr>
<tr>
<td>Planning Zone</td>
<td>379</td>
<td>5</td>
</tr>
<tr>
<td>Parks</td>
<td>811</td>
<td>11</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>4,121</strong></td>
<td><strong>54</strong></td>
</tr>
</tbody>
</table>
Figure 5.9. Baseline retained vegetation in the Darwin region. Coloured areas may not be cleared under existing NT land clearing guidelines (NRETA 2006), or have already been cleared.
Scenario 1: 50% retention of each vegetation type

Under the current land clearing guidelines, 3 of the 13 vegetation types in the Darwin region can be cleared by more than 50%: eucalypt open woodland (37%), drainage open woodland (46%) and eucalypt woodland (46%). Figure 5.10 shows a scenario in which additional areas are identified to bring these vegetation types to at least 50% retention.

Figure 5.10. Scenario 1: The inclusion of the areas coloured blue in addition to the baseline retained vegetation (Figure 5.9) ensures that at least 50% of each vegetation type is retained. Coloured areas may not be cleared or have already been cleared.
Scenario 2: 70% retention vegetation types + 50% properties > 150 ha

There are three vegetation types which can be cleared by more than 30% retention under scenario 1: Eucalypt open woodland, Eucalypt woodland and Drainage open woodland. There are also 449 properties greater than 150 ha in size which could be cleared by more than 50%. Figure 5.11 shows a scenario in which additional areas are identified to bring all vegetation types to 70% retention, spread such that that each property greater than 150 ha in size retains at least 50% of its vegetation cover.

Figure 5.11. Scenario 2: The inclusion of the areas coloured blue in addition to the baseline retained vegetation (Figure 5.9) ensures that at least 70% of each vegetation type is retained and that at least 50% vegetation cover is retained on all properties greater than 150 ha in size. Coloured areas may not be cleared or have already been cleared.
**Scenario 3: 90% retention vegetation types + 70% sub-catchments**

There are four vegetation types that can be cleared by more than 10% under scenario 2: Eucalyptus open woodland, Drainage open woodland, Eucalypt woodland and Eucalypt open forest. There are also 15 sub-catchments which can be cleared by more than 50% and 28 in which between 30% and 50% of their vegetation could be cleared. Figure 5.12 shows a scenario in which additional areas are identified to bring all vegetation types to at least 90% retention, spread such that at least 70% of vegetation cover is retained in each sub-catchment.

Figure 5.12. Scenario 3: The inclusion of the areas coloured blue in addition to the baseline retained vegetation (Figure 5.9) ensures that at least 90% of each vegetation type is retained and that at least 70% vegetation cover is retained in each sub-catchment. Coloured areas may not be cleared or have already been cleared.
### Summary of vegetation retention scenarios

Table 5.8. Proportion of each vegetation community in the Darwin region that is still clearable under the existing land clearing guidelines and under each of the scenarios in this plan

<table>
<thead>
<tr>
<th>Veg. type</th>
<th>Area (km²)</th>
<th>% currently cleared</th>
<th>% currently uncleared</th>
<th>% retained existing guidelines</th>
<th>% clearable existing guidelines</th>
<th>50% clearable scenario 1</th>
<th>70% clearable scenario 2</th>
<th>90% clearable scenario 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drainage open woodland</td>
<td>511</td>
<td>8</td>
<td>92</td>
<td>46</td>
<td>46</td>
<td>37</td>
<td>20</td>
<td>4</td>
</tr>
<tr>
<td>Dry Rainforest</td>
<td>34</td>
<td>2</td>
<td>98</td>
<td>98</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Eucalypt open forest</td>
<td>801</td>
<td>6</td>
<td>94</td>
<td>60</td>
<td>34</td>
<td>33</td>
<td>18</td>
<td>5</td>
</tr>
<tr>
<td>Eucalypt open woodland</td>
<td>1507</td>
<td>15</td>
<td>85</td>
<td>37</td>
<td>49</td>
<td>35</td>
<td>15</td>
<td>0</td>
</tr>
<tr>
<td>Eucalypt woodland</td>
<td>2262</td>
<td>4</td>
<td>96</td>
<td>46</td>
<td>50</td>
<td>41</td>
<td>25</td>
<td>5</td>
</tr>
<tr>
<td>Floodplain</td>
<td>327</td>
<td>1</td>
<td>99</td>
<td>99</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Grassy swamp</td>
<td>60</td>
<td>13</td>
<td>87</td>
<td>87</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Heath</td>
<td>56</td>
<td>21</td>
<td>79</td>
<td>79</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Mangrove forest</td>
<td>677</td>
<td>0</td>
<td>100</td>
<td>77</td>
<td>23</td>
<td>15</td>
<td>15</td>
<td>10</td>
</tr>
<tr>
<td>Melaleuca swamp</td>
<td>78</td>
<td>4</td>
<td>96</td>
<td>96</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<tr>
<td>Riparian open forest</td>
<td>414</td>
<td>3</td>
<td>97</td>
<td>84</td>
<td>12</td>
<td>8</td>
<td>8</td>
<td>3</td>
</tr>
<tr>
<td>Samphire</td>
<td>137</td>
<td>2</td>
<td>98</td>
<td>94</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Spring rainforest</td>
<td>13</td>
<td>3</td>
<td>97</td>
<td>97</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
Chapter 6. Katherine/ Mataranka Region vegetation retention plan

Description of the Katherine/ Mataranka region

The Katherine/ Mataranka region covers 8,800 km², encompassing both the Municipality of Katherine and the Mataranka Community Council region. The region is bounded to the north by the southern edge of Beswick and Jawoyn Aboriginal land and to the north-west by the Daly River land clearance moratorium boundary up to the Fergusson River. To the south-west, the region includes Manbulloo Station to its southern and western boundaries. Three local government areas occur in the region: the Municipality of Katherine, and the Community Government Council areas of Mataranka and part of the Nyirranggulung Marduulk Ngadberre (Figure 6.1). The majority of the region’s population occurs in and around Katherine, with the 2006 census recording 8194 residents. Mataranka is the next largest population centre, with 251 residents (ABS, 2007 #41).

Tenure and land use

Pastoral lease is the most extensive land tenure in the Katherine/ Mataranka region, covering 45% of the region (Figure 6.2a). The next most extensive land tenures are perpetual crown lease (32%) and freehold (21%), with the remaining 2% of the region made up of a variety of tenures including crown lease term, vacant crown land and special purpose lease. Protected
areas in the region include Elsey National Park, Cutta Cutta Caves Nature Park and Kintore Caves Conservation Reserve, together covering 155 km² (1.8%) of the region. Nitmiluk (Katherine Gorge) National Park directly abuts the region. Recent land clearing in the area has been concentrated in the vicinity of Mataranka and along the Stuart Highway between Katherine and Mataranka, mainly for the purpose of horticulture and pasture improvement.

Pastoralism is the dominant land use in the Katherine/Mataranka area, with the Australian Bureau of Statistics reporting 117,000 head of cattle in the area (ABS 2006). Katherine is also the transport hub for cattle from across the lower Top End, which includes the Gulf and Victoria River districts and supports approximately 40% of the NT’s livestock. There is a rapidly growing mango industry in the region, and, recently, an expansion into the peanut industry. Tourism is also a major industry in the region, with activity primarily focused on Nitmiluk National Park.
Figure 6.2. Distribution of (a) land tenure and (b) land use in the Katherine/ Mataranka region
Land units, drainage and elevation

The region comprises gently undulating plains with scattered low plateaus and low but steep hills. The region falls into the catchments of two river systems: the Katherine River and the Roper River, separated by an area of slightly elevated, dissected country between the towns of Katherine and Mataranka (Figure 6.3). A belt of limestone runs under Katherine town, extending to the north-west and south-east of the town (Figure 6.4). While fertile, limestone areas are prone to sinkhole formation, and are sensitive to changes in hydrology including those caused by vegetation clearance. Plains alongside the Katherine and Roper Rivers and their tributaries are prone to seasonal flooding.

Fourteen of the NT’s 112 recognised vegetation types mapped at 1:1,000,000 scale occur in the Katherine/ Mataranka region (Wilson et al. 1990; Figure 6.5). Land resource assessments, mapped at a scale of 1:250,000, have identified 49 land systems in the region (ASRIS 2006; Table 6.1; Figure 6.6). Land systems are areas which are characterised by recurring patterns of landforms, soils and vegetation. Nine of these land systems have been assessed as having high horticultural potential based on soil and landform. Areas that are prone to erosion, have rocky outcropping or are subject to seasonal inundation are not suitable for horticultural development. Being at such a coarse scale, this assessment is only indicative. A map of land systems prone to erosion is provided in Figure 6.8, while Figure 6.9 gives an indicative map of the agricultural potential of land systems in the region.

Table 6.1. Description of land systems within the Katherine/ Mataranka region. * Land systems have been classed into three categories relating to their potential for horticulture.

<table>
<thead>
<tr>
<th>Land system</th>
<th>Land form</th>
<th>Vegetation</th>
<th>Clearing limitations</th>
<th>Potential for horticulture*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ald</td>
<td>Gently undulating plains and rises</td>
<td>Mid-high woodland</td>
<td></td>
<td>Moderate</td>
</tr>
<tr>
<td>Alf</td>
<td>Undulating slopes and low hills</td>
<td>Tall open woodland</td>
<td>Erodible</td>
<td>Moderate</td>
</tr>
<tr>
<td>Alp</td>
<td>Low hills, rises and undulating areas</td>
<td>Mid-high open woodland</td>
<td>Erodible</td>
<td>Moderate</td>
</tr>
<tr>
<td>Als</td>
<td>Gently undulating to undulating rises</td>
<td>Mid-high open woodland</td>
<td>Extensive outcrop</td>
<td>Moderate</td>
</tr>
<tr>
<td>Asb</td>
<td>Steep rocky plateaux and steep linear ridges</td>
<td>Mid-high open woodland</td>
<td>Extensive outcrop</td>
<td>Low</td>
</tr>
<tr>
<td>Asw</td>
<td>Dissected plateaux and low hills</td>
<td>Mid-high open woodland</td>
<td>Erodible, outcrop</td>
<td>Low</td>
</tr>
<tr>
<td>B</td>
<td>Steep rocky ridges</td>
<td>Woodland</td>
<td>Erodible, outcrop</td>
<td>Low</td>
</tr>
<tr>
<td>Ba</td>
<td>Undulating plains and rises</td>
<td>Mixed open forest</td>
<td>Erodible, outcrop</td>
<td>Low</td>
</tr>
<tr>
<td>Bd</td>
<td>Steep rocky plateaux and steep linear ridges</td>
<td>Mid-high open woodland</td>
<td>Extensive outcrop</td>
<td>Low</td>
</tr>
<tr>
<td>Bdj</td>
<td>Undulating limestone terrain with rocky hills and outcrops</td>
<td>Savanna woodland</td>
<td>Extensive outcrop</td>
<td>Moderate</td>
</tr>
<tr>
<td>Be</td>
<td>Undulating low ridges and rises</td>
<td>Woodland</td>
<td>Erodible, outcrop</td>
<td>Moderate</td>
</tr>
<tr>
<td>Bj</td>
<td>Gently undulating to almost level plains</td>
<td>Woodland</td>
<td></td>
<td>High</td>
</tr>
<tr>
<td>Bl</td>
<td>Gently sloping sandy plains</td>
<td>Tall open woodland</td>
<td></td>
<td>High</td>
</tr>
<tr>
<td>Bn</td>
<td>Alluvial floodplains</td>
<td>Open savanna woodland, grassland</td>
<td>Seasonal flooding</td>
<td>Low</td>
</tr>
<tr>
<td>Ch</td>
<td>Undulating crests, rises and mid-slopes</td>
<td>Savanna woodland</td>
<td>Erodible</td>
<td>Moderate</td>
</tr>
<tr>
<td>Cl</td>
<td>Gently undulating sandy terrain</td>
<td>Tall open woodland</td>
<td>Gravelly soils</td>
<td>High</td>
</tr>
<tr>
<td>Cu</td>
<td>Undulating plains and rises</td>
<td>Woodland</td>
<td>Erodible</td>
<td>Moderate</td>
</tr>
<tr>
<td>Ibc</td>
<td>Gently undulating to hilly terrain</td>
<td>Mid-high open woodland</td>
<td>Erodible</td>
<td>Moderate</td>
</tr>
<tr>
<td>Land system</td>
<td>Land form</td>
<td>Vegetation</td>
<td>Clearing limitations</td>
<td>Potential for horticulture*</td>
</tr>
<tr>
<td>-------------</td>
<td>---------------------------------------------------------------------------</td>
<td>-----------------------------</td>
<td>----------------------------</td>
<td>----------------------------</td>
</tr>
<tr>
<td>Ja</td>
<td>Undulating terrain and seepage areas</td>
<td>Woodland</td>
<td>Poor drainage</td>
<td>High</td>
</tr>
<tr>
<td>Km</td>
<td>Stony and soil-covered plains</td>
<td>Savanna woodland</td>
<td></td>
<td>High</td>
</tr>
<tr>
<td>Kr</td>
<td>Tributary alluvial plains</td>
<td>Tall open woodland</td>
<td>Seasonal flooding</td>
<td>Low</td>
</tr>
<tr>
<td>La</td>
<td>Relict flood plains</td>
<td>Mid-high open woodland</td>
<td>Seasonal flooding</td>
<td>Low</td>
</tr>
<tr>
<td>Lcm</td>
<td>Plains and swamps on calcareous deposits</td>
<td>Mid-high open woodland</td>
<td>Seasonal flooding</td>
<td>Low</td>
</tr>
<tr>
<td>Lcw</td>
<td>Plains and swamps on calcareous deposits</td>
<td>Mid-high woodland</td>
<td>Seasonal flooding</td>
<td>Moderate</td>
</tr>
<tr>
<td>Lwm</td>
<td>Gently undulating plains</td>
<td>Mid-high open woodland</td>
<td></td>
<td>High</td>
</tr>
<tr>
<td>Md</td>
<td>Rocky hill slopes and sheer cliffs</td>
<td>Low woodland</td>
<td>Extensive outcrop, erodible</td>
<td>Low</td>
</tr>
<tr>
<td>Mg</td>
<td>Undulating low gravelly crests and slopes</td>
<td>Woodland</td>
<td>Gravelly soils</td>
<td>Moderate</td>
</tr>
<tr>
<td>Mn</td>
<td>Almost level plateau surface and steep margins</td>
<td>Woodland</td>
<td>Extensive outcrop</td>
<td>Low</td>
</tr>
<tr>
<td>Mr</td>
<td>Undulating low hills and stony slopes</td>
<td>Woodland</td>
<td>Gravelly soils</td>
<td>Low</td>
</tr>
<tr>
<td>Ms</td>
<td>Low broken plateaux and steep slopes</td>
<td>Woodland</td>
<td>Erodible, outcrop</td>
<td>Moderate</td>
</tr>
<tr>
<td>My</td>
<td>Gently undulating plains</td>
<td>Mid-high open woodland</td>
<td></td>
<td>Moderate</td>
</tr>
<tr>
<td>R</td>
<td>Levee systems and areas subject to flooding</td>
<td>Woodland</td>
<td>Seasonal flooding</td>
<td>Low</td>
</tr>
<tr>
<td>Rlf</td>
<td>Gently undulating plain</td>
<td>Mid-high open woodland</td>
<td></td>
<td>Moderate</td>
</tr>
<tr>
<td>S*</td>
<td>Aquifers adjacent to springs and swamps</td>
<td>Ranges from rainforest to open marshy grassland</td>
<td>Seasonal flooding</td>
<td>Low</td>
</tr>
<tr>
<td>Tac</td>
<td>Level to gently undulating plains</td>
<td>Mid-high open woodland</td>
<td>Seasonal flooding</td>
<td>Low</td>
</tr>
<tr>
<td>Tae</td>
<td>Broad levees and channels</td>
<td>Tall open woodland</td>
<td>Seasonal flooding</td>
<td>Low</td>
</tr>
<tr>
<td>Taf</td>
<td>Sandy floodplains and lower slopes</td>
<td>Mid-high open woodland</td>
<td>Seasonal flooding</td>
<td>Low</td>
</tr>
<tr>
<td>Tam</td>
<td>Drainage corridors</td>
<td>Mid-high open woodland</td>
<td>Seasonal flooding</td>
<td>Low</td>
</tr>
<tr>
<td>Tn</td>
<td>Undulating crests, upper slopes and rocky surfaces</td>
<td>Savanna woodland</td>
<td>Outcrops, erodible</td>
<td>High</td>
</tr>
<tr>
<td>Tpw</td>
<td>Seasonal and perennial swamps</td>
<td>Mid-high open woodland</td>
<td>Seasonal flooding</td>
<td>Low</td>
</tr>
<tr>
<td>V*</td>
<td>Low hills</td>
<td>Open woodland</td>
<td>Erodible</td>
<td>Moderate</td>
</tr>
<tr>
<td>Vu</td>
<td>Undulating hills with isolated mesas</td>
<td>Mod. tall woodland</td>
<td>Erodible, outcrop</td>
<td>Low</td>
</tr>
<tr>
<td>Wa</td>
<td>Tributary river plains, channels and depressions</td>
<td>Savanna woodland</td>
<td>Seasonal flooding</td>
<td>Low</td>
</tr>
<tr>
<td>Wg</td>
<td>Undulating with gently sloping crests</td>
<td>Mid-high open woodland</td>
<td></td>
<td>Moderate</td>
</tr>
<tr>
<td>Wg*</td>
<td>Gently undulating plateaux</td>
<td>Open forest</td>
<td>Gravelly soils</td>
<td>High</td>
</tr>
<tr>
<td>Wi</td>
<td>Undulating steeper slopes and crests</td>
<td>Savanna woodland</td>
<td>Outcrop</td>
<td>Moderate</td>
</tr>
<tr>
<td>Wy</td>
<td>Plains</td>
<td>Open savanna woodland</td>
<td></td>
<td>High</td>
</tr>
<tr>
<td>Yn</td>
<td>Plateaux and dissected undulating terrain</td>
<td>Tall open woodland</td>
<td>Erodible</td>
<td>Low</td>
</tr>
<tr>
<td>Yu</td>
<td>Low plateaux and gently undulating terrain</td>
<td>Tall open woodland</td>
<td></td>
<td>Moderate</td>
</tr>
</tbody>
</table>
Figure 6.3. Elevation and rivers in the Katherine/ Mataranka region.
Figure 6.4. Distribution of limestone in the Katherine/ Mataranka region. Also shown are locations of the limestone-associated restricted grass species *Vacoparis macrospermum*
Figure 6.5. Distribution of broad vegetation units 1:1 000 000 in the Katherine/ Mataranka region (Wilson et al 1990).
Figure 6.6. Distribution of land systems 1:250 000 in the Katherine/ Mataranka region.
Figure 6.7. Risk of erosion in land systems of the Katherine/ Mataranka region.
Figure 6.8. Agricultural potential of land systems in the Katherine/ Mataranka region.
Priority vegetation and threatened species in the Katherine/ Mataranka region

The Katherine/ Mataranka region contains substantial amounts of vegetation classified as “sensitive” under the NT Land Clearing Guidelines (NRETA 2006). In total, sensitive vegetation types and buffers to protect them account for approximately 22% of the region (Table 6.5). Rainforest vegetation covers 2153 ha of the region, with riparian rainforest predominantly along the Katherine River and pockets of dry rainforest in the vicinity of Katherine town. Wetlands in the region cover 20234 ha, with the largest of these occupying virtually all of Elsey National Park near Mataranka. Applying buffer zones of widths as recommended in the NT Land Clearing Guidelines, buffer zones to protect riparian vegetation along the Katherine, King, Roper and Dry Rivers and their tributaries cover 79076 ha.

Fifty-one species that are listed as of conservation significance under NT or Commonwealth legislation are known to occur in the Katherine/ Mataranka region. Of particular significance is the near threatened grass species *Vacoparis macrospermum*, with a very restricted range (less than 10,000 km² area) and 96% of known records occurring in the region (Table 6.2). Of the 50 animal species of conservation significance in the region, 10 are recognised as threatened while a further 20 are recognised as near threatened (Table 6.3). These include the critically endangered northern quoll, the endangered Gouldian finch, and the vulnerable northern shrike-tit, red goshawk and Merten’s water monitor. Twenty species in the region are recognised as migratory species protected by International treaties. A map showing records of conservation significant species is provided in Figure 6.10.

Table 6.2. Flora species of conservation significance listed under Northern Territory legislation (*Territory Parks and Wildlife Conservation Act 2001*). No flora species in the region are listed under Commonwealth legislation (*Environment Protection and Biodiversity Conservation Act 1999*).

<table>
<thead>
<tr>
<th>Name</th>
<th>Endemic</th>
<th>TPWCA status</th>
<th>Records in Kath/ Mata</th>
<th>% in Kath/ Mata</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Vacoparis macrospermum</em></td>
<td>1</td>
<td>NT</td>
<td>21</td>
<td>95.5</td>
</tr>
<tr>
<td>NT – Near Threatened.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>


<table>
<thead>
<tr>
<th>Common name</th>
<th>Scientific name</th>
<th>Group</th>
<th>TPWCA (EPBCA) status</th>
<th>CJB*</th>
<th>Records in Kath/ Mata</th>
<th>% in Kath/ Mata</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arafura Fantail</td>
<td><em>Rhipidura dryas</em></td>
<td>Bird</td>
<td>+</td>
<td>2</td>
<td>0.5</td>
<td></td>
</tr>
<tr>
<td>Australian Bustard</td>
<td><em>Ardeotis australis</em></td>
<td>Bird</td>
<td>VU</td>
<td>75</td>
<td>1.6</td>
<td></td>
</tr>
<tr>
<td>Bush Stone-curlew</td>
<td><em>Burhinus grallarius</em></td>
<td>Bird</td>
<td>NT</td>
<td>15</td>
<td>0.9</td>
<td></td>
</tr>
<tr>
<td>Cattle Egret</td>
<td><em>Ardea ibis</em></td>
<td>Bird</td>
<td>+</td>
<td>16</td>
<td>1.4</td>
<td></td>
</tr>
<tr>
<td>Clamorous Reed-Warbler</td>
<td><em>Acrocephalus australis</em></td>
<td>Bird</td>
<td>NT</td>
<td>2</td>
<td>0.2</td>
<td></td>
</tr>
<tr>
<td>Common Greenshank</td>
<td><em>Tringa nebularia</em></td>
<td>Bird</td>
<td>+</td>
<td>6</td>
<td>0.5</td>
<td></td>
</tr>
<tr>
<td>Common Sandpiper</td>
<td><em>Actitis hypoleucos</em></td>
<td>Bird</td>
<td>+</td>
<td>13</td>
<td>0.7</td>
<td></td>
</tr>
<tr>
<td>Emu</td>
<td><em>Dromaius novaehollandiae</em></td>
<td>Bird</td>
<td>VU</td>
<td>15</td>
<td>0.9</td>
<td></td>
</tr>
<tr>
<td>Flock Bronzewing</td>
<td><em>Phaps histrionica</em></td>
<td>Bird</td>
<td>NT</td>
<td>2</td>
<td>0.8</td>
<td></td>
</tr>
<tr>
<td>Common name</td>
<td>Scientific name</td>
<td>Group</td>
<td>TPWCA (EPBCA) status</td>
<td>CJB*</td>
<td>Records in Kath/ Mata</td>
<td>% in Kath/ Mata</td>
</tr>
<tr>
<td>----------------------</td>
<td>-----------------------</td>
<td>-------</td>
<td>----------------------</td>
<td>------</td>
<td>-----------------------</td>
<td>----------------</td>
</tr>
<tr>
<td>Fork-tailed Swift</td>
<td>Apus pacificus</td>
<td>Bird</td>
<td>+</td>
<td>9</td>
<td>3.4</td>
<td></td>
</tr>
<tr>
<td>Glossy Ibis</td>
<td>Plegadis falcinellus</td>
<td>Bird</td>
<td>+</td>
<td>12</td>
<td>0.8</td>
<td></td>
</tr>
<tr>
<td>Gouldian Finch</td>
<td>Erythrura gouldiae</td>
<td>Bird</td>
<td>EN (EN)</td>
<td>74</td>
<td>2.1</td>
<td></td>
</tr>
<tr>
<td>Great Egret</td>
<td>Ardea alba</td>
<td>Bird</td>
<td>+</td>
<td>56</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Grey Falcon</td>
<td>Falco hypoleucos</td>
<td>Bird</td>
<td>NT</td>
<td>4</td>
<td>2.4</td>
<td></td>
</tr>
<tr>
<td>Hooded Parrot</td>
<td>Psephotus dissimilis</td>
<td>Bird</td>
<td>NT</td>
<td>28</td>
<td>10.6</td>
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<tr>
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<td>97</td>
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<tr>
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<td>Bird</td>
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<td>1</td>
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<tr>
<td>Marsh Sandpiper</td>
<td>Tringa stagnatilis</td>
<td>Bird</td>
<td>+</td>
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<td>Falcunculus whitei</td>
<td>Bird</td>
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<td>7</td>
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<tr>
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<td>Cuculus saturatus</td>
<td>Bird</td>
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<td>Charadrius veredus</td>
<td>Bird</td>
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<td>Glareola maldivarum</td>
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<td>Geophaps smithii</td>
<td>Bird</td>
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<td>Heteromunia pectoralis</td>
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<td>Erythropiorchis radiatus</td>
<td>Bird</td>
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<tr>
<td>Red-necked Stint</td>
<td>Calidris ruficollis</td>
<td>Bird</td>
<td>+</td>
<td>1</td>
<td>0.1</td>
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<tr>
<td>Restless Flycatcher</td>
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<td>Bird</td>
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<tr>
<td>Sharp-tailed Sandpiper</td>
<td>Calidris acuminata</td>
<td>Bird</td>
<td>+</td>
<td>4</td>
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</tr>
<tr>
<td>Square-tailed Kite</td>
<td>Lophoictinia isura</td>
<td>Bird</td>
<td>NT</td>
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<td>Bird</td>
<td>NT</td>
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<td></td>
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<tr>
<td>Swinhoe's Snipe</td>
<td>Gallinago megalae</td>
<td>Bird</td>
<td>+</td>
<td>1</td>
<td>0.8</td>
<td></td>
</tr>
<tr>
<td>White-bellied Sea-eagle</td>
<td>Haliaeetus leucogaster</td>
<td>Bird</td>
<td>+</td>
<td>31</td>
<td>1.6</td>
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<tr>
<td>White-browed Robin</td>
<td>Poecilodryas superciliosa</td>
<td>Bird</td>
<td>NT</td>
<td>16</td>
<td>4.5</td>
<td></td>
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<tr>
<td>Yellow-rumped Mannikin</td>
<td>Lonchura flaviprymsa</td>
<td>Bird</td>
<td>NT</td>
<td>4</td>
<td>4.4</td>
<td></td>
</tr>
<tr>
<td>Black-footed Tree-rat</td>
<td>Mesembriomys gouldii</td>
<td>Mammal</td>
<td>NT</td>
<td>1</td>
<td>0.3</td>
<td></td>
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<tr>
<td>Ghost Bat</td>
<td>Macroderma gigas</td>
<td>Mammal</td>
<td>NT</td>
<td>20</td>
<td>11.4</td>
<td></td>
</tr>
<tr>
<td>Long-haired Rat</td>
<td>Rattus villosissimus</td>
<td>Mammal</td>
<td>NT</td>
<td>1</td>
<td>0.5</td>
<td></td>
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<tr>
<td>Northern Brush-tailed Phascogale</td>
<td>Phascogale pirata</td>
<td>Mammal</td>
<td>VU</td>
<td>2</td>
<td>2</td>
<td></td>
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<tr>
<td>Northern Nailtail Wallaby</td>
<td>Onychogalea unguifera</td>
<td>Mammal</td>
<td>NT</td>
<td>5</td>
<td>0.7</td>
<td></td>
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<tr>
<td>Northern Quoll</td>
<td>Dasyurus hallucatus</td>
<td>Mammal</td>
<td>CR (EN)</td>
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<tr>
<td>Orange Leaf-nosed bat</td>
<td>Rhinocricetis aurantia</td>
<td>Mammal</td>
<td>NT</td>
<td>27</td>
<td>16.6</td>
<td></td>
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<tr>
<td>Pale Field-rat</td>
<td>Rattus tunneyi</td>
<td>Mammal</td>
<td>NT</td>
<td>2</td>
<td>0.2</td>
<td></td>
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<tr>
<td>Spectacled Hare-wallaby</td>
<td>Lagorchestes conspiciullatus</td>
<td>Mammal</td>
<td>NT</td>
<td>4</td>
<td>0.8</td>
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<td>Western Chestnut Mouse</td>
<td>Pseudomys nanus</td>
<td>Mammal</td>
<td>NT</td>
<td>13</td>
<td>1.9</td>
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<tr>
<td>Nthn Ridge-tailed Monitor</td>
<td>Varanus primordius</td>
<td>Reptile</td>
<td>NT</td>
<td>1</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Chameleon Dragon</td>
<td>Chelosania brunnea</td>
<td>Reptile</td>
<td>NT</td>
<td>3</td>
<td>8.6</td>
<td></td>
</tr>
<tr>
<td>Floodplain Monitor</td>
<td>Varanus panoptes</td>
<td>Reptile</td>
<td>VU</td>
<td>6</td>
<td>1.1</td>
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<tr>
<td>Merten's Water Monitor</td>
<td>Varanus mertensi</td>
<td>Reptile</td>
<td>VU</td>
<td>37</td>
<td>6.7</td>
<td></td>
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<tr>
<td>Saltwater Crocodile</td>
<td>Crocodylus porosus</td>
<td>Reptile</td>
<td>+</td>
<td>8</td>
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</table>

Figure 6.9. Distribution of sensitive vegetation in the Katherine/ Mataranka region.
Figure 6.10. Flora and fauna species listed under Northern Territory, Commonwealth and International treaties in the Katherine/ Mataranka region.
Historical land clearing in the Katherine/ Mataranka region

Based on the Northern Territory Government Native Vegetation Clearing GIS dataset, 567 km² of the Katherine/ Mataranka region has been cleared: approximately 6.4% of the 8800 km² considered in this report. Clearing prior to 1990 generally occurred in the vicinity of Katherine and along the Katherine River. More recently, there has been considerable clearing of land along the Stuart Highway between Katherine and Mataranka, and in the vicinity of Mataranka (Figure 6.11).

Table 6.4 shows the proportion of cleared land for each of the land systems in the region. The land systems that have been cleared the most extensively are Banyan (31%), Kimbyan (26%) and Beemla (24%). Banyan and Kimbyan are both of high agricultural potential, although much of the Banyan land system is prone to seasonal inundation rendering it largely unsuitable for horticulture. Beemla is regarded as of moderate horticultural potential.

A small amount of clearing has occurred in vegetation types declared as sensitive under the NT Land Clearing Guidelines (2006). A total of 9373 ha of sensitive vegetation communities and associated buffers have been cleared in the Katherine/ Mataranka region (Table 6.5). Proportionally, buffers around rainforest have been the hardest hit, with 17% (3101 ha) of their extent cleared. In terms of total area cleared, the most extensive clearing of sensitive vegetation has been in riparian buffers, at 3856 ha (5%).

Table 6.4. Current amount of each land system cleared within the Katherine/ Mataranka region.

<table>
<thead>
<tr>
<th>Land system</th>
<th>Land system name</th>
<th>Area in region (ha)</th>
<th>Area cleared (ha)</th>
<th>% cleared</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ald</td>
<td>Downs</td>
<td>3135</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Alf</td>
<td>Flying Fox</td>
<td>418</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Alp</td>
<td>Patterson</td>
<td>1807</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Als</td>
<td>Seigal</td>
<td>918</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Asb</td>
<td>Bukalara</td>
<td>2105</td>
<td>0</td>
<td>0</td>
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<tr>
<td>Asw</td>
<td>Weston</td>
<td>1463</td>
<td>19</td>
<td>1</td>
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<tr>
<td>B</td>
<td>Baker</td>
<td>155193</td>
<td>740</td>
<td>0</td>
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<tr>
<td>Ba</td>
<td>Beemla</td>
<td>25095</td>
<td>6001</td>
<td>24</td>
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<td>Bd</td>
<td>Buldiva</td>
<td>12329</td>
<td>1465</td>
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<td>Bdj</td>
<td>Budbudjong</td>
<td>5679</td>
<td>970</td>
<td>17</td>
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<tr>
<td>Be</td>
<td>Bend</td>
<td>5985</td>
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<tr>
<td>Bj</td>
<td>Banjo</td>
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<td>Bl</td>
<td>Blain</td>
<td>56530</td>
<td>8758</td>
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<tr>
<td>Bn</td>
<td>Banyan</td>
<td>8690</td>
<td>2664</td>
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<td>Ch</td>
<td>Chinaman</td>
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<td>1249</td>
<td>12</td>
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<td>Cl</td>
<td>Claravale</td>
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<td>1754</td>
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<td>Cu</td>
<td>Cully</td>
<td>4472</td>
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<td>Ibc</td>
<td>Cliffordale</td>
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<td>0</td>
<td>0</td>
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<tr>
<td>Ja</td>
<td>Jindara</td>
<td>56619</td>
<td>543</td>
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<td>Km</td>
<td>Kimbyan</td>
<td>54618</td>
<td>14262</td>
<td>26</td>
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<td>Karaman</td>
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<td>La</td>
<td>Larrimah</td>
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<td>0</td>
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<tr>
<td>Lcm</td>
<td>Mataranka</td>
<td>5653</td>
<td>166</td>
<td>3</td>
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<td>Land system</td>
<td>Land system name</td>
<td>Area in region (ha)</td>
<td>Area cleared (ha)</td>
<td>% cleared</td>
</tr>
<tr>
<td>------------</td>
<td>-------------------------</td>
<td>---------------------</td>
<td>-------------------</td>
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</tr>
<tr>
<td>Lcw</td>
<td>Waterhouse</td>
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<td>0</td>
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<td>Lwm</td>
<td>Maranboy</td>
<td>3956</td>
<td>659</td>
<td>17</td>
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<tr>
<td>Md</td>
<td>Mullaman dissected 1</td>
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<td>0</td>
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<tr>
<td>Mg</td>
<td>Mering</td>
<td>3404</td>
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<td>0</td>
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<td>Mountnorris</td>
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<td>52</td>
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<tr>
<td>Mr</td>
<td>Mueller</td>
<td>4161</td>
<td>22</td>
<td>1</td>
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<tr>
<td>Ms</td>
<td>Mais</td>
<td>29366</td>
<td>55</td>
<td>0</td>
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<tr>
<td>My</td>
<td>McGorrery</td>
<td>848</td>
<td>7</td>
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<td>R</td>
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<td>253</td>
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<td>Frog</td>
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<td>Tam</td>
<td>McArthur</td>
<td>3945</td>
<td>53</td>
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<td>9167</td>
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<td>Wulkulyi</td>
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<td>30</td>
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<td>V*</td>
<td>Volcanics</td>
<td>10615</td>
<td>634</td>
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<td>Vu</td>
<td>Vernucose</td>
<td>1678</td>
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<td>Wongalla</td>
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<td>Wg</td>
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<td>Wingate</td>
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<td>Wallingin</td>
<td>46029</td>
<td>1947</td>
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<td>Wy</td>
<td>Wriggley</td>
<td>10203</td>
<td>813</td>
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<td>Yu</td>
<td>Yungman</td>
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<td><strong>Total</strong></td>
<td><strong>879544</strong></td>
<td><strong>56693</strong></td>
<td></td>
<td><strong>6</strong></td>
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</table>

Table 6.5. Amount of land clearing of sensitive vegetation (as defined under the NT Land Clearing Guidelines NRETA 2006)) in the Katherine/ Mataranka region.

<table>
<thead>
<tr>
<th>Sensitive vegetation</th>
<th>Area in region (ha)</th>
<th>Cleared (ha)</th>
<th>Cleared (%)</th>
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<tr>
<td><strong>Rainforest:</strong></td>
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<tr>
<td>Spring</td>
<td>349</td>
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<td>0.0</td>
</tr>
<tr>
<td>Dry</td>
<td>214</td>
<td>6</td>
<td>2.8</td>
</tr>
<tr>
<td>Riparian</td>
<td>1591</td>
<td>2</td>
<td>0.1</td>
</tr>
<tr>
<td>500 m rainforest buffer</td>
<td>18639</td>
<td>3101</td>
<td>16.6</td>
</tr>
<tr>
<td><strong>Riparian</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Riparian (buffer area)</td>
<td>79076</td>
<td>3856</td>
<td>4.9</td>
</tr>
<tr>
<td><strong>Wetlands</strong></td>
<td></td>
<td></td>
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<tr>
<td>Wetlands</td>
<td>20234</td>
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<td>0.0</td>
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<tr>
<td>200m wetland buffer</td>
<td>68619</td>
<td>2400</td>
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</table>
Figure 6.11. Historical land clearing in the Katherine/ Mataranka region.
Vegetation retention scenarios for the Katherine/ Mataranka region

All vegetation retention scenarios presented below are illustrative only. They do not represent any form of legally binding regulation of land clearing. Instead, they reflect planning principles for the retention of native vegetation. The scenarios were produced in two stages.

Stage 1 - Baseline retention

The first stage consisted of identifying vegetation that should already be excluded from clearing under the current Northern Territory Government Land Clearing Guidelines (NRETA 2006). Specifically, this included retaining all vegetation that is associated with:

- Drainage lines, watercourses, wetlands or seepage zones and recommended buffers
- Sensitive vegetation (rainforests, vine thicket or closed forest)
- Waterlogging and seasonal inundation
- Slopes greater than 5%

Areas which had already been cleared were also identified in this stage, as these are no longer available for vegetation retention.

For the Katherine/ Mataranka region, baseline vegetation retention mapping was based on land systems mapped at a scale of 1:250,000.

Stage 2 - Scenarios

The second stage consisted of introducing a number of different retention thresholds to the baseline vegetation map established in Stage 1. In the absence of high resolution vegetation mapping for the Katherine/ Mataranka region, each scenario was developed twice, once using land systems mapping at 1:250,000 and once using vegetation types mapped at 1:1,000,000.

Three scenarios are described below:

Scenario 1 - Baseline retention + 50% of land systems/ vegetation types + 50% properties > 25 ha

Scenario 2 - Baseline retention + 70% of land systems/ vegetation types + 50% sub-catchments + 50% properties > 25 ha

Scenario 3 - Baseline retention + 90% of land systems/ vegetation types + 70% sub-catchments + 50% properties > 25 ha
Baseline vegetation retention in the Katherine/ Mataranka region

A map of the baseline vegetation that is retained under current NT land clearing guidelines (NRETA 2006) is presented in Figure 6.12. The guidelines retain a total of 30% (2651 km²) of the native vegetation in the Katherine/ Mataranka region (Table 6.6).

Table 6.6. Summary of amount of vegetation retained in the Katherine/ Mataranka region under the existing NT land clearing guidelines.

<table>
<thead>
<tr>
<th>Baseline categories</th>
<th>Area km²</th>
<th>Proportion of region retained (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Park</td>
<td>158.2</td>
<td>1.8</td>
</tr>
<tr>
<td>Sensitive Habitat (including buffers)</td>
<td>1084.7</td>
<td>12.3</td>
</tr>
<tr>
<td>Land systems - subject to flooding</td>
<td>505.0</td>
<td>5.7</td>
</tr>
<tr>
<td>Land systems - low agricultural potential</td>
<td>425.1</td>
<td>4.8</td>
</tr>
<tr>
<td>Slope &gt; 5%</td>
<td>458.8</td>
<td>5.2</td>
</tr>
<tr>
<td>Conservation Planning Zone</td>
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</tr>
<tr>
<td>TOTAL</td>
<td>2650.9</td>
<td>30.0</td>
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</tbody>
</table>
Figure 6.12. Baseline retained vegetation in the Katherine/ Mataranka region. Coloured areas may not be cleared under existing NT land clearing guidelines (2006), or have already been cleared, or are of low agricultural potential.
**Scenario 1: 50% of each (a) land system or (b) vegetation type, + 50% properties > 25 ha**

(a) Using land systems

Under the current land clearing guidelines, 35 of the 58 land systems in the Katherine/ Mataranka region could have more than 50% of their extent cleared. Under the guidelines, 271 of the region’s 312 properties greater than 25 ha in size could be cleared by more than 50%. Figure 6.13 shows a scenario in which additional areas are identified to bring these land systems to at least 50% retention, spread such that each property greater than 25 ha in size retains at least 50% of its vegetation cover.

(b) Using broad vegetation types

Under the current land clearing guidelines, 7 of the region’s 14 vegetation types could be cleared by more than 50% of their extent. Under the guidelines, 271 of the region’s 312 properties greater than 25 ha in size could be cleared by more than 50%. Figure 6.14 shows a scenario in which additional areas are identified to bring these vegetation types to at least 50% retention, spread such that each property greater than 25 ha in size retains at least 50% of its vegetation cover.

**Scenario 2: 70% of each (a) land system or (b) vegetation type, + 50% sub-catchments + 50% properties > 25 ha**

(a) Using land systems

Under scenario 1a, there are 27 land systems which could be cleared by more than 30%, and 38 sub-catchments which could be cleared by more than 50%. Clearing has already exceeded 50% in 5 of these sub-catchments... Figure 6.15 shows a scenario in which additional areas are identified to bring all land systems to at least 70% retention, spread such that each sub-catchment and each property greater than 25 ha in size retains at least 50% of its vegetation cover (with the exception of properties and sub-catchments in which clearing has already exceeded 50%).

(b) Using broad vegetation types

Under scenario 1b, there are 6 vegetation types which could be cleared by more than 30%, and 48 sub-catchments which could be cleared by more than 50%. Clearing has already exceeded 50% in 5 of these sub-catchments. Figure 6.16 shows a scenario in which additional areas are identified to bring all land systems to at least 70% retention, spread such that each sub-catchment and each property greater than 25 ha in size retains at least 50% of its vegetation cover (with the exception of properties and sub-catchments in which clearing has already exceeded 50%).

**Scenario 3: 90% of each (a) land system or (b) vegetation type, + 70% sub-catchments + 50% properties > 25 ha**

(a) Using land systems

Under scenario 2a, there are 26 land systems which could be cleared by more than 10%, and 35 sub-catchments which could be cleared by more than 30%. Clearing has already exceeded 30% in 13 of these sub-catchments. Figure 6.17 shows a scenario in which additional areas are identified to bring all land systems to 90%
retention, spread such that each sub-catchment retains at least 70% and each property greater than 25 ha in size at least 50% of its vegetation cover (with the exception of properties and sub-catchments in which clearing has already exceeded these thresholds).

(b) Using broad vegetation types

Under scenario 2b, there are 8 vegetation types which could be cleared by more than 10%, and 53 sub-catchments which could be cleared by more than 30%. Clearing has already exceeded 30% in 12 of these sub-catchments. Figure 6.18 shows a scenario in which additional areas are identified to bring all vegetation types to 90% retention, spread such that each sub-catchment retains at least 70% and each property greater than 25 ha in size at least 50% of its vegetation cover (with the exception of properties and sub-catchments in which clearing has already exceeded these thresholds).
Figure 6.13. Scenario 1a: The inclusion of the areas coloured blue in addition to the baseline retained vegetation (Figure 6.12) ensures that at least 50% of each land system is retained and that at least 50% vegetation cover is retained on all properties greater than 25 ha in size. Coloured areas may not be cleared or have already been cleared.
Figure 6.14. Scenario 1b: The inclusion of the areas coloured blue in addition to the baseline retained vegetation (Figure 6.12) ensures that at least 50% of each vegetation type is retained and that at least 50% vegetation cover is retained on all properties greater than 25 ha in size. Coloured areas may not be cleared or have already been cleared.
Figure 6.15. Scenario 2a: The inclusion of the areas coloured blue in addition to the baseline retained vegetation (Figure 6.12) ensures that at least 70% of each land system is retained, at least 50% vegetation cover is retained in each sub-catchment, and at least 50% vegetation cover is retained on all properties greater than 25 ha in size. Coloured areas may not be cleared or have already been cleared.
Figure 6.16. Scenario 2b: The inclusion of the areas coloured blue in addition to the baseline retained vegetation (Figure 6.12) ensures that at least 70% of each vegetation type is retained, at least 50% vegetation cover is retained in each sub-catchment, and at least 50% vegetation cover is retained on all properties greater than 25 ha in size. Coloured areas may not be cleared or have already been cleared.
Figure 6.17. Scenario 3a: The inclusion of the areas coloured blue in addition to the baseline retained vegetation (Figure 6.12) ensures that at least 90% of each land system is retained, at least 70% vegetation cover is retained in each sub-catchment, and at least 50% vegetation cover is retained on all properties greater than 25 ha in size. Coloured areas may not be cleared or have already been cleared.
Figure 6.18. Scenario 3b: The inclusion of the areas coloured blue in addition to the baseline retained vegetation (Figure 6.12) ensures that at least 90% of each vegetation type is retained, at least 70% vegetation cover is retained in each sub-catchment, and at least 50% vegetation cover is retained on all properties greater than 25 ha in size. Coloured areas may not be cleared or have already been cleared.
**Summary of vegetation retention scenarios**

Table 6.7. Proportion of each land system in the Katherine/ Mataranka region that is still clearable under the existing land clearing guidelines and under each of the scenarios in this plan

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<th>% retained existing guidelines</th>
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Table 6.8. Proportion of each broad vegetation type in the Katherine/ Mataranka region that is still clearable under the existing land clearing guidelines and under each of the scenarios in this plan.
Chapter 7. Marrakai Region vegetation retention plan

Description of Marrakai region

The Marrakai region is located 70 km south east of Darwin and covers 660 km². The region’s boundaries are based on the Marrakai land unit mapping (Fogarty 1980): the western border runs along Adelaide River, the northern border along Arnhem Highway, and southern and eastern borders run along pastoral property boundaries. The region has a relatively small population, with 342 people recorded in the 2006 census of the broader region that extends to the coast (ABS 2007). The Marrakai region is currently not included in any Local Government area.

Tenure and land use

A range of land tenure covers the Marrakai region (Figure 7.1a). Crown lease in perpetuity (represented solely by the Adelaide River Pastoral station) covers 60% of the region. Freehold tenure exists over 5% and consists of residential and horticulture. Protected areas (represented by the Leaning Tree Lagoon Nature Park) cover 101.3ha (0.15%) of the region, although Djukbinj National Park is directly adjacent. Leaning Tree Lagoon provides a refuge for waterbirds, and is managed to protect its wildlife and for recreational activities. Recent development within the Marrakai region has occurred along the Arnhem Highway, where 23 km² (4% of Marrakai area) has been subdivided in stages into 214 plots ranging from 2 ha since 1994. These small plots are mostly being used for rural residential and irrigated horticulture. Approval has been granted for further subdivisions in the area.

Historically, the Marrakai region was one of the first agricultural areas of the Top End of the Northern Territory, with buffalo harvested for skins in the late 1880s, followed by the establishment of numerous pastoral stations. Current land use in the Marrakai region is a mix of pastoralism, horticulture, residential and conservation (Figure 7.1b). Pastoralism is the dominant land use in the region, along with horticultural crops includes tropical fruits such as mangoes, citrus and paw paw, and vegetables.
Figure 7.1. Distribution of (a) land tenure and (b) land use in the Marrakai region.
Land units, drainage and elevation

A land resource assessment of the Marrakai region was published in 1980, and five land systems and 26 land unit units were identified at a scale of 1:25,000 (Figure 7.2) (Fogarty 1980). The land resource assessment evaluated the potential of each land unit based on soils and drainage and a brief description of each of the Marrakai land units is provided in Table 7.1. Potential for horticultural development is highest in land systems 2 and 3, due to factors relating to soil and landform. Extensive hills and rises dominate the eastern and southern part of the region while the large areas in the eastern part of the region are poorly drained and seasonally inundated (Figure 7.3).

Table 7.1. Description of 26 land unit within the Marrakai region (Fogarty 1980).

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<td>2a</td>
<td>Gently undulating</td>
<td>Open forest</td>
<td>Erodible</td>
<td>Moderate</td>
</tr>
<tr>
<td>2b</td>
<td>Level - gently undulating</td>
<td>Open forest</td>
<td>None</td>
<td>High</td>
</tr>
<tr>
<td>3a</td>
<td>Footslopes</td>
<td>Woodland</td>
<td>Gravely soils</td>
<td>Moderate</td>
</tr>
<tr>
<td>3b</td>
<td>Sideslopes</td>
<td>Woodland</td>
<td>Erodible</td>
<td>Moderate</td>
</tr>
<tr>
<td>3c</td>
<td>Lower sideslopes</td>
<td>Woodland</td>
<td>Imperfect drainage</td>
<td>Low</td>
</tr>
<tr>
<td>3d</td>
<td>Gravely upper slopes</td>
<td>Woodland</td>
<td>Gravely soils</td>
<td>Low</td>
</tr>
<tr>
<td>3e</td>
<td>Gentle sideslopes</td>
<td>Woodland</td>
<td>Erodible</td>
<td>Low</td>
</tr>
<tr>
<td>3f</td>
<td>Very gentle sideslopes</td>
<td>Woodland</td>
<td>Seasonal flooding</td>
<td>Low</td>
</tr>
<tr>
<td>4a</td>
<td>Perennial wetlands</td>
<td>Sedgeland</td>
<td>Seasonal flooding</td>
<td>Low</td>
</tr>
<tr>
<td>4b</td>
<td>Drainage ways</td>
<td>Woodland</td>
<td>Seasonal flooding</td>
<td>Low</td>
</tr>
<tr>
<td>4c</td>
<td>Floodplain (north)</td>
<td>Woodland</td>
<td>Seasonal flooding</td>
<td>Low</td>
</tr>
<tr>
<td>4d</td>
<td>Broad floodplain (south)</td>
<td>Grassland</td>
<td>Seasonal flooding</td>
<td>Low</td>
</tr>
<tr>
<td>4e</td>
<td>Narrow drainage ways</td>
<td>Woodland</td>
<td>Seasonal flooding</td>
<td>Low</td>
</tr>
<tr>
<td>4f</td>
<td>Stream channel</td>
<td>Woodland</td>
<td>Erodible</td>
<td>Low</td>
</tr>
<tr>
<td>4g</td>
<td>Undulating plains</td>
<td>Grassland</td>
<td>Seasonal flooding</td>
<td>Low</td>
</tr>
<tr>
<td>5a1</td>
<td>Levy bank (downstream)</td>
<td>Grassland</td>
<td>Seasonal flooding</td>
<td>Low</td>
</tr>
<tr>
<td>5a2</td>
<td>Levy bank (upstream)</td>
<td>Woodland</td>
<td>Erodible</td>
<td>Low</td>
</tr>
<tr>
<td>5b1</td>
<td>Extensive clay pans</td>
<td>Grassland</td>
<td>Seasonal flooding</td>
<td>Low</td>
</tr>
<tr>
<td>5b2</td>
<td>Clay pans</td>
<td>Sedgeland</td>
<td>Seasonal flooding</td>
<td>Low</td>
</tr>
<tr>
<td>5c</td>
<td>Clay plains (brown clay)</td>
<td>Grassland</td>
<td>Seasonal flooding</td>
<td>Low</td>
</tr>
<tr>
<td>5d</td>
<td>Clay plains (black clay)</td>
<td>Woodland</td>
<td>Seasonal flooding</td>
<td>Low</td>
</tr>
<tr>
<td>5e</td>
<td>Blackplain swamp</td>
<td>Woodland</td>
<td>Inundation</td>
<td>Low</td>
</tr>
<tr>
<td>5f</td>
<td>River banks</td>
<td>Forest</td>
<td>Seasonal flooding</td>
<td>Low</td>
</tr>
</tbody>
</table>

* Land units have been classed into three categories relating to their potential for horticulture and this is based limitations such erodibility (e.g. slope), soil type and drainage.
Figure 7.2. Distribution of land units at (a) broad scale and (b) 1:25,000 for the Marrakai region (mapping based on Fogarty 1980).
Figure 7.3. (a) Elevation and (b) drainage coverage of Marrakai region.
Priority vegetation and threatened species in Marrakai region

The Marrakai region contains substantial amounts of vegetation types classified as "sensitive" under the Land Clearing Guidelines (NRETA 2006). In total, sensitive vegetation types comprise approximately 28% of the Marrakai region (Figure 7.4a). Rainforest vegetation covers 8866 ha of the Marrakai region and is concentrated on the edge of the Adelaide River floodplain (13%). Extensive wetlands occur throughout the area, covering 16133 ha (25%). Riparian vegetation occurs along the Adelaide River and the Marrakai creek, covering 11111 ha (1.7%).

The Marrakai region contains one flora species and 23 fauna species that are listed as of conservation significance under Northern Territory and/or Commonwealth legislation, including 12 species protected under international migratory species treaties (Table 7.2 and Table 7.3). The distribution of records for these species is clustered close to the Arnhem Highway, reflecting a lack of access to the broader region (Figure 7.4b). The northern quoll (*Dasyurus hallucatus*) is the only Critically Endangered species recorded from the region, having suffered a substantial decline following the colonisation of the cane toad *Chaunus [Bufo] marinus*.

Table 7.2. Flora species of conservation significance listed under Commonwealth legislation (*Environment Protection and Biodiversity Conservation Act 1999*). There are no flora species in the region listed as threatened under NT legislation (*Territory Parks and Wildlife Conservation Act 2001*),

<table>
<thead>
<tr>
<th>Name</th>
<th>endemic</th>
<th>TPWCA (EPBCA) status</th>
<th>Records in Marrakai</th>
<th>% in Marrakai</th>
</tr>
</thead>
<tbody>
<tr>
<td>Goodenia quadrifida</td>
<td>1</td>
<td>(VU)</td>
<td>1</td>
<td>20.0</td>
</tr>
</tbody>
</table>

VU – Vulnerable


<table>
<thead>
<tr>
<th>Scientific name</th>
<th>Common name</th>
<th>Group</th>
<th>TPWCA (EPBCA) status</th>
<th>CJB*</th>
<th>Records in Marrakai</th>
<th>% in Marrakai</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ardea alba</td>
<td>Great Egret</td>
<td>Bird</td>
<td>+</td>
<td>20</td>
<td>0.8</td>
<td></td>
</tr>
<tr>
<td>Ardea ibis</td>
<td>Cattle Egret</td>
<td>Bird</td>
<td>+</td>
<td>13</td>
<td>1.2</td>
<td></td>
</tr>
<tr>
<td>Ardeotis australis</td>
<td>Australian Bustard</td>
<td>Bird</td>
<td>VU</td>
<td>6</td>
<td>0.1</td>
<td></td>
</tr>
<tr>
<td>Burhinus grallarius</td>
<td>Bush Stone-curlew</td>
<td>Bird</td>
<td>NT</td>
<td>6</td>
<td>0.4</td>
<td></td>
</tr>
<tr>
<td>Geophaps smithii</td>
<td>Partridge Pigeon</td>
<td>Bird</td>
<td>VU (VU)</td>
<td>3</td>
<td>0.1</td>
<td></td>
</tr>
<tr>
<td>Haliaeetus leucogaster</td>
<td>White-bellied Sea-eagle</td>
<td>Bird</td>
<td>+</td>
<td>9</td>
<td>0.6</td>
<td></td>
</tr>
<tr>
<td>Limosa limosa</td>
<td>Black-tailed Godwit</td>
<td>Bird</td>
<td>+</td>
<td>1</td>
<td>0.2</td>
<td></td>
</tr>
<tr>
<td>Lophoictinia isura</td>
<td>Square-tailed Kite</td>
<td>Bird</td>
<td>NT</td>
<td>1</td>
<td>0.5</td>
<td></td>
</tr>
<tr>
<td>Merops ornatus</td>
<td>Rainbow Bee-eater</td>
<td>Bird</td>
<td>+</td>
<td>18</td>
<td>0.2</td>
<td></td>
</tr>
<tr>
<td>Myiagra inquieta</td>
<td>Restless Flycatcher</td>
<td>Bird</td>
<td>+</td>
<td>4</td>
<td>0.2</td>
<td></td>
</tr>
<tr>
<td>Myiagra rubecula</td>
<td>Leaden Flycatcher</td>
<td>Bird</td>
<td>+</td>
<td>1</td>
<td>0.04</td>
<td></td>
</tr>
<tr>
<td>Numenius minutus</td>
<td>Little Curlew</td>
<td>Bird</td>
<td>+</td>
<td>1</td>
<td>0.2</td>
<td></td>
</tr>
<tr>
<td>Plegadis falcinellus</td>
<td>Glossy Ibis</td>
<td>Bird</td>
<td>+</td>
<td>4</td>
<td>0.3</td>
<td></td>
</tr>
<tr>
<td>Poecilodryas superciliosa</td>
<td>White-browed Robin</td>
<td>Bird</td>
<td>NT</td>
<td>1</td>
<td>0.3</td>
<td></td>
</tr>
<tr>
<td>Tringa nebularia</td>
<td>Common Greenshank</td>
<td>Bird</td>
<td>+</td>
<td>1</td>
<td>0.1</td>
<td></td>
</tr>
<tr>
<td>Tringa stagnatilis</td>
<td>Marsh Sandpiper</td>
<td>Bird</td>
<td>+</td>
<td>2</td>
<td>0.2</td>
<td></td>
</tr>
<tr>
<td>Dasyurus hallucatus</td>
<td>Northern Quoll</td>
<td>Mammal</td>
<td>CR (EN)</td>
<td>9</td>
<td>0.4</td>
<td></td>
</tr>
<tr>
<td>Onychogalea unguifera</td>
<td>Northern Nailtail Wallaby</td>
<td>Mammal</td>
<td>NT</td>
<td>1</td>
<td>0.1</td>
<td></td>
</tr>
<tr>
<td>Scientific name</td>
<td>Common name</td>
<td>Group</td>
<td>TPWCA (EPBCA) status</td>
<td>CJB* Records in Marrakai</td>
<td>% in Marrakai</td>
<td></td>
</tr>
<tr>
<td>-----------------------</td>
<td>----------------------</td>
<td>---------</td>
<td>----------------------</td>
<td>--------------------------</td>
<td>---------------</td>
<td></td>
</tr>
<tr>
<td><em>Rhinonicteris aurantia</em></td>
<td>Orange Leaf-nosed bat</td>
<td>Mammal</td>
<td>NT</td>
<td>1</td>
<td>0.6</td>
<td></td>
</tr>
<tr>
<td><em>Acanthophis praelongus</em></td>
<td>Northern Death Adder</td>
<td>Reptile</td>
<td>NT</td>
<td>13</td>
<td>11.7</td>
<td></td>
</tr>
<tr>
<td><em>Crocodylus porosus</em></td>
<td>Saltwater Crocodile</td>
<td>Reptile</td>
<td>+</td>
<td>182</td>
<td>2.1</td>
<td></td>
</tr>
<tr>
<td><em>Varanus mertensi</em></td>
<td>Merten's Water Monitor</td>
<td>Reptile</td>
<td>VU</td>
<td>3</td>
<td>0.6</td>
<td></td>
</tr>
<tr>
<td><em>Varanus panoptes</em></td>
<td>Floodplain Monitor</td>
<td>Reptile</td>
<td>VU</td>
<td>6</td>
<td>1.2</td>
<td></td>
</tr>
</tbody>
</table>

Figure 7.4. Distribution of (a) sensitive vegetation and (b) flora and fauna species listed under Northern Territory, Commonwealth and International treaties in the Marrakai region.
Historical land clearing in the Marrakai region

There has been an increase in land clearing in the Marrakai region over the last twenty years, primarily for horticulture and residential developments. Based on the Northern Territory Government Native Vegetation Clearing GIS dataset (2005), 32 km² of the Marrakai region has been cleared, or approximately 5% of the 660 km² considered in this report. The spatial distribution of land clearing has concentrated in the area close to the Arnhem Highway. Table 7.4 shows the proportion of cleared land for each of the 26 Land Units. Land clearing greater than the 70% threshold has occurred on Land Units 3a (footslopes with woodland vegetation), 3b (sideslopes with woodland vegetation). Two other land units that have had substantial land clearing include 1c (low gravelly rises with woodland vegetation) and 2a (gently undulating with open forest vegetation).

A small amount of land clearing has occurred in vegetation types declared as sensitive under the NT Land Clearing Guidelines (NRETA 2006). Table 7.5 shows the amount of land cleared for each of the sensitive vegetation communities and associated buffers in the Marrakai region. A total of 1475 ha of sensitive vegetation and associated buffers has been cleared in the Marrakai region. Of the sensitive vegetation types, wetland and riparian buffers have been cleared the most, but as a proportion of total area the area cleared has been small.

Table 7.4. Current amount of land cleared by land unit within the Marrakai region.

<table>
<thead>
<tr>
<th>Land unit</th>
<th>Area in region (ha)</th>
<th>Land cleared (ha)</th>
<th>% land cleared</th>
</tr>
</thead>
<tbody>
<tr>
<td>1a</td>
<td>8025</td>
<td>528</td>
<td>7</td>
</tr>
<tr>
<td>1b</td>
<td>15469</td>
<td>1256</td>
<td>8</td>
</tr>
<tr>
<td>1c</td>
<td>664</td>
<td>141</td>
<td>21</td>
</tr>
<tr>
<td>2a</td>
<td>1795</td>
<td>352</td>
<td>20</td>
</tr>
<tr>
<td>2b</td>
<td>212</td>
<td>23</td>
<td>11</td>
</tr>
<tr>
<td>3a</td>
<td>255</td>
<td>145</td>
<td>57</td>
</tr>
<tr>
<td>3b</td>
<td>650</td>
<td>241</td>
<td>37</td>
</tr>
<tr>
<td>3c</td>
<td>1176</td>
<td>78</td>
<td>7</td>
</tr>
<tr>
<td>3d</td>
<td>2932</td>
<td>219</td>
<td>7</td>
</tr>
<tr>
<td>3e</td>
<td>4617</td>
<td>262</td>
<td>6</td>
</tr>
<tr>
<td>3f</td>
<td>5219</td>
<td>281</td>
<td>5</td>
</tr>
<tr>
<td>4a</td>
<td>211</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>4b</td>
<td>581</td>
<td>77</td>
<td>13</td>
</tr>
<tr>
<td>4c</td>
<td>961</td>
<td>62</td>
<td>6</td>
</tr>
<tr>
<td>4d</td>
<td>5239</td>
<td>188</td>
<td>4</td>
</tr>
<tr>
<td>4e</td>
<td>1443</td>
<td>56</td>
<td>4</td>
</tr>
<tr>
<td>4f</td>
<td>1691</td>
<td>59</td>
<td>3</td>
</tr>
<tr>
<td>4g</td>
<td>1076</td>
<td>35</td>
<td>3</td>
</tr>
<tr>
<td>5a1</td>
<td>641</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>5a2</td>
<td>84</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>5b1</td>
<td>5272</td>
<td>28</td>
<td>1</td>
</tr>
<tr>
<td>5b2</td>
<td>2052</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>5c</td>
<td>540</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>5d</td>
<td>839</td>
<td>7</td>
<td>1</td>
</tr>
<tr>
<td>5e</td>
<td>1853</td>
<td>42</td>
<td>2</td>
</tr>
<tr>
<td>5f</td>
<td>648.21</td>
<td>0.47</td>
<td>0.07</td>
</tr>
</tbody>
</table>
Table 7.5. Amount of land clearing of sensitive vegetation (as defined under the NT Land Clearing Guidelines, NRETA 2006) in the Marrakai region.

<table>
<thead>
<tr>
<th>Sensitive vegetation</th>
<th>Area in region (ha)</th>
<th>Land cleared (ha)</th>
<th>% Land cleared</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rainforest:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spring</td>
<td>1131</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Dry</td>
<td>2688</td>
<td>8</td>
<td>0.3</td>
</tr>
<tr>
<td>500 m rainforest buffer</td>
<td>7850</td>
<td>300</td>
<td>4</td>
</tr>
<tr>
<td>Riparian</td>
<td>4847</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Riparian (buffer area)</td>
<td>11111</td>
<td>391</td>
<td>4</td>
</tr>
<tr>
<td>Wetlands</td>
<td>16133</td>
<td>239</td>
<td>1</td>
</tr>
<tr>
<td>200 m wetland buffer</td>
<td>22694</td>
<td>545</td>
<td>2</td>
</tr>
</tbody>
</table>
Vegetation retention scenarios for the Marrakai region

All vegetation retention scenarios presented below are illustrative only. They do not represent any form of legally binding regulation of land clearing. Instead, they reflect planning principles for the retention of native vegetation. The scenarios were produced in two stages.

For the Marrakai region, vegetation retention thresholds were based on Land Units mapped at a scale of 1:25,000 (Fogarty 1980).

Stage 1 - Baseline retention

The first stage consisted of identifying vegetation that should already be excluded from clearing under the current Northern Territory Government Land Clearing Guidelines (NRETA 2006). Specifically, this included retaining all vegetation that was associated with:

- Drainage lines, watercourses, wetlands or seepage zones and recommended buffers
- Sensitive vegetation (rainforests, vine thicket or closed forest)
- Waterlogging and seasonal inundation
- Slopes greater than 5%

In addition, Land Units that were primarily rocky outcrops were considered unsuitable for land clearing due to poor soils and high potential for erosion. Therefore, we included Land Unit 1a (Hills and Outcrops) in the baseline mapping. Areas which had already been cleared were also identified in this stage, as these are no longer available for vegetation retention.

Stage 2 - Scenarios

The second stage consisted of introducing a number of different vegetation retention thresholds to the baseline vegetation map established in Stage 1. Land unit and sub-catchment thresholds were set to illustrate the potential vegetation retention scenarios in the region. Three scenarios are described below:

- Scenario 1 - Baseline retention + 50% of Land Units
- Scenario 2 - Baseline retention + 70% of Land Units + 50% of sub-catchments
- Scenario 3 - Baseline retention + 90% of Land Units + 70% of sub-catchments
Baseline vegetation retention in the Marrakai region

A summary of the baseline vegetation retention mapping conducted in Stage 1 is presented in Table 7.6. A total of 65% of the Marrakai region was retained using criteria in the current NT Land Clearing Guidelines (NRETA 2006). Sensitive habitats and seasonally inundated areas contributed the most to the total, due to the Adelaide River floodplain and associated wetlands in the region.

Table 7.6. Summary of amount of vegetation retained in the Marrakai region under the existing NT land clearing guidelines.

<table>
<thead>
<tr>
<th>Baseline categories</th>
<th>Area km²</th>
<th>Proportion of region retained (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensitive habitats (including buffers)</td>
<td>288</td>
<td>44</td>
</tr>
<tr>
<td>Leaning Tree Lagoon Nature Park</td>
<td>1</td>
<td>0.2</td>
</tr>
<tr>
<td>Seasonally waterlogged or flooded land units</td>
<td>75</td>
<td>11</td>
</tr>
<tr>
<td>Slope &gt; 5%</td>
<td>29</td>
<td>4</td>
</tr>
<tr>
<td>Landunit 1a - extensive outcropping &amp; stones</td>
<td>35</td>
<td>5</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>428</strong></td>
<td><strong>65</strong></td>
</tr>
</tbody>
</table>

Table 7.7. Summary of amount of each land unit retained in the Marrakai region under the existing NT land clearing guidelines.

<table>
<thead>
<tr>
<th>Land Unit</th>
<th>Area (km²)</th>
<th>Proportion retained (%)</th>
<th>Area cleared (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1b</td>
<td>155</td>
<td>22</td>
<td>8</td>
</tr>
<tr>
<td>1c</td>
<td>7</td>
<td>22</td>
<td>21</td>
</tr>
<tr>
<td>2a</td>
<td>18</td>
<td>15</td>
<td>20</td>
</tr>
<tr>
<td>2b</td>
<td>2</td>
<td>18</td>
<td>11</td>
</tr>
<tr>
<td>3a</td>
<td>3</td>
<td>23</td>
<td>57</td>
</tr>
<tr>
<td>3b</td>
<td>7</td>
<td>23</td>
<td>37</td>
</tr>
<tr>
<td>3d</td>
<td>29</td>
<td>22</td>
<td>7</td>
</tr>
<tr>
<td>3e</td>
<td>47</td>
<td>25</td>
<td>6</td>
</tr>
</tbody>
</table>
Figure 7.5. Baseline retained vegetation in the Marrakai region. Coloured areas may not be cleared under existing NT land clearing guidelines (NRETA 2006), or have already been cleared, or are unsuitable for horticulture.
**Scenario 1: 50% of each land unit**

Under the current land clearing guidelines, 8 of the 26 land units in the Marrakai region could have more than 50% of their extent cleared. Figure 7.6 shows a scenario in which additional areas are identified to bring all land units to at least 50% retention.

**Scenario 2: 70% of each land unit + 50% of each sub-catchment**

Under the current land clearing guidelines, 8 of the 26 land units in the Marrakai region could be cleared by more than 30% of their extent. Figure 7.7 shows a scenario in which additional areas are identified to bring all land units to at least 70% retention, spread such that each sub-catchment retains at least 50% of its vegetation cover (with the exception of sub-catchments in which clearing has already exceeded this threshold).

**Scenario 3: 90% of each land unit + 70% of each sub-catchment**

Under the current land clearing guidelines, 10 of the 26 land units in the Marrakai region could be cleared by more than 10% of their extent. Figure 7.8 shows a scenario in which additional areas are identified to bring all land units to at least 90% retention, distributed such that at least 70% of the vegetation cover of each sub-catchment is retained (with the exception of sub-catchments in which clearing has already exceeded this threshold).
Figure 7.6. Scenario 1: The inclusion of the areas coloured blue in addition to the baseline retained vegetation (Figure 7.5) ensures that at least 50% of each land unit is retained. Coloured areas may not be cleared or have already been cleared.
Figure 7.7. Scenario 2: The inclusion of the areas coloured blue in addition to the baseline retained vegetation (Figure 7.5) ensures that at least 70% of each land unit is retained, and at least 50% vegetation cover is retained in each sub-catchment. Coloured areas may not be cleared or have already been cleared.
Figure 7.8. Scenario 3: The inclusion of the areas coloured blue in addition to the baseline retained vegetation (Figure 7.5) ensures that at least 90% of each land unit is retained, and at least 70% vegetation cover is retained in each sub-catchment. Coloured areas may not be cleared or have already been cleared.
### Summary of vegetation retention scenarios

Table 7.8. Proportion of each land unit in the Marrakai region that is still clearable under the existing land clearing guidelines and under each of the scenarios in this plan

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Chapter 8. Management guidelines for remnant vegetation

Introduction

The management of native vegetation post-land clearing should be seen as a priority for effective land management and the conservation of biodiversity. Clearing land for purely economic gain often ignores the important role that native vegetation plays in maintaining the health of landscapes. In addition, land owners who clear land often do not take into account the issues relating to and cost of management of native vegetation and this can result in significant reduction in biodiversity values of the native vegetation. This chapter provides a summary of benefits of native vegetation on properties, highlights the main issues relating to native vegetation management post-clearing, and describes a number of schemes that provide incentives for landholders to manage native vegetation on their properties.

Benefits of retaining native vegetation

It is often argued by land owners that clearing as much native vegetation as permissible is necessary to make properties financially viable. Furthermore, they tend to consider native vegetation and wildlife of little or no value, even a liability. This argument ignores the many services that native vegetation can contribute directly and indirectly to the long-term sustainability of individual properties. Native vegetation can provide the following direct benefits to land owners: shade and shelter for stock; maintain watertable levels and prevent salinity; contribute to soil erosion control; microhabitats which assist water retention and quality; and habitat for natural pollinators of crops (e.g. native stingless bees)(Ricketts 2004). Indirectly, the benefits of retaining native vegetation include: storage of carbon to offset global warming; habitat for native fauna and flora; potential income from harvest of native species; potential income from tourism and recreation; and conservation of genetic resources.

Management of native vegetation

The management of native vegetation from detrimental impacts following land clearing is important to conserving the biodiversity and maintaining ecosystem health. Below are some management issues associated to ensure remnants are not degraded by detrimental processes.

Pest animals

Native vegetation can be damaged by pest animals that can prevent regeneration from occurring or impact on the conservation value. For example, feral pigs can cause considerable damage to soil and vegetation and may have a detrimental impact on the conservation value and farm productivity. A control program for each problem species should be developed and ideally involve neighbouring properties. Advice on control techniques for pest animals can be obtained from the Department Natural Resources, Environment, and the Arts and Department of Primary Industries, Fisheries and Mines.
**Weeds**

Weeds are potentially the biggest threat to conservation values of the native vegetation in the Northern Territory. Being able to identify and control weeds and prevent the introduction of weed species is necessary to effectively manage native vegetation. Controlling weeds can improve natural regeneration by removing competition. The control of weeds can include techniques such as strategic burning, herbicide application, mechanical removal and grazing. Advice on control techniques for pest animals can be obtained from the Department Natural Resources, Environment, and the Arts and Department of Primary Industries, Fisheries and Mines.

**Fire**

Fire is a form of disturbance that can have both positive and negative impacts on remnant vegetation. Fire is an ecological tool that can be used to control weeds, encourage natural regeneration and alter the species composition of a remnant (Dyer et al. 2001). Due to the high potential for frequent fires to alter and degrade native vegetation it is important to implement an appropriate regime. The frequency, season and intensity of a fire and the impact of these factors need to be considered prior to burning. Wildfire can pose a severe threat to small patches of native vegetation. Small areas of vegetation lack the regenerative ability of larger areas due to the greater chance of them being completely burnt out. If a small patch is completely burnt out it is harder for recolonisation by flora and fauna to take place. Access within large remnants is recommended to enable fire protection activities to be undertaken. Advice on fire management can be obtained from the Bushfires NT.

**Fencing**

Fencing may be a feasible management option for smaller properties or patches of native vegetation. Fencing enables stock grazing to be prevented or controlled. Over grazing by stock greatly reduces the ability of native vegetation to regenerate, encourages the introduction of weeds and can lead to the death of older trees due to de-barking or soil compaction. Fencing may be used to prevent pest animals from entering a remnant. Sensitive vegetation such as rainforests, swamps and riparian closed forests will benefit the most from exclusion of stock.

**Incentives for managing vegetation**

The costs to land owners for maintaining native vegetation could potentially be high for the direct benefits they receive. Many land owners are not convinced that the retention and management of native vegetation is beneficial to their livelihood. In response to this, the use of incentives is becoming more widespread in Australia and overseas. For example, the United Kingdom’s Environmentally Sensitive Areas program has over 13,000 participants and an annual expenditure on farm agreements of £37 million. The uses of financial and non-financial incentives for the management of native vegetation on properties in the Northern Territory are summaries briefly below.
Direct assistance and grants

Land owners or local landcare groups can apply to a range of funding bodies for direct assistance in managing natural resources. The most common example is funding through the Natural Heritage Trust (NHT) Bushcare and Envirofund program for fencing of sensitive vegetation types. However, the amount of funding is relatively small (e.g. $146,745 awarded to NT projects in Round 8 for exclusion fencing) and is unlikely to increase.

Taxation incentives

Tax incentives provide a means of encouraging a range of environmentally sensitive practices in natural resource management and take one of two forms. Tax rebates reduce the amount of tax that a landholder or business is required to pay, while tax deductions subtract an expense from the taxable income of an individual or business. Some voluntary conservation arrangements allow landholders the benefits of income tax deduction for any loss in land value resulting from conservation activities, as well as special treatment of capital gains tax. The Australian Tax Office allows tax deductions for capital expenditure on landcare operations and for water facilities (e.g. plant or structural improvement for the purpose of conserving and conveying water).

Auctions and tenders

An auction or land management tender enables government agencies, catchment authorities and community groups to fund improved natural resource management by choosing between tenders to gain the greatest environmental benefits at least cost. The agency assesses bids tendered by land managers and ranks them to select and award contracts to those offering the highest value for money. An auction/tender process allows land managers to set a price (tender price) for actions or ecological services that the community wish to purchase, just as they would set the price for other farm products. From a land manager’s perspective, the auction/tender process means all on-ground works, costs and benefits are planned and accounted for. This provides security for long-term farm planning. Auctions or tenders introduce competition among farmers for participation in catchment health activities.

As part of a pilot project, an auction was recently held in north-east of the Western Australian wheatbelt by WWF-Australia and collaborators. The auction was devised as a simple sealed bid, price-discriminating auction over two rounds, with $200,000 available to private landholders submitting single, multiple or joint tenders for on-ground works focussing on biodiversity conservation measures. Management actions focussed on the fencing of remnants and other biodiversity assets such as naturally saline wetlands and granite outcrops, revegetation and associated fencing, rabbit and fox control and corridor construction. The tender resulted in a total of 21 separate management contracts for periods of up to three years. Landholders committed to one nature conservation covenant and 14 Voluntary Management Agreements.
Offsets

A natural resource management offset is an off-site action that counterbalances an environmental impact on-site. Developers often use offsets as a means of meeting a regulatory requirement, and have the option of either undertaking the action themselves or paying for another party to do so on their behalf. Offsets provide a useful tool for achieving environmental outcomes at lower cost than on-site mitigation, allowing development costs to be reduced while environmental standards are improved. Natural resource management agencies in Australia have implemented various forms of offset schemes. Developers investigate opportunities for using offsets to satisfy a regulatory requirement imposed by an environmental agency. Landholders create offsets as a means of meeting an environmental obligation. For example, the Western Arnhem Land Fire Abatement program is a partnership between Darwin Liquefied Natural Gas (DLNG), the Northern Territory Government, the Northern Land Council and relevant Aboriginal Traditional Owners and indigenous representative organisations. The program aims to implement strategic fire management across 28,000 km² of Western Arnhem Land for the purposes of offsetting some of the greenhouse gas emissions from the Liquefied Natural Gas plant at Wickham Point in Darwin Harbour. Other examples include the South Australian Biodiversity Offset Scheme that allowed landholders to undertake a management plan for the conservation or enhancement of biodiversity assets on their property, as an alternative to paying an environmental levy. Landholders establish offset credits on their property, which may be registered and sold to developers wishing to meet their own obligations. The Victorian BushBroker program involves landholders establishing native vegetation credits by revegetation, improving the management of existing vegetation, or by protecting old trees.

Conclusion

Retaining native vegetation is an important first step, but it is also vital that retained vegetated areas are managed to maintain their conservation values. Successful management of native vegetation relies upon employing a range of techniques to protect and enhance the values of the patch. Management of native vegetation should be seen as a priority for effective land management, and there are a range of incentives to encourage land owners to manage native vegetation for the conservation of biodiversity.
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Appendix 1. Native vegetation policies and regulations in Australian jurisdictions

Commonwealth

Environment Protection and Biodiversity Act 1999

The Commonwealth’s Environment Protection and Biodiversity Act 1999 (EPBC Act) provides a national framework for environmental protection, particularly matters of national significance. The EPBC Act promotes the conservation of biodiversity including native vegetation by providing strong protection for matters of national environmental significance. It provides for: the identification of key threatening processes; the protection of critical habitat; the preparation of recovery plans; threat abatement plans; wildlife conservation plans; bioregional plans; and conservation agreements; and the issuing of conservation orders. A number of threatened native vegetation communities have been identified for protection under the Act. In April 2001 the Commonwealth also listed land clearance as a key threatening process under the Act, in view of the evidence that land clearing has been the most significant threatening process in Australia since European settlement. If land clearing is not controlled it will lead to additional species and ecological communities becoming threatened.

National Framework for the management and monitoring of Australia's native vegetation (2001)

The National Framework for the Management and Monitoring of Australia's Native Vegetation, an initiative of the former Australian and New Zealand Environment and Conservation Council (ANZECC), provides a vehicle through which to implement this goal in a unified and consistent manner, against an agreed framework of best practice management and monitoring measures. Primary Industries, Natural Resources, Environment and Water Ministers from across Australia met jointly for the first time in Canberra on 31 August 2001 to consider the way forward on Australia's pressing natural resource management issues. One of the first actions taken by the new Natural Resource Management Ministerial Council (NRMMC) was to adopt the National Framework for the Management and Monitoring of Australia's Native Vegetation. The native vegetation outcomes being sought in the Framework are:

a) Reversal in the long-term decline in the extent and quality of Australia’s native vegetation cover by:

b) conserving native vegetation, and substantially reducing land clearing; conserving Australia’s biodiversity;

c) and restoring, by means of substantially increased revegetation, the environmental values and productive capacity of Australia’s degraded land and water;

d) Conservation and, where appropriate, restoration of native vegetation to maintain and enhance biodiversity, protect water quality and conserve soil resources, including on private managed land for agriculture, forestry and urban development;

e) Retention and enhancement of biodiversity and native vegetation at both regional and national levels; and

f) an improvement in the condition of existing native vegetation.
New South Wales

*Native Vegetation Act 2003*

Under the New South Wales *Native Vegetation Act 2003*, clearing of native vegetation is only permitted if it improves or maintains environmental outcomes. Landholders may apply to their local Catchment Management Authority either to prepare a Property Vegetation Plan (PVP) or make an application for Development Consent. Under a PVP, a proponent may propose to offset losses with commensurate long-term gains from revegetation or management. Offsets are not available under Development Consent, so the clearing must itself improve or maintain environmental outcomes. Some clearing can not be offset, and is therefore not permitted (e.g. clearing of overcleared native vegetation unless it is in low condition, clearing of Ramsar wetlands, clearing of threatened species which cannot sustain a loss in the local area, clearing where it would create a high salinity or land degradation risk). Overcleared vegetation includes native vegetation that is a type that has been more than 70% cleared and is not in low condition. Assessment of environmental outcomes is done using complex decision support software to weigh up contributing factors. Methodology for assessing environmental outcomes is available at [http://www.nativevegetation.nsw.gov.au/methodology/index.shtml](http://www.nativevegetation.nsw.gov.au/methodology/index.shtml).

Queensland

*Integrated Planning Act 1997, Vegetation Management Act 1999*

In Queensland, permits for broadscale land clearing are no longer issued. However, permits to clear native vegetation may still be obtained for a limited range of purposes, including fodder harvesting, creating firebreaks, and the building of infrastructure. Applications to clear native vegetation are assessed according to the remaining extent of the affected vegetation types, the purpose for which clearing is requested, and whether adequate measures are proposed to mitigate the environmental impacts of the clearing. Remnant vegetation types are classified as: *endangered* if less than 10% per of the pre-clearing extent remains, or 10–30% of the pre-clearing extent remains if the total area of the vegetation type is less than 10,000 ha; *of concern* if 10–30% of the pre-clearing extent remains, or more than 30% of the pre-clearing extent remains if the total area is less than 10,000 ha; or *not of concern* if more than 30% of the pre-clearing extent remains and the total area is more than 10,000 ha. Regional vegetation management codes have been developed that specify acceptable mitigation measures in that region for each of the allowable purposes for clearing (Department of Natural Resources and Water 2006). For example, an application to harvest fodder in the brigalow region may only occur in 7 specified vegetation types, and may not occur in or near a wetland, watercourse or essential habitat, or on steep or erodible land. The fodder collection may only be carried out in a way that maintains connectivity to any remnant vegetation in adjoining lots, and occurs in blocks or narrow strips such that at least 5 ha of vegetation in any 9 ha area is retained.
South Australia


In South Australia, permits are required for clearing any native vegetation except in a few very specific circumstances. The Native Vegetation Council (NVC) assesses applications for clearance against principles set out in the Native Vegetation Act 1991. Broadly, these are that clearing is not permitted if native vegetation provides significant habitat or diversity of plant species; is a rare, vulnerable or endangered species; is in a wetland environment; is a significant remnant in an area already cleared to a significant extent or if clearing would contribute to soil erosion or salinity or a deterioration in surface or underground water quality. They cannot give consent to the clearance of an 'intact stratum' of native vegetation, unless the landholder can provide a compensating significant environmental benefit, such as fencing, destocking and management of remnant bushland on the property, or revegetation of cleared areas. Most applications concern clearing of scattered paddock trees in areas that are already extensively cleared. The applicant identifies the area they wish to clear and the area where offsets can occur. The NVC has a system for scoring the habitat value of these trees and determining a suitable amount of offset which takes into account how extensively vegetation has already been cleared in that area. Vegetation with an intact stratum may not be cleared.

Tasmania

Forest Practices Act 1985

In Tasmania, government regulation of native vegetation clearing applies only to forested areas and to threatened plant communities, and is managed by the Forest Practices Authority. Threatened native vegetation includes plant communities that have been assessed and gazetted as rare (a total range of less than 1,000 hectares), vulnerable (70% of original area cleared), and endangered (90% of original area cleared). An approved Forest Practices Plan (FPP) is required to clear or convert a threatened plant community or to clear forested areas. FPPs must adhere to the Forest Practices Code (Forest Practices Board 2000), which describes measures to minimise environmental damage during forestry operations. These measures include avoiding logging on erodible soils and in steep areas, buffering watercourses, retaining wildlife habitat strips, and minimising damage to areas of vegetation of particular significance for maintaining biodiversity (e.g. knolls, heath, stream banks). Forest Practise Plans are developed and certified on behalf of the proponent by authorised Forest Practices Officers who have been trained by (but are not in the employ of) the Forest Practices Authority. The NHT Bilateral Agreement includes a requirement that a proponent seeking to clear or convert a threatened plant community must demonstrate exceptional circumstances (e.g. if clearing would provide particular economic benefit; or if the patch of plant community is seriously degraded). They will also usually be required to offset the loss by protecting an area of that vegetation type. The usual offset ratio is for five times as much area to be protected as that being removed. Proponents must also adhere to other regulations, including those imposed by the Regional Forest Agreement (RFA). There is a requirement under the RFA that no more than 5% of forested area as mapped in 1997 can be cleared, and that no more than 50% of each non-threatened forest type can be cleared in each bioregion.
Victoria

*Planning and Environment Act 1987*

In Victoria, a planning permit is required to remove, destroy or lop native vegetation. Local councils are responsible for deciding permit applications, except in some specific circumstances. Assessment of clearing applications includes consideration of the conservation status of affected vegetation. Threatened vegetation types are recognised according to their remaining extent and condition in that bioregion. Broadly, *Endangered* status is accorded if less than 10% of pre-European extent remains, *Vulnerable* if 10-30% remains, or *Depleted* where 30-50% remains. These thresholds are raised if the remaining vegetation is in poor condition (a vegetation type that is severely degraded over the majority of its range will still be declared *Vulnerable* even if more than 50% of its original extent remains). In most cases, the clearing of any native vegetation must be offset by a gain elsewhere. Offsets are permanently protected and linked to a particular clearing site.

In areas of high development pressure, Precinct Plans aim to manage the conservation of native vegetation in a larger predetermined area rather than on an ad hoc site-by-site basis. They specify the native vegetation that can be removed and retained, based on the conservation significance and land protection role of the vegetation. Once approved by the minister, precinct plans are incorporated into the planning scheme. At the property scale, a landholder can develop a Property Vegetation Plan (PVP) which identifies any native vegetation that may be removed and any offset arrangements over a ten year period. It also identifies areas that may attract government incentives for better management of native vegetation. At the catchment scale, Catchment Management Authorities can develop *Regional Native Vegetation Plans* that identify priorities for native vegetation in their region. Priorities can include targets for permanent protection of existing vegetation and restoration of degraded vegetation types. While priorities and targets may be identified in these plans, they are not bound in legislation.

Western Australia

*Environmental Protection Act 1986*

In Western Australia, permits are required for clearing any native vegetation except in a few specific circumstances. In determining whether to issue a land clearing permit, the Department of Environment (DoE) must consider ten principles related to native vegetation in the *Environmental Protection Act* which provide a guide for when native vegetation should not be cleared, which consider biodiversity, land degradation and water quality. Clearing is not permitted if native vegetation provides significant habitat or diversity of plant species; is a rare, vulnerable or endangered species; is in a wetland environment; is a significant remnant in an area already cleared to a significant extent, or if clearing would contribute to soil erosion or salinity or deterioration in surface or underground water quality. Proposals to clear are expected to demonstrate that they will not reduce vegetation types or total vegetation cover below 30% of the original extent in that bioregion or local area, or, if they will breach this threshold, that they will provide offsets such that there is an net environmental gain. It is recognised that in some areas deep-rooted vegetation cover needs to be retained at levels nearer to 50-85% to maintain hydrological processes and avoid land salinisation. DoE have internal guidelines and tools for assessing applications to clear that include how to determine whether the proposal is at variance with the ten principles, ways to modify clearing proposals to minimise their
environmental impacts (e.g. buffers, corridors, avoiding erodible soils), and how to calculate a suitable offset. These guidelines are not publicly available at present.